201617
ANNUAL REPORT

LSTM
LIVERPOOL SCHOOL
OF TROPICAL MEDICINE

Contents

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

Dr Amuam Andrew Beng and Agbor Emilia from the COU**NTD**OWN team in Buea, South West Cameroon, count and dissect blackflies to look for Onchocerca volvulus larvae in the Meme River Basin, South West Cameroon. The black fly is the vector that transmits onchocerciasis (river blindness). LSTM is a partner in, and hosts, the COU**NTD**OWN consortium.

Chairman's Foreword

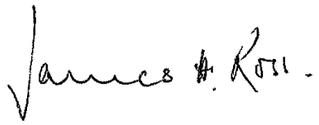
Looking back on the year 2016/17, it marks a significant step in the development of LSTM. We have continued to grow as a research centre and are benefitting from being a higher education institution in our own right. We have now been granted degree awarding powers to underpin the growth of our teaching and learning activities.

But we are not just looking back on past achievements – we are carefully planning for future success. We have articulated our strategy through to 2023 with its three goals. They are firstly to strengthen the translational activities of LSTM; this simply means being able to demonstrate the beneficial impact of the research and teaching of LSTM in resource poor countries where we aim to save lives. Secondly, the goal is to expand our teaching portfolio. Teaching has sometimes been seen to be the poor cousin of research; this is no longer the case, as LSTM invests in the vital task of equipping future generations to continue the battle to defeat tropical diseases. Thirdly we are planning for growth. As an organisation whose strength is its people, that means initially managing a generational change in the most senior executives of LSTM.

Janet Hemingway has started the process by asking the Board of Trustees to find her successor as Director. Fortunately, she is not going anywhere, so we will continue to benefit from her professional and personal experience. Janet has led the most remarkable turnaround and growth in the fortunes of LSTM since 2001. Her outstanding leadership has been pivotal in all that LSTM has achieved and the organisation and those that have worked in and with it, owe her a great debt.

In finding her successor, I have the benefit of the international reputation of LSTM and of the strength of its people, its research and teaching portfolio and its balance sheet. Moreover, the Board has been reinforced by the appointment of Jon Schofield as Vice Chair and as Honorary Treasurer and by the recruitment of three new trustees – Sue Russell, Eileen Thornton and John O'Brien. We have our work cut out to find a worthy successor to Janet but I am confident that the quality of LSTM will attract outstanding individuals.

I would like to thank everyone at LSTM, staff, students and trustees alike, for their contribution to the success of 2016-17 and to the preparations for the future.



James Ross OBE
Chairman

"Janet has led the most remarkable turnaround and growth in the fortunes of LSTM since 2001. Her outstanding leadership has been pivotal in all that LSTM has achieved and the organisation and those that have worked in and with it, owe her a great debt."

LSTM Annual Report 2016-17

Director's Foreword

This year will be seen as a significant one in LSTM's history. In August 2017, we were awarded our own teaching and research degree awarding powers. An essential step to underpin our intentions of radically changing what, how and where we teach. We will combine the strength and depth of LSTM's operational experience in Global Health with state of the art technology and the best in learning and teaching practice to provide a better, more extensive and more accessible portfolio of credit bearing courses.

This emphasis on learning and teaching is evident in our new Strategic Plan, which takes LSTM up to its 125th anniversary in 2023. The plan emphasises the step change that we anticipate in impact, through our translational research agenda. Key supporting elements of this are already in place. We have launched CEIDR (the Centre of Excellence in Infectious Diseases Research), an initiative with the University of Liverpool. It will soon have senior staff joining, to strengthen our links with commercial partners, alongside a growing portfolio of pilot projects with a range of stakeholders.

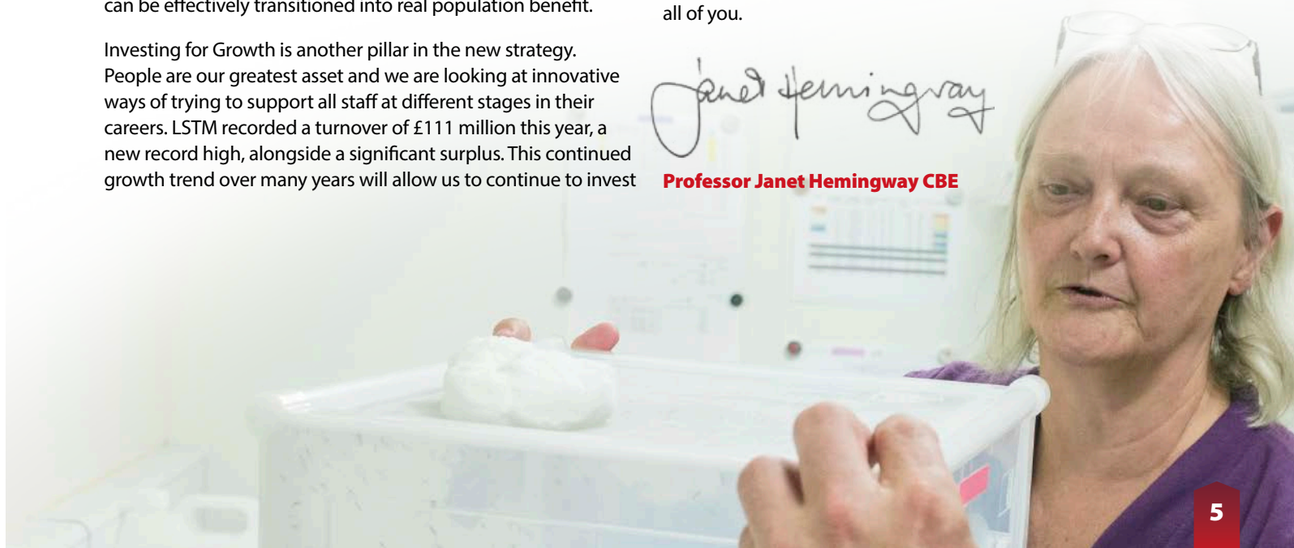
The new Accelerator building will be formally opened in January 2018, housing LSTM's antimicrobial and insect vector activities, in a format that is more easily accessible to industrial collaborators. In a single location at the heart of the city's Knowledge Quarter, three floors are available for SMEs and commercial partners, bringing them into proximity with the NHS and LSTM's research and commercial development activities.

The Liverpool City Region has also highlighted Infection as one of three pillars of research excellence on which the region will build over the coming years. This alignment of agendas and facilities should act synergistically to ensure that our research can be effectively transitioned into real population benefit.

Investing for Growth is another pillar in the new strategy. People are our greatest asset and we are looking at innovative ways of trying to support all staff at different stages in their careers. LSTM recorded a turnover of £111 million this year, a new record high, alongside a significant surplus. This continued growth trend over many years will allow us to continue to invest in people, facilities and capability development. It also signals an appropriate timeline for starting the generational change in LSTM's senior management.

After 17 years in charge of LSTM I have asked the Board to start the search for my successor. This should allow for an orderly transition of leadership, at a time when LSTM is in a great place and has enormous potential for future growth. Personally, this is a change in direction for me, rather than a prelude to retirement, and I look forward to continuing to make a contribution to infectious diseases research. As this may however be my last foreword to an LSTM Annual Report, I do want to take the opportunity to thank the numerous people who have made LSTM the great institution that it is today. The Senior Team, most of whom started this journey with me back in 2000, and have always been prepared to go the extra mile. The Board of Trustees who have freely given up so much of their time and energy to ensure that we have excellent governance. LSTM staff, who really do come to work here knowing that what they do makes a difference to so many throughout the world. And our many students, collaborators, funders and other stakeholders, who make up an astonishing global network supporting us in our mission of improving health for those who need it most. It has been a pleasure and a privilege to work with all of you.

Professor Janet Hemingway CBE

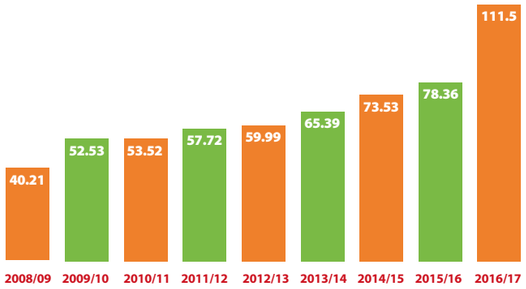


Treasurer's Report

For the ninth successive year the LSTM Group is able to report a record level of income. The reported total income exceeded £100m for the first time in LSTM's history. The total surplus for the year was £5.7m and Group net assets at the year-end were £46m.

Group income totalled £111m. This included £21m of 'gifts in kind' which were mosquito nets used for an effectiveness study in Uganda. Excluding the gifts in kind, the Group reported total income of £90m, which represented a 15% increase over the previous year. The increase in income was used to increase our expenditure on research and academic activities.

Total Group Income (£'m)



Our operating surplus for the year was £1.5m which we view as satisfactory. This is the figure that we use to assess LSTM's operational financial performance.

The increase to a total surplus of £5.7m resulted primarily from favourable movements on our investment portfolio. Whilst we are delighted that our portfolio went up in value, we are also aware that investments can go down as well as up.

Group net assets at the year-end totalled £46m. Excluding deferred capital grants of £24m, which are unlikely ever to be repaid, net assets totalled £70m. LSTM's financial condition remains healthy.

Equally important is the pipeline of research projects. At the year end, I am pleased to report that LSTM still had secured research contracts of £188m which have yet to be spent.

Looking ahead, following the granting of degree awarding powers, we are expanding our investment in educational activities and expect to see good growth in this area over the coming years.

Underpinning the LSTM's activity is the continuing investment in our Estates to accommodate future growth plans. During the year we acquired another site on Pembroke Place and following the year-end we have taken occupation of two floors of the Accelerator Building in a partnership with The Royal Liverpool Hospital Trust.

Jon Schofield

Jon Schofield BA ACA

Find throughout this Annual Report testimonials from LSTM scholarship recipients:

> *The scholarship has been a great benefit to me. It has given me access to a course that would have been quite expensive without it.*
>
> ***- Courtenay Greaves (UK), Merit Scholar, MSc Biology and Control of Parasites and Disease Vectors***

LSTM Annual Report 2016-17

Introduction to the Feature Articles

Throughout its history LSTM always had a strong translational element to its research activities. As a medium sized research-led institution, LSTM needs to continue to build on its strengths, periodically assessing whether new areas should be added to our research portfolio, or whether non-competitive areas should be dropped.

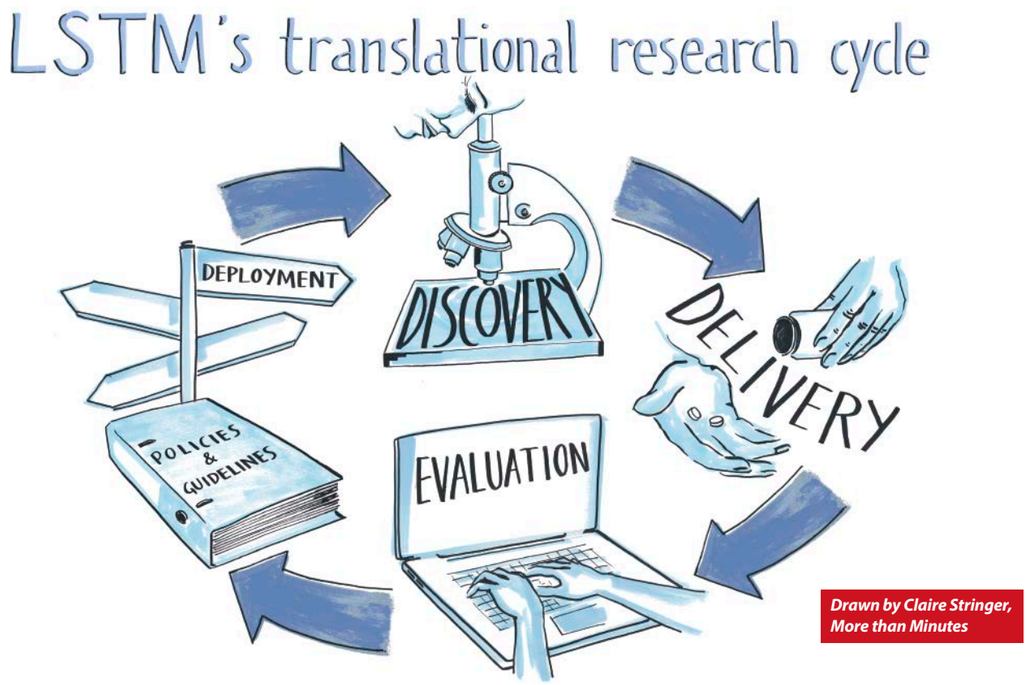
With our new Strategic Plan 2017/23 now in place we will increase our activities in the evaluation (T3) and deployment (T4) areas of the translational research cycle, building on and complementing our traditional strengths in the discovery (T1) and delivery (T2) space.

This approach embraces all LSTM research areas, while aiming to align our research portfolio with global infection priorities. The phenomenon of resistance specifically intersects across all areas of infectious disease and we need to ensure that our footprint in this area, especially with respect to antimicrobial resistance (AMR), becomes increasingly visible externally building on recent successful initiatives implemented during 2017.

In doing this we will drive genuine interdisciplinary activities that are capable of accelerating our research output into health impact, forging global partnerships with multiple stakeholders from academia, government and non-governmental organisations and industry.

The following feature articles and departmental updates highlight how, in the past academic year, we have implemented this translational pathway approach to develop products; improve treatments and practices and implement policies to break the cycle of poor health and poverty.

Professor Steve Ward, Deputy director LSTM



Drawn by Claire Stringer, More than Minutes

FEATURE ARTICLE

Neglected Tropical Diseases

Neglected Tropical Diseases (NTDs) have continued to make headlines both within and outside LSTM over the past year. LSTM was involved in the organisation of the first Global NTD Summit, which was held in Geneva in April 2017 where the progress in NTDs since the 2012 London Declaration was celebrated.

The summit commenced with a one day WHO meeting in the WHO Executive Boardroom chaired by the then Director General, Margaret Chan, and attended by several leaders in the field including Bill Gates and Kofi Annan and NTD Stakeholders representing the diverse NTD community. The meeting heard the progress made over the past 5 years and many key partners reiterated their commitments and new donations and resources were pledged. The WHO meeting was followed by 3 days of NTD technical groups and partnership meetings, which included the Global Alliance to Eliminate Lymphatic Filariasis (GAELF), its Secretariat being based at LSTM. The week provided an ideal environment for networking, cross disciplinary discussions and formal scientific presentations, allowing the next generation of NTD researchers to forge the necessary links and meet scientists and practitioners from endemic countries. Topics were followed up on during the World Health Assembly meeting in May and the World Health Summit in October. LSTM's diverse portfolio of NTD research and implementation activities is a prime example of the multi-disciplinary approaches needed to address the broad range of challenges NTDs face. LSTM embraces the full spectrum of translational research from basic research to implementation, together with advocacy promoting changes in NTD policy and practice.

Cameroonian blackflies, the vectors for onchocerciasis

The NTD summit was preceded by the announcement by the UK Department for International Development (DFID) committing significantly increased support for NTDs, an endorsement of the impact of NTD programmes and a recognition that such programmes embrace the key objectives of DFID policy. They address a major cause of poverty, provide value for money interventions, disability alleviation through wide ranging effective partnerships underpinned by measurable results. This increased DFID support has resulted in LSTM's Centre for Neglected Tropical Diseases (CNTD) long term lymphatic filariasis (LF) programme being awarded an extension to 2019 after receiving the highest A* rating by DFID. The same accolade was also accorded to the COU**NTD**OWN implementation research programme working in partnership with Ghana, Cameroon, Nigeria and Liberia to increase knowledge and evidence for cost-effective scale-up and sustainable control and elimination of NTDs.

LSTM Professor David Molyneux at the World Health Assembly in Geneva

With DFID, The End Fund and GSK as funders, CNTD's LF Elimination Programme supports national NTD programmes in 12 countries in sub-Saharan Africa and Asia to deliver treatments for lymphatic filariasis through mass drug administration (MDA) and providing care to those suffering from the disease. Since 2009, more than 238 million people have been treated with preventive chemotherapy and since the commencement of the morbidity management and disability prevention component of the programme in 2015, 12,400 men have had surgery to treat hydrocele and 12,457 doctors, nurses and community care workers have been trained to treat and support patients with lymphoedema. The Programme is beginning to scale-down MDA activities in many countries with increased surveillance and monitoring of programmatic endpoints. Countries that are continuing with MDA treatments are all on track to scale down and impact surveys show clear evidence of reductions in infection rates and that MDA's will progressively scale down and end treatment programmes in parallel with increased provision of morbidity management and surgery. Successful programmes in Bangladesh, Zambia and Mozambique demonstrate the real impact of CNTD in partnership with Ministries of Health and other international partners over several years. Partnership between LSTM and Sightsavers has delivered important advances in Nigeria on the problem of urban LF where DFID support to Sightsavers for NTD implementation has linked COU**NTD**OWN's implementation research with Advisory Group meetings with Nigerian colleagues.

The LSTM NTDs group has been active in providing regular information to the NTD community through targeted communications and social media to some 2000 individuals and organisations. This is linked closely to other LSTM communicators such as the COU**NTD**OWN programme, CNTD and externally with other partner organisations, which are supported through LSTM NTDs notably the International Society for NTDs (ISNTD), InfoNTD, and NTD News for Africa. Our links with the ISNTD has provided a platform for LSTM speakers as have the links with the British Society for Parasitology (BSP) and the Royal Society of Tropical Medicine and Hygiene (RSTMH), which have included NTDs as one of their focus priorities in their new strategy.

LSTM's Dr Rob Harrison with former UN Secreatry General Kofi Annan

A unique component of the LSTM NTD portfolio is the public health, therapeutic research and advocacy activity focused upon tropical snakebite. Thus, for the first time the Kofi Annan Foundation has highlighted the neglect of African snakebite victims and Dr Rob Harrison was invited to chair a conference tasked with identifying priority interventions to reduce snakebite disease burden in Africa. A major outcome was Mr Kofi Annan's announcement that he would use his personal and institutional advocacy reach to raise awareness of the public health importance of snakebite and need for investment. This was followed by the WHO's re-classification of snakebite as a priority Neglected Tropical Disease and the establishment of a 'WHO Working group on Snakebite Envenoming'. The Lillian Lincoln Foundation 'Minutes to Die' documentary, which features LSTM's activity in Kenya and UK, adds a powerful, far-reaching media advocacy component highlighting the medical and societal challenges of rural, tropical snakebite. Perhaps linked to these advocacy gains, LSTM has benefitted from an upward trajectory in substantive UK government investment via NIHR and MRC grants to major projects in sub-Saharan Africa and Sri Lanka which gather data to design effective, affordable, culturally-achievable interventions to reduce snakebite deaths and disability.


Blackfly larvae from Big Massaka, South West Cameroon

At the discovery and development end of our translational research activities the A·WOL Consortium has continued to advance its drug discovery work with several new potential drugs being identified for macrofilaricidal treatment of LF and onchocerciasis (river blindness) reducing treatment duration from 4-6 weeks with the current drug doxycycline to regimens of a week or less. Joint appointments between the Vector Biology and Parasitology departments link work on visceral leishmaniasis and sleeping sickness vector control of sandflies in India and tsetse flies in several African countries to form a major platform for the elimination of these NTDs. Significant progress has been reported by WHO as the numbers of cases of both infections decline to historically low levels. Studies on cutaneous leishmaniasis have focussed on work in conflict areas of the Middle East and recent work has highlighted the huge discrepancy in reported prevalence of this condition as reported in Global Disease Burden studies as well as the significant mental health co-morbidities associated with this disease as well as other NTDs.


A patient taking his doxycycline

LSTM continues to be a major global player in its NTD research whilst working with partners in many countries to assist in programme implementation and strengthen local capacity. Recognising that NTDs are part of the health targets of the UN Sustainable Development Goals interfacing with many of the non-health Goals such as Poverty Alleviation, Water and Sanitation, Gender and Equity, Education, Food Security, Environment and Climate Change and Partnerships.

The role of NTDs as a core LSTM theme reflects the wider impact of our work as Universal Health Coverage (UHC) becomes a priority message of the new Director General of WHO. NTD programmes are now reaching around one billion people each year with donated medicines, a significant contribution to the delivery of UHC.

> *This scholarship had a critical role in making me choose LSTM for my academic career as a global health specialist.*
>
> ***-Oh Kyoung Kyun (South Korea), Merit Scholar, MSc Biology and Control of Parasites and Disease Vectors***

Department of Parasitology

The Department of Parasitology continues to lead internationally renowned research on the key tropical parasites, snakebite and antimicrobial resistance. Its research into new therapies, implementing alternative intervention strategies and disease surveillance policies have had a positive impact on the health of hundreds of millions of people in lower and middle-income countries.


Professor Mark Taylor - Head of Parasitology

Malaria

Following a five-year study, Professor Alister Craig's group have shown that parasites taken from children with cerebral malaria, a syndrome of severe malaria with 15% mortality, are able to sequester at higher levels in brain vessels than isolates sampled from children with uncomplicated malaria. This fits with the relatively low frequency of severe malaria (2-3% of infections) and suggests that parasite variants have acquired the ability to bind in the brain and thereby cause cerebral complications.

Dr Britta Urban's group studies the role of the Plasmodium falciparum erythrocyte membrane protein 1 (PfEMP1) in mediating this pathology and evading immune responses due to antigenic variation. They have identified cross-reactive antibodies against 'pathological' PfEMP1 variants and are investigating how these could be exploited in therapeutic and preventative interventions. Dr Ian Hastings' simulation group received renewed funding this year to continue work on understanding the impact of drug- and insecticide-resistance on malaria treatment and control.

Drugs & Biologics as new therapies

There has been significant progress made on several drug discovery projects over the past year. In particular, the A·WOL consortium has candidate selected AWZ1066S, a totally novel macofilaricide chemotype that targets the endosymbiont Wolbachia within the filarial parasite. This molecule originates from a series that emerged from a very early in vitro screen in the Bill and Melinda Gates Foundation (BMGF) funded A·WOL programme lead by Professors Mark Taylor and Steve Ward. Through meticulous medicinal chemistry strategies, in partnership with Professor Paul O'Neill (University of Liverpool), the original lead has been optimized to have high metabolic stability in man and very high potency at killing Wolbachia. These combined features have generated a drug that is predicted to be effective in a seven day or less treatment in patients - the key characteristic of current macrofilaricide Target Product Profiles. This molecule has been through a battery of safety pharmacology studies without cause for concern and is about to enter forma pre-clinical evaluation. Although we do not yet fully understand how this drug works, it kills Wolbachia significantly faster than any other anti-wolbachial macrofilaricide studied to date. This project has attracted the interest of a number of pharmaceutical companies and we have entered into a collaboration with Eisai Pharma of Japan, to guide this drug through to a full international registration over the next few years.

A·WOL
ANTI-WOLBACHIA CONSORTIUM

Drug discovery projects lead by Professor Giancarlo Biagini for tuberculosis (TB) have identified a new combination therapy targeting the respiratory chain of Mycobacterium tuberculosis (Mtb), the causative agent of TB. This work is currently progressing in collaboration with the TB Alliance (TB), testing novel combinations in both acute and chronic infection. New tools are constantly being developed to accelerate and de-risk the drug development pipeline, and this year the group published a pre-clinical imaging-based method that measures the drug response of Mtb residing inside human macrophages. This approach is now being used to determine how to optimise treatment of drug resistant TB and is also being expanded to include co-infection models.

Dr Adam Roberts has established his lab in the new Accelerator Life Sciences building and secured funding from the MRC to investigate the biological costs associated with emergence of resistance in Klebsiella pneumoniae strains from Malawi. His antimicrobial resistance (AMR) work has rapidly integrated into a range of research and public engagement activities across LSTM.


Confocal laser scanning image of TB and HIV-1 coinfection in microphages. Red (TB) green (HIV) and blue (macrophage)

This year LSTM established a scientific computing group, led by Dr Simon Wagstaff, that provides oversight and LSTM wide support for all aspects of data management and analysis. The group have been active in developing new infrastructure, data management pipelines and policies to support all aspects of public health, clinical, laboratory, field-based and theoretical studies.


Dr Adam Roberts

Professor Richard Pleass's work on hexa-Fc antibody technology for vaccine/diagnostic development has been funded by Innovate UK to develop adjuvant free vaccines and companion diagnostics to control emerging flaviviruses, including ZIKV, dengue and JEV, but also for less well known flaviviruses e.g. Aroa, Spondweni, and Entebbe bat, that may be the cause of future emerging disease foci in endemic countries.

The Alistair Reid Venom Research Unit (ARVRU) led by Dr Rob Harrison was awarded £0.5m from The Global Challenge Research Fund (MRC) for Professor Lalloo's 'Health in a changing climate: snake bite in South Asia' project. Also, the National Institute of Health Research awarded £2m to Dr Harrison and Professor Lalloo's 'African Snakebite Research Group' to undertake diverse and inter-locking clinical, diagnostic and socioeconomic research studies with collaborating units in Nigeria, Cameroon and Kenya (Snakebite Research and Intervention Centres, SRICs). These advances have been matched by the ARVRU's lab-based innovative therapeutic research, led by Dr Nick Casewell, which has delivered invigorating progress on the translation-potential of re-purposed enzyme inhibitors for treating snake venom-induced, on devising new technical strategies for treating venom- and bacteria-induced tissue destruction and on the development of new, more appropriate ocular and tissue models of snake envenoming.

Parasitology in the field

Implementing alternative strategies

As part of the COU**NTD**OWN consortium, Dr Joe Turner, Dr Louise Hamill and Professor Mark Taylor are collaborating with Professor Samuel Wanji's group at The University of Buea, Cameroon, to assess the impact of implementing test-and-treat with doxycycline for the control of onchocerciasis (river blindness). The team is simultaneously comparing the effectiveness of integrating insecticide-based suppression of blackfly, the vectors of onchocerciasis. Throughout 2017, baseline data has been collected which has revealed higher than predicted prevalence of onchocerciasis (>70% in certain communities) and identified a high transmission potential in blackflies in the Meme river basin, South West Cameroon. Blackfly larvae have been tested for susceptibility to insecticide and shown to be highly sensitive. Some 200,000 doxycycline tablets have been shipped from LSTM and have begun to be distributed to a population of 6,000 patients in twenty communities in the Meme river basin. Doxycycline treatments will dovetail with focal suppression of blackfly with insecticide spraying set to commence in November.

Monitoring & surveillance

Professor Russ Stothard and Dr Michelle Stanton are evaluating statistical sampling frameworks and DNA diagnostic methods for detection of schistosome infection in snails, as well as, environmental water samples infested with parasite larvae.

COUNTDOWN
Calling time on Neglected Tropical Diseases

New evidence is starting to be assembled into revised disease surveillance policies, especially where ongoing control is progressing towards near 'end game' scenarios, where infections in people become increasing difficult to detect. Schistosomiasis surveillance of key transmission foci continues in Uganda, alongside introduction of host-morbidity metrics with recent epidemiological investigations in primary school children including 20m shuttle runs as a measurement of physical fitness.


Primary school children shuttle runs as a measurement of the impact of parasites on physical fitness

Preliminary analysis reveals correlates of aerobic performance with anaemia and parasitic disease aetiology, some of which can be reversed with anti-parasitic treatment. Dr Emily Adams and her group are expanding diagnostic evaluation of visceral leishmaniasis elimination in India. Novel diagnostics are being used to detect outbreaks and follow-up of cases to prevent onwards transmission in these elimination zones. Dr Alvaro Acosta-Serrano's lab has recently discovered and characterised a new family of invariant proteins named MISP that is exclusively expressed by the infectious form of African trypanosomes that is transmitted by the tsetse flies. MISP proteins can be exploited for the development of a transmission-blocking vaccine against trypanosomiasis and as xenodiagnosis makers for determining the percentage of flies carrying infectious trypanosomes in endemic areas of sub-Saharan Africa.

Impact of implementation - Centre for Neglected Tropical Disease

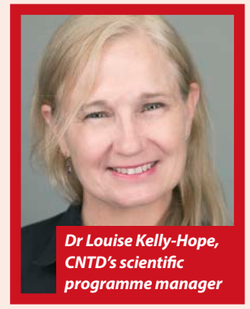
CENTRE FOR NEGLECTED TROPICAL DISEASES

With funding from DFID, The End Fund and Glaxo Smith Kline (GSK), CNTD's LF Elimination Programme supports national NTD programmes in 12 countries in sub-Saharan Africa and Asia to deliver treatments for lymphatic filariasis through mass drug administration and provide care to those suffering from the disease.

Since CNTD started the LF Elimination Programme in 2009, more than 238 million people have been treated with preventive chemotherapy and since the commencement of the morbidity management and disability prevention component of the programme in 2015, 12,400 men have had surgery to treat hydrocele and 12,457 doctors, nurses and community care workers have been trained to treat and support patients with lymphoedema. In 2017, DFID increased its commitment to CNTD with a continuation of funding until 2019.

The Programme now shows a scale-down of MDA and an increase in surveillance and transmission assessment surveys. Countries that are continuing with MDA treatments are all on track to scale down and impact surveys show clear evidence of reductions in infection rates and that MDAs will progressively scale down and end. Bangladesh had one of the highest burdens of LF at the start of the GPELF with an estimated 70 million people at risk. With the support of CNTD, it has conducted the largest scale up of surveillance reported in any of the 73 LF endemic countries in the world and is now considered to have very low or no risk of LF infection and is on track to meet elimination targets. Zambia, with an LF programme wholly funded by CNTD/DFID is showing a significant decline in LF and has progressed to pre-surveillance after only three rounds of MDA. Mozambique will scale down MDA, after successfully passing transmission surveillance. A further eight countries are now implementing and scaling up morbidity management activities.


Sian Freer, CNTD's Chief Operating Officer


Dr Louise Kelly-Hope, CNTD's scientific programme manager


LF patients

> *It opened a great opportunity for me to study. It has made me realize my potential in this field and open my mind to opportunities.*
>
> ***- Nelly Dindi (Kenya), Thomas Mark Scholar, MSc Tropical Paediatrics***

FEATURE ARTICLE

Resistance Research & Management

The global threat posed by the rapid emergence of resistance to certain drugs and insecticides remains an area of great concern with lower and middle-income countries (LMIC) facing the biggest challenges. The World Health Organization (WHO) and key national policy makers, such as the UK's Chief Medical Officer Dame Sally Davies, warn that if antibiotics lose their effectiveness it would spell "the end of modern medicine", as routine operations and treatments come under significant threat.

In recent years, the UK has led a drive to raise global awareness of the threat posed to modern medicine by antimicrobial resistance (AMR).

Antimicrobial resistance

In February 2017, Dr Adam Roberts moved from University College London to LSTM. His research group has embarked on a programme of work trying to use evolutionary biology to combat antibiotic resistant pathogens.

Antimicrobial resistance in bacteria is an inevitability; they are experts in adapting to virtually any chemical challenges, such as antibiotics, that people throw at them. Mutations, which arise in their DNA during replication, or acquisition of DNA via horizontal gene transfer, endow them with the ability to resist the antibiotics we use rapidly and pass on this resistance to their offspring. Bacterial cells can take as little as twenty minutes to replicate meaning that an entire population can transition to resistance within hours following a single mutation to resistance. Problems occur when this happens in patients undergoing therapy and when resistant bacteria spread between humans in hospital wards, towns and cities and, due to international travel and other natural processes, between countries.

When a bacterium becomes resistant there is usually a cost. In biology, this means that the bacteria cannot grow quite as fast as they could before they became resistant. This also means that they can't compete well for resources such as nutrients when in direct competition with other strains and is why often resistant strains don't persist in the environment when antibiotic selective pressure is absent. This "biological cost", as it is called, which usually accompanies the acquisition of resistance is a potential Achilles heel in the development of resistance which we can exploit to minimise the persistence of resistance following the cessation of antibiotic therapy.

At LSTM, Dr Roberts' group is determining the cost of resistances which emerge in bacteria in response to treatments in different parts of the world. The drugs which are available in different countries are not the same, equality of medical access and access to medicines is something that Roberts' LSTM colleagues are striving to improve as there is often limited choice of antibiotics in LMICs. Until there is equitable access, the available antibiotics have to be used in the best way to treat disease and to protect society from the emergence of resistant strains.

Bacteria colonies growing on MRSA indicator strain in an LSTM lab

To do this we are determining which antibiotics lead to the highest biological cost in different bacteria when they develop resistance to inform clinicians on the best drugs to use to prevent resistant strains emerging and replacing the susceptible ones. We do this by letting them evolve resistance, determining how they have evolved and how fit they are (how fast they can grow).

If there are multiple resistance mutations or horizontal gene transfer events conferring resistance to multiple antibiotics then we would predict that there would be more cost and the strains would be less fit, however there are instances where multiple mutations leading to resistance to multiple antibiotics lead to fitter strains. This unusual phenomenon of interactions between different resistance mutations is called epistasis and it is what we are looking for when combinations of antibiotics are used. We want to avoid setting bacteria upon an evolutionary path whereby multiple resistances will make them more fit than susceptible ones and if we do find combinations of antibiotics that consistently result in this we would advise against their combinatorial use. Conversely if we find combinations of antibiotics which lead to very unfit strains when resistance develops; this is what we would advise to use in the clinic as any strains which developed resistance would not persist in the environment for long, preserving the useful lifetime of the few antibiotics we currently rely on while we develop new ones.

TRANSPOSON REGISTRY

Transposon Registry

In May 2017, LSTM launched a new Transposon Registry which serves as a repository of information on all bacterial transposons for the scientific community.

A transposon is defined as a specific DNA segment that can repeatedly insert into one or more sites in one or more genomes. They are fundamental to bacterial evolution and as stretches of DNA they can move from one place to another and sometimes between one bacterial cell to another. They often carry genes encoding antimicrobial resistance.

The Transposon Registry, hosted by LSTM and managed by LSTM Senior Lecturer Dr Adam Roberts, assigns transposon (Tn) numbers on request and provides a unique service to academics around the globe investigating aspects of transposon biology. Once a Tn number has been allocated it will be part of the overall searchable repository.

"This kind of registry is an essential reference point for researchers, institutions, industry and scientific journals alike ensuring uniformity and consistency in a rapidly expanding area of scientific investigation", said Dr Adam Roberts. "The functionality and stability of the registry has much improved, ensuring a better service to all involved."

Previously described transposons have been added to the repository and it is envisioned that this will become a central resource of information on transposable elements. The rules governing the requesting of Tn numbers are explained when visiting the Registry, which can be accessed via: **http://transposon.lstmed.ac.uk**.

Since the launch in May 2017, the Registry has already designated more than 40 Tn numbers to the community and been visited more than 310 times (per 1 October 2017).

Research Centre for Drugs & Diagnostics

LSTM's Research Centre for Drugs and Diagnostics (RCDD) focuses on the translational pipeline of discovery through development, evaluation and implementation. This year has seen some key achievements in the field on both the diagnostics as well as on the drug development side.

LSTM
RESEARCH CENTRE FOR DRUGS & DIAGNOSTICS

Diagnostic developments


Dr Emily Adams

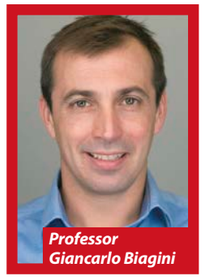
The diagnostic side of RCDD, led by Dr Emily Adams, has expanded its portfolio to include discovery and development of novel antimicrobial resistance (AMR) diagnostics. This includes tests for detecting multi-drug resistant isolates in the UK setting as-well as Malawi and Nepal who have differing antibiotics available for use, and therefore differing resistance patterns. The focus is the development of molecular detection tools that are able to rapidly identify up to 10 markers in 90 minutes with the aim of reducing time to result. Dr Thomas Edwards will be evaluating these tests in the Royal University hospital, Liverpool, and AMR reference centres in Nepal and Malawi over the coming year.

Our TB-Reach project in Nigeria is achieving early success. Professor Luis Cuevas leads the programme in Nigeria and aims to engage private chemists and vendors to identify people with chronic cough and offer them access to modern diagnostics. Early findings of 1700 clients enrolled in 3 months, show that 5% of them have tuberculosis which has doubled the number of cases identified by the health centres. We are planning to expand this approach in the second year of the study due to this success.

RCDD is involved in several projects on emerging threats including Zika and chikungunya. Zika virus has caused hundreds of thousands of infections in 2015-16, as well as many thousands of cases of congenital Zika syndrome (CZS), but there is no vaccine, no treatment and few diagnostics available. Professor Cuevas and Dr Adams are funded by a Zika emergency grant from the MRC to diagnose Zika and other flaviviruses such as dengue and chikungunya in direct from blood molecular assays. Our industrial collaborators, BioGene, and LSTM have co-developed a diagnostic assay for evaluation in Brazil in early 2018.

Professor Richard Pleass is funded on an Innovate UK Vaccines for Global Development Preclinical grant to re-purpose technology for the delivery of flaviviral antigens directly to antigen-presenting cells (APCs), and to develop diagnostic markers and vaccines against flaviviruses such as West Nile and Zika viruses.

Drug developments


Professor Giancarlo Biagini

The drug development side of RCDD, led by Professor Biagini, saw some major results in the past academic year: such as the small molecule TylAMac™, which became the first 'designer drug' candidate to emerge from A•WOL's collaboration with AbbVie and DNDi. It has the potential to provide a safe alternative treatment in areas at risk of Loiasis driven adverse events to ivermectin.

In addition the LSTM hosted A•WOL consortium discovered a clinically safe dose of rifampicin to elicit the same result as the standard 4-6-week doxycycline therapy when administered over just 1-2 weeks. The therapy is also safe for children and pregnant women meaning interventions are more likely to benefit the community as a whole, taking us one step closer to the WHO's ambition to control and eliminate lymphatic filariasis (LF) and onchocerciasis.

The A·WOL drug discovery pipeline was further boosted with a whole-cell screening of 10,000 compounds from the BioFocus Soft Focus® group of compound libraries which identified six new chemical series which could be developed into completely novel anti-Wolbachia drugs that would translate into improved antibiotic treatments for LF and onchocerciasis.

The RCDD antimalarial pipeline generated a further Candidate molecule, E209. This is a fully synthetic endoperoxide (artemisinin-like) drug which was shown in a Nature Communications publication to possess improved drug like features (long-half life) offering the potential to simplify treatment and have activity against current multi-drug resistant malaria parasites.

In the malaria drug development pipeline: the malaria epidemiology group lead by Professor Feiko ter Kuile received a new grant from the Medicines for Malaria Venture (MMV) to investigate the safety of the artemisinin-based combination, dihydroartemisinin-piperaquine in women of child bearing age who are often inadvertently exposed to these antimalarials in early pregnancy before they knew or reported that they were pregnant. The study will be led by LSTM's Indonesia based Dr Rukhsana Ahmed and will be conducted in Papua province where dihydroartemisinin-piperaquine has been the first-line antimalarial in the general population for over a decade. It will use record linkage to link antenatal and birth outcome data with electronic out-patient treatment records.

Tuberculosis (TB) drug development efforts were boosted by the development and validation of a novel in vitro PK-PD (pharmacokinetics-pharmacodynamics) imaging platform that measures the response of macrophage intracellular Mycobacterium tuberculosis (the pathogen causing TB). This new platform was developed via funding from the EU, MRC and WT and will facilitate and accelerate the identification of new therapies and combination therapies that can shorten TB treatment duration, which is typically 6-9 months.

MRC Confidence in Concept

RCDD manages the Medical Research Council (MRC) Confidence in Concept which brings together much of the UK's expertise in tropical infectious diseases into a single translational partnership, known as the Tropical Infectious Disease Consortium. The Consortium is between the Liverpool School of Tropical Medicine (LSTM), the London School of Hygiene and Tropical Medicine (LSHTM), the Jenner Institute at Oxford University and Public Health England, Microbiology Research Services, Porton Down (PHE), and is strategically placed to deliver an unprecedented portfolio of domain specific expertise in all the key research areas of interest.

The consortium was able to attract further funding from the MRC and to date has attracted 125 competitive applications. These are scored by an External Scientific Advisory Committee consisting of international leaders in translational research including vaccine, therapeutics, diagnostics and vector control. The Consortium has funded the top 53 scoring projects, 21 of which have included collaborations within the Consortium, 28 have included partners external to the Consortium, and 37 have involved industrial partners. The funded projects have gone on to lever over £19 million in additional external funding from a variety of sources including RCUK, Wellcome Trust, Bill & Melinda Gates Foundation and industry. These activities demonstrate that RCDD's Tropical Infectious Disease Consortium truly has a UK-wide reach, attracting external industry and academic partners that address important unmet global health needs with innovative translational solutions.

Department of Vector Biology

The research of the department continues to diversify encompassing new disciplines and working with an increasing number of partners as we strive to improve the control of vector borne diseases.

Professor Hilary Ranson - Head of Vector Biology

Exciting new developments in the past 12 months have included a dramatic expansion of our facilities with the construction of the Liverpool Life Sciences Accelerator building and the establishment of malaria infections in our existing Category 3 facility, and successful applications to the UK Government's new Global Challenge Research Fund.

An expansion in facilities and disciplines

In October 2017 we moved into purpose built new laboratory and insectary space on the 4th floor of the Liverpool Life Sciences Accelerator building. This world class facility contains seven large insectaries, bespoke insecticide testing laboratories and rooms for using state of the art tracking systems for measuring vector behavior, greatly expanding our capacity for research and contract work with industry partners. Included amongst the projects now taking place in the Accelerator is a major new award from the Bill and Melinda Gates Foundation to Professor Philip McCall to inform and accelerate the deployment of new public health insecticides by quantifying the full range of effects of sub lethal exposure. Further expansion of the Category 3 insectaries in our existing space has enabled us to establish human malaria infections and expand our research on vector parasite interactions.

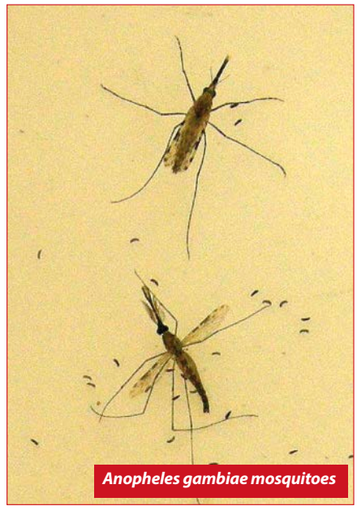
Via new appointments we have also increased the multidisciplinary nature of our work with several new projects focusing on health economics of vector control interventions, use of serious gaming for disease prevention and social anthropological studies to understand factors influencing use of vector control tools.

Tsetse fly survival just 24 hours after ingesting a drug-spiked bloodmeal (left, dead) or a regular bloodmeal (right, alive)

Several exciting new projects have been initiated with support the Confidence in Concept scheme, which supports early stage translational research. These include the use of sugar baits containing inhibitors of amino acid degradation, which selectively kill blood-feeding insects characterised by the Alvaro Acosta-Serrano group, the application of transgenic mosquitoes developed by the Gareth Lycett group to predict cross resistance profiles and the development of smart materials to increase the bio-efficacy of insecticides, led by the Mark Paine group. The Lycett and Paine groups have partnered with IVCC to establish a screening facility to examine metabolism by mosquito P450s to rapidly assess potential metabolic resistance liabilities for new insecticides. More recently the work has extended to examining in vivo resistance conferred to novel compounds by overexpressing individual P450 enzymes in transgenic mosquitoes. This is providing vital information to select compounds to take forward in the development pipeline.

Global Challenges Research Fund

This new fund, part of the UK Overseas Development Assistance, has spurred a number of new opportunities for exciting projects in the Department. Professor Martin Donnelly is leading a Foundation Award to harness the power of genomic technologies to design new insecticides and develop strategies that delay the onset of resistance. This project recognises that the deep understanding of the biology of the major malaria vector Anopheles gambiae lies with scientists in Africa whilst the skills to sequence and analyse genomic data are held by centres in the North and aims to draw together these two groups, with support from world-leading spatial statisticians, to understand more about the key issue of insecticide resistance evolution. Dr Lisa Reimer was awarded a Foundation Award to improve the rapid detection of vector borne disease via a novel approach involving surveillance of vector excreta.



Anopheles gambiae mosquitoes

The department successfully bid for the GCRF's Growing Research Capability Call, which has led to the formation of a major new partnership between Burkina Faso, Cameroon, Malawi and the UK to increase the impact of vector control.

The PIIVeC project will strengthen capacity in disease control programmes and national research institutes and aims to increase both the supply and demand for national evidence in the planning and implementation of vector control strategies.

Staff news

Dr Michael Coleman

Dr Lisa Reimer

Congratulations to Dr Lisa Reimer and Dr Michael Coleman, who were promoted to Senior Lecturer and Reader respectively, in recognition of their major contributions to controlling vector borne disease.

Professor Hilary Ranson undertook a six-month sabbatical at Harvard School of Public Health, USA, where she has been appointed Visiting Professor of Immunology and Infectious Disease. This gave her time out from her role as Head of Department to focus on her research and develop further collaborations. Professor Martin Donnelly ably led the department for this period and has now taken on the role as Deputy Head of Vector Biology.

We are delighted to welcome Dr Chris Jones back to LSTM as a Senior Lecturer. He will be based at the Malawi Liverpool Wellcome Centre where he will lead the expansion of a vector biology research programme.

The department also celebrated the success of several PhD students all of whom are continuing their careers in science. New PhD graduates Dr Glauber Lima and Dr Adriana Adolfi have begun postdoc positions in the USA at the University of Florida, Gainesville, and University of California, Los Angeles, respectively. Dr Kemi Tesfazghi is now the Malaria Technical Advisor for PSI in Cambodia and Dr Nelson Grisales is working for Abt International on the Zika response in Central America. Dr Lucas Cunningham has remained at LSTM as a postdoc and finally Dr Kevin Opondo was awarded a highly competitive Wellcome Trust Fellowship to continue his work in the MRC, the Gambia.

Academic staff in the department continue to play an important role in developing global policy for vector control and working with control programmes to develop and implement national strategies. Professor Ranson has recently been appointed to the World Health Organization (WHO)'s Vector Control Advisory Group and Dr Charles Wondji has been appointed as a member of the newly formed WHO prequalification team for vector control products.

FEATURE ARTICLE

Malaria and other Vector Borne Diseases

Many of the world's most deadly infectious diseases in humans are transmitted by insects with malaria alone killing over half a million children each year as well as numerous other diseases and neglected tropical diseases being spread by mosquitoes and other vectors. LSTM remains at the cutting edge of pioneering work in vector biology and hosts the largest concentration of medical entomologists in Europe, seeking to find new solutions to end human suffering in disease endemic countries.

Visceral leishmaniasis elimination in India

LSTM is continuing its role to support the Indian visceral elimination (VL) programme providing monitoring and evaluation (M&E) efforts across three States: Bihar, Jharkhand and West Bengal. Activities include sand fly vector abundance and insecticide resistance monitoring, evaluation of spray quality and indoor residual spray coverage, and case surveillance. In Bangladesh, Dr Emily Adams is performing diagnostic trials together with the Foundation of Innovative New Diagnostics (FIND) and the international health research organisation ICDDRb, based in Dhaka, on novel antigen and molecular tests in the field.

Research led by Professor Janet Hemingway and Dr Michael Coleman demonstrated that indoor residual spraying (IRS) with DDT to target VL vectors was a suboptimal strategy to achieve elimination by 2020. This led to changes in national policy and alpha-cypermethrin was adopted as the new insecticide of choice. LSTM also procured, on behalf of the government, 2,756 hand-compression pumps and 4,265 sets of personal protective equipment to support concerted efforts to improve IRS impact. Data from 2017 shows that alpha-cypermethrin remains an effective insecticide for achieving VL elimination.

An Indoor Residual Spraying (IRS) team in Bihar State, India, prepare for a day's work

LSTM will be expanding the M&E activities to include use of molecular diagnostic tools for sand fly species confirmation, L.donovani parasite detection and resistance mechanism monitoring. In addition the team is supporting three Indian scientists conducting their doctoral studies in order to build capacity. Dr Emily Adams, Dr Michael Coleman and Professor Janet Hemingway are now members of the SPEAK India consortia and are developing plans to work in the area of outbreak response of VL to ensure that the VL elimination programme is sustainable into the future.

Impact of new bed nets

Scale-up of insecticide-based interventions targeting malaria vectors is estimated to have averted >500 million malaria cases in sub-Saharan Africa since 2000. Increases in the geographic extent and intensity of insecticide resistance in malaria vectors could herald a potentially disastrous rebound in disease and mortality. Studies seeking to assess the direct impact of resistance on malaria disease burden are still being conducted but in the interim there is a need for new technologies which can sustain the success achieved.

The "PBO-LLIN study" is a cluster-randomised trial designed to evaluate the impact of a new type of long-lasting insecticidal nets (LLINs) on malaria prevalence in Uganda. The LLINs are treated with a compound, piperonyl butoxide (PBO), which may enhance the potency of the insecticide and result in the death of even some insecticide resistant mosquitoes. The trial is unique as it is conducted over almost half of Uganda and the interventions are delivered as part of the Ugandan national universal LLIN coverage campaign in 2017. For this study, a cluster has been defined as a health sub-district (HSD) and a total of 104 clusters are included in the study, covering 48 districts in Eastern and Western Uganda. The primary objective of the study is to evaluate the impact of combination LLINs (with PBO), as compared to conventional LLINs (without PBO), on parasite prevalence. The study is conducted in association with partners in the Ugandan National Malaria Control Programme, Makerere University, University of California San Francisco and the London School of Hygiene and Tropical Medicine.

Hunting secretive Zika mosquitoes in the human home

Aedes aegypti is the most important mosquito vector transmitting dengue, Zika, yellow fever and chikungunya viruses to humans in urban areas. It is notoriously difficult to control, and outbreaks continue to exert a relentless burden on communities that are powerless to protect themselves.

Aedes aegypti thrives in small water bodies and preferentially lays eggs in man-made containers found throughout the home: from discarded bottles or cans, buckets or water storage tanks, many hidden (e.g. underground drains, overhead tanks) and found on multiple levels of high rise buildings. Not surprisingly, routinely targeting (either by eliminating or covering them, or treating with insecticide) enough of these containers to reduce mosquito populations is rarely feasible.

The adult females rest inside human houses where outdoor insecticide fogging, the standard control method, has little impact as the insecticide doesn't penetrate that far indoors, and as these are daytime biters bed nets are also ineffective.

A solution would be for householders to spray insecticide residues in their own homes, avoiding the need for house-to-house visits by 'pest control' teams, impossible in the today's high-density megacities.

The city of Recife, Brazil, showing the high density three-dimensional environment where Aedes aegypti mosquitoes are abundant

However more understanding is needed as to where they are most likely to rest, or where they prefer to fly through the interior space in the home.

Typical city home where all stages of the life cycle of the Aedes aegypti can be found

To investigate this, Professor Philip McCall and Dr Luca Facchinelli are being funded by Fiotec Brazil, to carry out a study in the Brazilian city of Recife, where the 2016 Zika outbreak was most severe. They will work in collaboration with Dr Constância Ayres Lopez of Fiocruz Recife, and Professor David Towers of the University of Warwick, to provide answers to two questions: Where do adult Ae. aegypti mosquitoes rest within the human home, and where do Ae. aegypti mosquitoes move through indoor space? This research might sound simple until you look at the photographs showing the type of environment where the mosquito lives.

Low-technology transfluthrin emanators for protecting against Zika

Personal protection measures against outdoor-biting mosquitos can offer simultaneous, daytime protection against transmission of Zika, dengue, chikungunya and yellow fever, as well as night time protection against other mosquitoes carrying malaria and filariasis. However, existing repellent products only provide protection for hours, days or weeks per application or dispensing dose, making them too expensive for continuous use in low-income settings. LSTM is working with partners in Tanzania, Haiti, France and Glasgow to test a simple, affordable, low-technology transfluthrin emanator. The emanator will be made in Tanzania, using locally available materials and tested to ensure safety, user acceptability, cost and effectiveness. The optimised product will then be transferred to Haiti where acceptability and effectiveness will be measured in this new setting to inform potential scale up.

Tsetse research and control

New methods are needed to control tsetse flies which transmit trypanosomes causing human African trypanosomiasis, or 'sleeping sickness', which is found only in sub-Saharan Africa and exists in two forms. 'Gambian sleeping sickness' represents more than 95% of all cases and occurs in West and Central Africa. The second form of the disease 'Rhodesian sleeping sickness' is associated with wilderness areas of East and Southern Africa where tsetse flies transmit trypanosomes from infected wild animals to humans. WHO aims to eliminate sleeping sickness as a public health problem by 2020 and LSTM is contributing towards this goal by developing new methods of tsetse control.

- Gambian sleeping sickness

Work undertaken by LSTM in partnership with scientists from Africa and Europe resulted in the development of 'Tiny Targets', small panels of insecticide-treated material which attract and kill tsetse flies. Trials conducted in Kenya, Uganda and Guinea demonstrated the cost-effectiveness of using Tiny Targets to control tsetse and Gambian sleeping sickness and, with support from the Bill and Melinda Gates Foundation, we are now working with our partners to expand the use of Tiny Targets.

Tiny Target deployer in Chad

As reported in a paper published in PLOS Neglected Tropical Diseases, the impact of the deployment of 2600 Tiny Targets in Chad reduced the numbers of tsetse by 99.99% and medical screening of the human population showed that the numbers of sleeping sickness declined from about 100 cases per year before targets to 47 cases in 2015, with a further decline being reported. The results from Chad add to the growing evidence that elimination of Gambian sleeping sickness can be achieved through a combination of medical screening and tsetse control.

LSTM is also supporting the deployment of >20,000 Tiny Targets across NW Uganda, where the intervention has already led to a decline in disease incidence. However, there is worry about disease resurgence due to the influx of refugees from neighbouring South Sudan. Many of the refugees have come from areas of South Sudan where sleeping sickness occurs and they are being settled in areas of Uganda where tsetse exist. Working with the government of Uganda and FIND we are tackling this risk by screening and treating refugees for sleeping sickness and deploying Tiny Targets in the vicinity of refugee camps.

Tiny Target deployers in Uganda

- Rhodesian sleeping sickness

With support from the UK's Department for International Development and Research Councils-UK and in partnership with scientists from the UK, South Africa and Tanzania, LSTM is carrying out research on the transmission of sleeping sickness at the interface between farming and wilderness areas. With work focussed on the Serengeti National Park in Northern Tanzania, we examined the distribution and abundance of tsetse along transects extending from wilderness to farming areas and found that numbers of tsetse declined with distance from the park. This decline in tsetse is due, in part, to degradation of the habitat related to settlement and farming activities.

Xenomonitoring

Dr Lisa Reimer's group is developing methods to use mosquitoes to provide an early warning of the emergence of a range of diseases, including those transmitted by mosquitoes and those with other insect vectors. With funding from the Medical Research Council and the Global Challenge Research Fund, the team, in collaboration with colleagues at Smith College (Massachusetts, USA) aim to use mosquitoes as 'flying syringes' whereby wild-caught mosquitoes can be screened for a range of pathogens picked up from the local community. This approach allows for non-invasive monitoring of hard to reach communities, giving real-time information about the presence or persistence of a disease in a specific area, enabling rapid detection of disease outbreaks and thus rapid, targeted responses.

The technique being developed utilises nanotechnology to enable the efficient collection of mosquito excreta and faeces which can be screened for the presence of pathogens, previously ingested when the mosquito took a bloodmeal. The team has developed a low-cost funnel with a superhydrophobic coating, allowing the material to be collected. Using the voided material, instead of whole mosquitoes, greatly improves the ratio of parasite to mosquito DNA and allows the screening of at least twenty times the number of mosquitoes than the standard approach.

Dr Reimer's team has demonstrated sensitive detection of plasmodium falciparum, Brugia malayi and Trypanosoma brucei and pilot tests conducted in Ghana, using wild-caught mosquitoes, have confirmed that the superhydrophobic funnel performs well in a field setting. In the next phase of the project, testing will begin to see if dengue virus and West Nile virus can be detected in excreta (with Matthew Baylis' team at the University of Liverpool) and a more extensive field trial is due to begin which will provide further information about how this novel approach to xenomonitoring could aid currently available disease mapping tools.

Department of Clinical Sciences

The department enjoyed a very successful and active year, with continued expansion of staff numbers and awards won. We continue to focus on research that is relevant to populations with limited resources in low income countries, producing evidence that is considered crucial for international policy guidance.

Professor Luis Cuevas - Head of Clinical Sciences

Many of the department's activities are highlighted as special features in this report, such as the National Institute of Health Research (NIHR) Global Health Research Unit on Lung Health and Tuberculosis in Africa, led by Professor Bertie Squire; on human models for vaccine immunology, led by Dr Daniela Ferreira and on the successful completion of the Malaria in Pregnancy Consortium, led by Professor Feiko ter Kuile. We welcomed 19 new staff in 2017, to reach a record 120 staff by the end of the year. Our larger research portfolio has led to new appointments, including the Health Economics and the tropical Clinical Trials Groups.

Professor Feiko ter Kuile

Malaria epidemiology

The malaria epidemiology group, led by Professor ter Kuile, continues its collaboration with the Kenya Medical Research Institute (KEMRI) and the US Centers for Disease Control and Prevention (CDC) in western Kenya, where they conduct malaria transmission reduction studies, malaria vaccine trials, and innovative methodologies to measure transmission intensity. Prof ter Kuile also leads a trial of malaria chemoprevention for post-discharge management of children with severe anaemia in western Kenya and Uganda. The group completed the first large-scale malaria chemoprevention trial in Indonesia, led by Dr Rukhsana Ahmed to evaluate the impact of monthly prophylaxis and screening strategies for the prevention of malaria in pregnancy in low transmission areas. With the end of the Malaria in Pregnancy Consortium, Professor ter Kuile and Dr Jenny Hill initiated the new IMPROVE Consortium funded by the MRC/DFID/Wellcome Trust and EDCTP to conduct two multicentre chemoprevention trials for the control of malaria, sexually transmitted and reproductive tract infections in HIV-infected and -uninfected pregnant women in Kenya, Malawi and Tanzania.

A child receiving an elemental therapeutic feed, Blantyre, Malawi

Paediatrics

Professor Stephen Allen completed a clinical trial exploring whether therapeutic feeds effective in food intolerance and intestinal inflammation would benefit children with complicated severe acute malnutrition in Malawi.

Although the study had negative results, it demonstrated that severe gut pathology persists despite the treatment. He has also initiated recruitment for NIHR-funded studies of faecal volatiles in the diagnosis and pathogenesis of inflammatory bowel disease, with Alder Hey as the lead site and further patient recruitment in Bristol and Birmingham Children's hospitals. A newly funded study will also evaluate the potential of bovine colostrum in mucosal healing and maintaining remission in Crohn's disease.

Evidence synthesis

The Cochrane Infectious Diseases Group support continued through DFiD, the Cochrane Central Executive and the World Health Organization (WHO). The group worked with partners in Cape Town who have mapped out priority areas in nutrition and are now co-ordinating the Cochrane nutrition field. New staff in Liverpool will work on Cochrane reviews in malaria vector control to help with WHO guidelines, and to complete systematic reviews in extra-pulmonary tuberculosis prompted by the group's work with guideline development in India.

The Cochrane review of Integrated Management of Childhood Illness and an article appraising options for influenza vaccine were published. The latter was commended by the UK's Chief Medical Officer. The group was asked to prepare a plenary for the Global Evidence Summit with 8 young presenters, mostly from Africa and Asia.

Tuberculosis

In addition to Professor Squire and Dr Kevin Mortimer's leading roles in the NIHR Global Health Research Unit on Lung Health and Tuberculosis in Africa, in collaboration with senior colleagues in the Department of International Public Health, our department continues to have a strong portfolio on tuberculosis. These include the evaluation of new diagnostics though EDCTP-funded studies led by Professor Luis Cuevas in Nigeria, Ethiopia, Barcelona and Moldova and embedded in LSTM's Research Centre for Drug and Diagnostics (RCDD). These studies simultaneously evaluate the performance of selected new tuberculosis diagnostics with the intention to develop diagnostic algorithms that could facilitate a faster and more efficient diagnosis. Diagnostics however are ineffective if they are not accessed by populations with a high risk of disease. We are conducting two TB REACH funded studies (STOP TB Partnership) to increase access to diagnosis to key populations in Nigeria and Ethiopia. The plan is to up-scale these approaches in 2018 to provide the service to several million inhabitants and a blueprint of approaches that reach populations in slum and rural areas. Increasing the numbers of TB patients being enrolled into TB treatment and care is also the focus of the IMPACT-TB programme funded by the European Union. This work, led by Dr Maxine Caws and launched early in 2017, is developing the knowledge base for scale up of different active TB case-finding approaches in Nepal and Vietnam.

The tropical Clinical Trials Unit

Our unit is undergoing a planned phase of expansion and development. In the last year, we have welcomed the unit's manager, three statisticians, one data manager and our information systems officer. We will be joined soon by a further two statisticians, one clinical trials manager, a pharmacovigilance officer to monitor side effects of trials and an administrator. We are working hard to serve trials and studies within LSTM – some of them described above – on malaria, HIV, tuberculosis and others, with partners such as Liverpool University and others. Our portfolio is increasing very rapidly and staff have this year visited several countries (Uganda, South Africa, Malawi, and Kenya) to gain familiarity with the trials and the local working environment.

Health economics

The Health Economics team, one of the youngest within the department, has participated in remarkable successes in terms of funding expansions during 2016/17. We have established new collaborations with NIHR Units and Groups in Lung Health and Tuberculosis; HIV and Non-Communicable Diseases (International Public Health) and Snakebites (Vector Biology). These research programmes consider estimating economic and disease burden, poverty impact and evaluation of health interventions (value for money) in African countries including new projects in Kenya, Nigeria, Tanzania, Uganda, and South Africa. The new collaborations are funded through the first call by of the NIHR, UK and EDCTP. We made progress in Health Economics studies for Neglected Tropical Diseases in Ghana, Cameroon and Liberia, training and supporting the country teams and data collection. Studies on cholera vaccinations (willingness-to-pay and investment case) in Bangladesh are taking shape. Our postgraduate research training has increased and the team supports post- and undergraduate LSTM courses.

FEATURE ARTICLE

Lung Health & TB

LSTM's research covers the full spectrum of the complex, often poverty driven, global problems around chronic lung diseases, respiratory infection and tuberculosis (TB). It aims to reduce infection, improve prevention and optimise treatments.

IMPALA

LSTM and the Collaboration for Applied Health Research and Delivery (CAHRD) secured funding of close to £7m from the National Institute for Health Research (NIHR) to create an Africa-focused NIHR Global Health Research Unit for lung health and tuberculosis (TB). Led by Professor Bertie Squire, Dr Angela Obasi and Dr Kevin Mortimer, the overall aim is for an 'International Multidisciplinary Programme to Address Lung Health and TB in Africa' (IMPALA) to improve the health of children and adults in Africa.

IMPALA International Multidisciplinary Programme to Address Lung Health & TB in Africa

IMPALA brings together a team of investigators, representing the spectrum of applied health research disciplines from LSTM, CAHRD, existing research consortia and 17 organisations across 11 African countries with existing established and successful collaborations. The Unit is supported by leading respiratory academics and institutions including the leadership of The Union, the Pan-African Thoracic Society (PATS) and the American Thoracic Society (ATS).

The programme will focus research efforts on improving lung health and fighting TB in Africa. It supports scientists and works to strengthen the research infrastructure of their institutions and conducts collaborative research to fill gaps in the current evidence base. For example: exploring ways to bring basic effective and affordable care to people living in both remote rural areas and expanding cities and slums.

A key goal of the Unit is to develop a long-term strategy for research in lung health and TB; looking well beyond initial funding with sights set on delivering improvements in health for Africa's poorest populations.

The Unit will have 5 PhD studentships specifically for African scientists. At the heart of this is the MRC-funded Doctoral Training Partnership (DTP) in Global Health in partnership with the University of Lancaster to develop a cadre of researchers with the quantitative and interdisciplinary skills needed to work across the traditional phases of translational research.

The DTP has a strong applied health research emphasis. Dr Kevin Mortimer co-leads the DTP with Professor Giancarlo Biagini at LSTM, and Bertie Squire is part of the DTP Leadership Team.

LSTM has supported the ATS and PATS research capacity building programme 'MECOR' for a decade.

Through IMPALA we will upscale our pan-African lung health research-focused capacity building through this successful tried and tested approach.

In July 2017 a three-day meeting was held in Blantyre, Malawi, to plan and discuss the future of the Unit, assigning research goals and PhD themes.

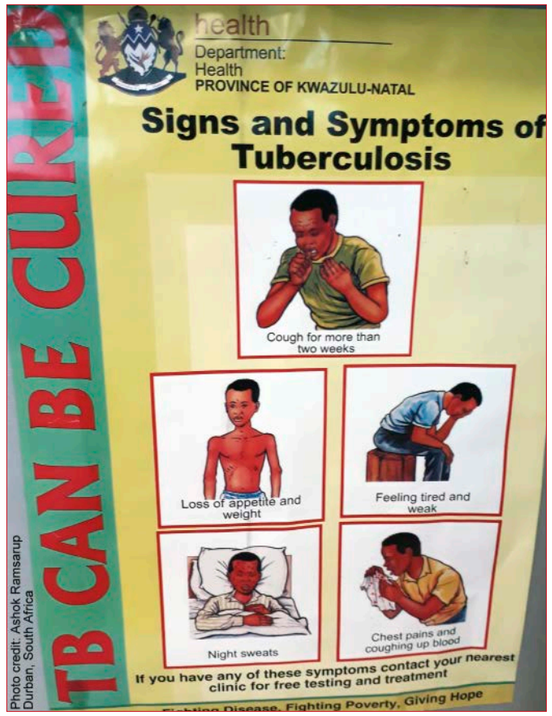


Photo credit: Ashok Ramsarup Durban, South Africa

STREAM

STREAM is an ongoing trial of new treatment regimens for multi-drug resistant tuberculosis (MDR-TB). The LSTM component of this trial (led by Bertie Squire) is to complete health economic studies of health system and patient impacts of the alternative regimens in the trial.

Interim results from STREAM 1 show that the economic burden of MDR-TB reduces significantly when a nine month treatment regimen is being followed compared to the existing standard 20 month treatment regimen. Data from South Africa and Ethiopia showed that the costs to the health system for each patient were reduced by approximately a third given the shorter regimen. This healthy system saving is coupled with lower costs for patients themselves due to fewer visits to health facilities and earlier return to work on the shorter regimen. The trial is ongoing with full findings from STREAM 1 expected in April 2018.

Poster by the National TB Programme Nepal stating 'Anybody can be infected with Tuberculosis. Regular treatment can cure Tuberculosis completely. Let's visit the health facility for free diagnosis and treatment service'

STREAM 2 is currently recruiting and testing new shortened regimens which include the novel drug bedaquiline. Data collection for the health economic analysis of STREAM 2 is proceeding in Ethiopia and Moldova and will begin shortly in India. STREAM 2 will report in 2020.

IMPACT TB

IMPACT TB, led by LSTM's Dr Maxine Caws and funded by the European Union, is implementing and evaluating alternative active case finding strategies for TB in communities of Nepal and Vietnam. The project consortium, which includes Karolinska Institute (Sweden) and KNCV (Netherlands) aims to provide evidence to support policy decisions by National Tuberculosis Programmes on practical strategies to reduce TB in low and middle income countries. Active case finding has begun in six districts of Ho Chi Minh City, Vietnam, and in four districts of Nepal and will continue for two years. IMPACT TB will evaluate the health economics of the different strategies, use mathematical modelling to understand potential future effects on the TB epidemic and work with National TB Programmes to translate the evidence to policy through national strategic plans.

Location in Nepal for sputum sample collection to be tested for TB

Pneumonia vaccine research

The Respiratory Infection and Vaccine Group, led by Dr Daniela Ferreira, has had another successful year, conducting pioneering research in partnership with the NHS and worldwide collaborators to develop better vaccines against pneumonia. The Group has developed a model of human colonisation in which healthy volunteers are exposed to pneumococcal bacteria by nasal inoculation to mimic natural acquisition of the bacteria. This allows examination of the natural immune response to pneumococcal bacteria and expands the knowledge to develop better vaccines in the future.

This Experimental Human Pneumococcal Challenge (EHPC) model has been effectively running now for over 8 years. During this time, over 850 healthy volunteers have been innoculated. The model is used to test new vaccine candidates using smaller sample sizes and therefore at a reduced cost and time than the traditional vaccine trials. The results have shown that small numbers of bacteria present in the nose could help to protect people against disease, information now being used to develop a live attenuated vaccine to be delivered as a nasal spray, similar to the existent live flu vaccine.

Flu

This year the team completed trials investigating the effect of the Live Attenuated Influenza Vaccine (Fluenz) on pneumococcal colonisation. The Fluenz is given to young children as a spray in their nose and the work looked at if this caused increased pneumococcal colonization, potentially leading to spread of this bacteria in the community and increased pneumonia in older adults.

As part of these trials the team also investigated how flu can alter immune responses that control pneumococcus infection in the nose and in the lung and how flu alters the nasal microbiome. This work was funded by Bill and Melinda Gates Foundation and results are currently being prepared for publication.

Understanding host susceptibility

Until recently the EHPC model has primarily been used in healthy volunteers. In context of a MRC Programme grant, this has been expanded to include more susceptible groups within the model to further understand what makes these groups more predisposed to pneumonia and pneumococcal disease. These studies will provide vital information about vaccine development for these individuals. While currently investigating asthmatics and adults over 50 years old studies will expand to include smokers and individuals with Chronic Obstructive Pulmonary Disease (COPD) in 2018.

Commercial Partnerships

The team recently completed a study looking at the transmission of bacteria from the hand to the nose with support from Unilever. Following the completion of this, larger trials to test the effectiveness of hand washing products with commercial partners are underway.

Working together with Liverpool hospitals

New collaborations include those with nasal surgeons to collect larger samples of tissue from the nose and throat of volunteers following pneumococcal challenge, while a new study is starting at Alder Hey to look at children who carry pneumococcus naturally. This work led by Dr Simon Jochems and funded by LSTM's Director's Catalyst Fund will translate our findings from studying adults to children, the target group for vaccination.

Sharing research with the public

Thanks to the support of LSTM and the British Society of Immunology, the team organised an exhibition 'breath-taking pneumococcus' for the Big Bang North West science festival. This was very successful and was attended by children who learned how to prevent transmitting bacteria and viruses as well as how scientists study diseases. We have also had stands at University Fresher's events and were able to attract over 1500 participants who are interested in taking part in one of our studies.

Sepsis

Research into pneumococcal bacteria has led to studies relating to sepsis. Dr Ben Morton and colleagues have successfully completed an MRC Developmental Pathway Funding Scheme Project to develop pre-clinical data for P4 peptide, a sepsis therapeutic that induces phagocytic cells to better ingest and kill bacteria. We have successfully developed a project protocol and investigators brochure in line with MHRA guidelines to conduct the First-In-Human clinical trial at the Royal Liverpool University Hospital and are currently exploring funding opportunities.

In a separate but aligned project Dr Morton, Dr Rylance and colleagues have successfully completed an MRC Confidence in Concept funded project to refine and validate a test to measure neutrophil function in patients with community acquired pneumonia. There are now plans to use this test in future studies involving children before and after chemotherapy and in patients with HIV co-infection in patients presenting to hospital with sepsis.

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A volunteer having a FENO respiratory test. This is a measure of exhaled nitric oxide which if raised is an indicator of inflammation.

The model is also being expanded to use new strains of pneumococcal bacteria aiming to achieve similar or higher carriage rates and early results are encouraging.

Department of International Public Health

The department's portfolio includes large-scale research studies evaluating the scale-up interventions of proven efficacy, clinical trials and the many components of health systems research to inform policy and programming. Most notably is the expansion in HIV-related research.

Professor Shabbar Jaffar - Head of International Public Health

HIV-infection in Africa

Following on from the appointments of Professor Shabbar Jaffar in 2015 and Professor Frances Cowan in 2016, we have recruited Dr Chelsea Morroni, a clinical epidemiologist and Reader in Global Sexual and Reproductive Health.

Dr Morroni leads the Botswana Sexual and Reproductive Health Initiative and is based in its capital Gaborone. Her research includes prevention of HIV-infection in mothers and young persons. She starts at LSTM from 1st November 2017.

Professor Cowan is the Director of The Centre for Sexual Health and HIV AIDS Research Zimbabwe (CESHHAR). She is leading extensive large-scale studies of prevention of HIV-infection in Zimbabwe, with a particular focus on key populations including sex-workers and adolescents. Her work on evaluating non-monetary incentives to increase couples counselling was published in The Lancet. She was awarded an MRC grant with University of Zimbabwe to Scale up of Friendship Bench to adolescents in Zimbabwe. With Dr Miriam Taegtmeyer she is Deputy Director for Research for Self-Testing Africa (STAR). In July 2017 UNITAID agreed to extend this work for a further three years and to expand the geographic scope from Malawi, Zambia and Zimbabwe to include South Africa, Swaziland and Lesotho. Webster Mavhu and Euphemia Sibanda, project leads within CeSHHAR Zimbabwe have been awarded honorary appointments with LSTM.

STAR is evaluating the expansion of HIV self- testing in Africa – a potential game changer in the field. As Deputy Director for Research, Dr Taegtmeyer also leads work on designing and evaluating interventions to enhance HIV testing through other innovative methods, and on intimate partner violence and the HIV cascade.

Professor Jaffar is collaborating with St Georges University of London and London's LSHTM on studies of the prevention and management of late-stage HIV-infected persons. The group is currently publishing data from a number of trials and conducting cost effectiveness analyses with Professor Louis Niessen, Dr Tao Chen and others. The group were awarded a NIHR award to develop a research agenda on the prevention and management of HIV-infection, diabetes and hypertension in Africa.

Dr Angela Obasi became co-Deputy Director of the NIHR unit to develop research on Lung Health and TB in Africa. This new £7 million initiative, the IMPALA programme, will conduct a programme of clinical, health economics, social science and health systems research involving 13 partners in 11 countries. Dr Obasi has also taken over as Acting Co- Director of LSTM's flagship Diploma in Tropical Medicine and Hygiene (DTMH), sharing this role with Professor Stephen Allen.

Centre for Maternal & Newborn Health (CMNH)

CMNH is an internationally recognized 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 growing team is multidisciplinary and comprising more than 100 staff with programmes across Asia and Africa. For more information on their work, see the special feature on Maternal, Newborn & Child Health.

Health Systems and Workforce Strengthening Unit (HSWS)

The Unit has now started a 5-year EU Horizon 2020 project to implement and study the scale-up the district management strengthening initiative to improve health workforce performance developed under the PERFORM project. PERFORM2scale is now working in Ghana, Malawi and Uganda. The DFID-funded ReBUILD consortium, working on health systems in countries emerging from conflict and crisis, has won a 2-year extension. New countries covered by ReBUILD now include Timor Leste, Liberia and the DRC. We hosted a two week visit for the four RECAP-SL research fellows in July to Liverpool for research capacity building.

Community health

Our 5-year EC funded REACHOUT consortium, linking communities and health systems, has come to an end. Following a context analysis and two quality improvement cycles in 6 countries, REACHOUT has developed the evidence base on strategies to support close to community providers in their critical interface role – linking communities and health systems. New work on community health include collaboration with a clinical trial on new antiretrovirals in late pregnancy (DOLPHIN2) and a multidisciplinary NIHR Unit on TB and lung health (IMPALA).

Gender and health

Recent work in the gender and health group includes taking forward the Research in Gender and Ethics: Building stronger health systems (RinGs) consortium and developing the evidence base and tools and resources on gender analysis; work within the DFID funded COUNTDOWN on gender equity and Neglected Tropical Diseases in collaboration with NTD programmes and exploring how to create gender equitable scientific career pathways as part of the DELTAS LRP.

Capacity Research Unit

The Capacity Research Unit (CRU) is at the forefront of operational research into capacity strengthening. During the last year, it acquired major new funding to support capacity development in the Wellcome Trust-DFID funded DELTAS Africa initiative and in various NIHR and GCRF funded initiatives.

Monitoring, Evaluation, Training and Research (METRe)

The Monitoring, Evaluation, Technical Assistance and Research Group (METRe) is a leading unit for monitoring and evaluation, operations and implementation research in the UK. During the last year with funding from the Bill and Melinda Gates Foundation it supported the Government of Bihar, India, strengthening its health system informatics. With UNICEF/ New York it developed methods to rapidly assess Child Heath Days in sub-Saharan Africa. In South Sudan METRe supports to the Ministry of Health to carryout nationwide assessments of knowledge, attitudes and practices for health, and of the quality of clinical care. In Nepal it supports the Ministry of Health to carryout operations research in support of its National Health System Strengthening Project.

Health Systems Global 2018

Preparations for the Health Systems Global Conference, scheduled for October 2018, are well underway. LSTM, together with a number of UK partners, won the bid to bring the conference to Liverpool as subtly reflected in the logo.

"The scholarship from LSTM has had a huge impact on my professional and career development.

- Ahmed Bulama (Nigeria), Merit Scholar, MSc Tropical and Infectious Diseases

FEATURE ARTICLE

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 still pose significant global health challenges despite progress made over the past years.

Maternal & newborn health

LSTM's Centre for Maternal & Newborn Health (CMNH), led by Professor Nynke van den Broek, conducts implementation research, to discover and share what works when and where, to reduce maternal and perinatal mortality, to improve health and healthcare delivery. CMNH works to strengthen existing data collection methods, the use of data, and develop new indicators and framework to evaluate effectiveness of single or complex interventions.

Professor Nynke van den Broek - Head of CMNH

During the past five years CMNH has focused on healthcare interventions required at the time of birth when most maternal deaths, stillbirths and early neonatal deaths occur (the 'triple return'). Whilst continuing to maintain this core focus, and in line with LSTMS's new strategic plan (2018-2023) in 2017 CMNH has:

- Broadened the scope of the CMNH portfolio such that this is inclusive of the continuum of care for mother and baby throughout pregnancy, childbirth and in the postnatal period with a renewed focus on antenatal and postnatal care
- Continued to link the maternal and newborn health agenda whilst expanding the portfolio in neonatal health and healthcare delivery
- Maintaining a strong focus on reducing preventable deaths, CMNH will expand its portfolio further to include research and programs that will improve the health of mothers and babies, in line with the new international strategy that seeks to ensure mothers and babies 'survive and thrive'

In 2017 CMNH completed and has ongoing programmes in 17 countries across sub-Saharan Africa and Southeast Asia with grants from 11 donors totalling £16.5m under management.

The Centre has expanded its reach geographically, starting new programmes in Francophone countries in West Africa (Togo and Niger), as well as commencing a multi-year programme in Afghanistan.

Improving maternal health

CMNH undertook a descriptive observational cross-sectional study to assess the extent and type of maternal morbidity using in a purposeful sample of primary and secondary healthcare facilities in India, Pakistan, Kenya, and Malawi to assess physical, psychological and social morbidity. The study found that women suffer significant ill-health which is still largely unrecognised, therefore, current antenatal and postnatal care packages require adaptation if they are to meet the identified health needs of women.

The multi-country study including >10 000 women showed that:

- Almost 3 out of 4 women have clinical symptoms and/or abnormalities on clinical and/or laboratory investigation.
- Almost 1 in 10 women had an identified infectious disease (HIV, malaria, syphilis or chest infection) and 1 in 4 had signs of early infection.
- 1 in 2 women were anaemic, 1 in 10 had other medical or obstetric conditions.

- 1 in 4 women have psychological ill health and 1 in 3 social morbidity (domestic violence and/or substance misuse).
- The likelihood of morbidity decreased with increased education level.

A new focus on antenatal and postnatal care

Antenatal care is a major success story. Demand has increased and continues to do so in most parts of the world. Globally 83% of women attend for antenatal care on at least one occasion during pregnancy and 64% attend four times or more. In many cases this constitutes a series of 'missed opportunities'.

In line with the Global Fund Strategy to fight AIDS, tuberculosis and malaria, strengthen health systems and improve the health of mothers and children, CMNH has been awarded new grants to design and implement innovative approaches to address the identified health needs of mothers and babies during and after pregnancy with integration of care across the three main diseases - HIV/AIDS, TB and malaria. In up to six countries, the availability and content of care will be strengthened using a health systems approach through building the capacity of healthcare providers and the enabling environment. Quality of care will be improved by the adoption of standards-based audit. Robust research methodology will be used to generate new evidence for the effectiveness of this approach.

Skilled birth attendance

In 2017 CMNH conducted a study to explore factors that enable or hinder the auxiliary nurse- midwife (ANM) in their practice, to understand their scope of work and to identify how this cadre can be supported in future to make an effective contribution to the delivery of healthcare for women and children at the primary care level in India. In both sub Saharan Africa and South-East Asia case studies were conducted to explore the contribution of various cadres of Community Health Worker (CHW) to providing care at time of birth as well as during and after pregnancy and how these workers are linked (or not) to the formal health system.

Newborn care

Every year 2.9 million neonates die globally, accounting for 45% of all under-5 child mortality. Severe respiratory distress is common to the three main causes of neonatal death (i.e. prematurity, intrapartum-related deaths and neonatal infections). Continuous Positive Airway Pressure (CPAP) is a simple and highly effective form of respiratory support. CMNH conducted a national survey in India to evaluate the use of CPAP and is currently conducting a similar national survey of CPAP use in Kenya. The results of both studies will inform policy makers and healthcare implementers about the current standards of CPAP use and its effectiveness in these diverse low resource settings.

Emergency Obstetric Care and Newborn Care (EmOC&NC)

Up to 80% of the 300,000 annual maternal deaths are the result of obstetric emergencies. By 2017, more than 30,000 healthcare providers have been trained using the CMNH 'skills and drills' EmOC&NC training package which is now uses as the national in-service training package in many countries. Evaluation shows that over 95% of healthcare providers improve their knowledge and skills leading to a significant improvement in availability and quality of EmOC&NC and reduced maternal deaths and stillbirths. CMNH will continue to support in-service and pre-service training in EmOC&NC and will evaluate the effectiveness of training in combination with regular 'drills' and/or supportive supervision.

EmOC&NC training session in Zimbabwe

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Quality of Care

Quality improvement is a critical component of CMNH's work in many countries. CMNH has developed a core set of more than 60 standards for the quality of integrated antenatal and postnatal care, which have been reviewed by international experts and will be used to support standards-based audit.

Qualitative studies were conducted among both women and healthcare providers to understand what quality of care means and how this can be provided. A multi-level study of factors influencing the success of quality improvement methods, and an innovative study to develop Patient Reported Outcome Measures (PROMS) for maternity care were conducted in Malawi, Kenya and South Africa.

An in-depth study of the causes of and factors contributing to 1,500 stillbirths was conducted in four sub-Saharan countries which concluded that the majority could be avoided through improved access to quality antenatal care, skilled attendance at birth and emergency obstetric care. The team supported WHO to introduce the new WHO tools on stillbirth and neonatal death reviews at the WHO European Regional Meeting in Uzbekistan and to implement these in Turkmenistan.

Maternal and perinatal death audit are supported in Tanzania, Nigeria and Malawi. Funded by Johnson and Johnson (Nigeria), UNICEF (Tanzania and Malawi) and the Salamanca Group (Malawi), this has led to changes in the care processes and improvement in the management of women at time of birth.

In Kenya, the first ever national confidential enquiry into maternal deaths was published in September 2017 with CMNH support.

B!RTH

In 2017 CMNH commenced a new partnership with the Royal Exchange Theatre and the Oglesby Charitable Trust in Manchester. B!RTH uses the power of theatre and scientific debate together, to highlight the issues and solutions regarding global inequality in the availability and quality of care for women before, during and at the time of giving birth. Performances at the Royal Exchange Theatre in Manchester, the Traverse Theatre in Edinburgh and the Product Arts Centre in Dublin as part of Fringe Festivals were very successful. Evaluation shows that audience members felt emotionally moved by the performances (93%), felt challenged and provoked (71%) and are interested in finding out more about solutions to the themes highlighted in each of the plays (77%).

A tribute to David Goodall FRCOG (1939 – 2017)

It was with great sadness that CMNH said goodbye to Dr David Goodall this year – one of the great obstetricians and gynaecologists of our time, a truly inspirational clinician and teacher, a wise counsellor; but more than that, he was quite simply our friend. David volunteered with CMNH on over 41 EmOC&NC trainings in 9 countries.

"Being awarded a scholarship has enabled me to attend the Masters and work towards my dream of being an Infectious Diseases physician."

- Vaitehi Kathiresu Nageshwaran (UK), Merit Scholar, MSc Tropical and Infectious Diseases

Paediatrics and child health

Our study in Blantyre, Malawi, recruited 95 children admitted with complicated severe acute malnutrition to the Moyo ward, Queen Elizabeth Central Hospital. Therapeutic feeds that are effective in food intolerance and intestinal inflammation did not show any clear benefits. Although a negative result, our study demonstrated that markedly impaired gut integrity and intestinal and systemic inflammation persist despite treatment in these children and will inform development of alternative interventions.

Presentation of the findings at the CAPGAN conference in Lusaka in October won best presentation prize. MSc/BSc projects were completed in a range of topics. These included the implementation of WHO guidelines for Emergency Triage, Assessment and Treatment in a hospital in Nepal; desk-based reviews of the prevalence and screening programmes for carriers of haemoglobinopathies in Asia and quality of life and cost of illness in transfusion-dependent b-thalassaemia in treatment centres in Kandy and Ragama, Sri Lanka.

Point-of-care testing of faecal calprotectin, a biomarker of intestinal inflammation, in the Moyo ward, Blantyre, Malawi

Professor Stephen Allen continues to lead the Quality Improvement in Global Child Health MSc module and has also been appointed as Co-Director of the DTM&H course.

Our programme of research in paediatric gastroenterology in the UK has expanded significantly. Recruitment to our NIHR Research for Patient Benefit funded study of faecal volatiles in the diagnosis and pathogenesis of inflammatory bowel disease started in October in collaboration with the Probert laboratory in the University of Liverpool. Alder Hey is the lead site with recruitment also in gastroenterology clinics in Bristol and Birmingham Children's hospitals. Working with Professor Bernie Carter and colleagues, Edge Hill University and funded by Crohn's Colitis UK, we will be assessing means to counter loneliness and social isolation in young people with inflammatory bowel disease. We have also secured funding from NIHR to undertake qualitative research on nutritional interventions and to evaluate bovine colostrum in mucosal healing and maintaining remission in Crohn's disease starting in 2018. Alder Hey is also the lead site for a UK multicentre, commercial study of ferric maltol, a novel oral iron formulation, in children with iron deficiency. Ferric maltol may be an effective alternative to parenteral iron even in children with intestinal inflammation due to Crohn's disease.

Professor Stephen Allen will complete his term as Chair of the BSPGHAN/NIHR-Children Gastroenterology, Hepatology and Nutrition Research Working Group in 2018. The collaboration between BSPGHAN and linked charities to fund research start-up grants is now in its fourth year. This year, in partnership with the charity CORE, projects in paediatric inflammatory bowel disease to characterize the gut mycobiome and metabolo-genomic interactions were supported.

Malaria in Pregnancy

This year saw the final chapter of the Malaria in Pregnancy (MiP) Consortium grants from EDCTP and the Bill & Melinda Gates Foundation (BMGF), which ended in July 2017. During the final year the LSTM-based secretariat focussed its activities on data sharing and dissemination to ensure the project delivered on its Global Access Strategy. To sustain the infrastructure, databases and tools developed by the MiP Consortium over the past ten years, a collaboration with the Oxford-led Worldwide Antimalarial Resistance Network (WWARN) was established involving the transfer of data from its clinical trials to enable a series of pooled meta-analyses to address priority questions for policy, led by a dedicated malaria in pregnancy scientific group created within the WWARN platform headed by LSTM's Professor Feiko ter Kuile. This partnership not only ensures maximum use and impact of EDCTP and the Gates Foundation's initial investment to the MiP Consortium, but continues to leverage funding to ensure that all pregnant women receive effective prophylaxis to prevent malaria and safe and effective treatment at the appropriate dose.

In collaboration with WHO, the secretariat organised a meeting of WHO's Evidence Review Group on MiP where partners presented the final results from the Consortium's clinical trials in Asia, to inform the development of regional and national policy in the Asia/Pacific region, where very few countries have a dedicated policy on MiP. This included the results of our recently completed prevention studies in Indonesia that, for first the time, evaluated the impact of monthly prophylaxis and monthly screening strategies for the prevention of MIP in low transmission areas outside of Africa. Together with a grant from EDCTP for translational activities in Africa, the secretariat continued to support dissemination of all research outputs of policy relevance to Ministries of Health in endemic countries at regional meetings held in Africa (in Nairobi, Kenya for countries in East and Southern Africa, and in Lomé, Togo for countries in West and Central Africa), and in Bali, Indonesia for the Asia-Pacific region, in collaboration with WHO, the Roll Back Malaria Partnership, the West Africa Health Organization, ECOWAS and the Asia Pacific Malaria Elimination Network (APMEN).

Our clinical trials work expanded with the award of two grants jointly funded by EDCTP and the MRC/DFID/Wellcome Trust Joint Global Health Trials Scheme to undertake two large prevention trials to evaluate the safety and efficacy of prophylaxis with the antimalarial dihydroartemisinin-piperaquine, alone or combined with a single course of the antibiotic azithromycin in HIV-infected and -uninfected pregnant women, with our partners in Kenya, Tanzania, and Malawi. This is an important first step towards more integrated control of malaria and sexually transmitted and reproductive tract infections in areas where they co-exist and conspire to threaten maternal health. These grants also include funding for multidisciplinary studies to assess the acceptability, feasibility and cost effectiveness of these interventions in parallel to both trials. In addition, we received a new grant from the Medicines for Malaria Venture (MMV) to further evaluate the efficacy and safety of dihydroartemisinin-piperaquine in women of childbearing age with our partners in Indonesia.

Strategic & Clinical Partnerships

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

MLW is the largest LSTM overseas programme and the only Wellcome major overseas programme in a low-income country. MLW is a partnership including the College of Medicine in Malawi, the Wellcome Trust, LSTM, the University of Liverpool and others. There are 450 staff working in 12 Research Groups with a grant portfolio of ~£60m. A major MLW success of 2017 was the successful renewal and increase of core funding (£27.1m for 2018-2023) from the Wellcome Trust. The substantial increase in core funding was awarded in recognition of scientific excellence and pressing, tractable research challenges. The grant will be used to increase clinical trial support, increase provision for training and career development of scientists, improve clinical research facilities and develop a policy unit.

MLW learning & traning centre

Clinical trials at MLW

MLW has a long and distinguished history in clinical trials including those in malaria, meningitis, pneumococcal and rotavirus vaccination. The opportunity to go to much higher scale in 2018 has presented with landmark studies in salmonella and malaria vaccines involving much larger numbers of subjects than have been studied before in Malawi. In addition, new studies of antibiotic treatments, novel rotavirus vaccine, altered pneumococcal vaccine schedules and acute management of sepsis are planned. Our behavioural scientists are investigating community perceptions and attitudes to maternal, child and adult vaccination as well as expanding previous work to discover behavioural limitations on rapid referral of very sick patients to health facilities. All of these activities are now coordinated by our newly launched Clinical Research Support Unit, led by Markus Gmeiner.

Training and career development

There are now more than 100 clinical, laboratory, epidemiology, biostatistics and behavioural science trainees at MLW training at BSc, MSc and PhD level. The rapid expansion in trainees has occurred at the same time as several previous PhD students have completed their degree and formed a new and vibrant post-doctoral science cadre in MLW. More senior post-doctoral scientists are encouraged to develop strategic plans as Associate Group Heads. The first two promotions of Associate to full Group Head with membership of the Research Strategy Group (Kondwani Jambo and Jen Cornick) have been made.

73% of trainees are Malawian, with more than 80% from Africa; 48% of trainees are women.

MLW laboratory, Blantyre, Malawi

Clinical research facilities

MLW is organised in 2 major Programmes. Programme 1 (Preventing death from infection) is largely hospital based in the acute admissions units, wards and clinical investigation facilities of the Queen Elizabeth Central Hospital. Urgent refurbishment of high dependency bays, endoscopy facilities and radiology is under way as these underpin essential studies of HIV, sepsis, pneumonia, meningitis, typhoid, tuberculosis and chronic lung disease. Programme 2 (Reducing transmission of infectious diseases) is largely community based in the Health Centres, clinics and schools of Blantyre and Chikwawa Districts. Urgent refurbishment of clinic rooms, field worker facilities including transport, data systems and geospatial mapping is underway as these underpin critical work to increase the rate of HIV self-testing and to decrease HIV, TB and malaria transmission.

Controlled human infection models

LSTM is a global leader in controlled human infection models (CHIM), particularly the experimental challenge of healthy volunteers with pneumococcus in the discovery path of new vaccines. MLW recently hosted an exciting workshop to discuss if CHIM studies could accelerate and focus vaccine discovery in Malawi. Wellcome sponsored the workshop and have subsequently invited submissions from the Major Overseas Programmes for CHIM studies in LMIC.

Policy unit and Leadership

Malawi has an under-resourced health sector and so every choice is an important one. There is no room for waste and mistakes carry a heavy penalty. There is enormous scope for impact, however, and great cause for optimism – life expectancy has risen from 45 to over 60 since the millennium. We will establish a policy partnership with multiple stakeholders this year to optimise the extent to which we answer relevant questions and use the discoveries made.

Malawi needs good leadership in every sector. Our strong Operations team, led by new COO Neil Smith, reported successful internal and external audit this year in preparation for the expanded research support needed in 2018.

Training in management and leadership form a key part of our training strategy, both in Research Groups, Research Support Units and Operational Departments. A final major success of this year was the award of MRC African Research Leader to Dr Henry Mwandumba.

Dr Henry Mwandumba

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 Lalloo, 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.

BREATHE

The BREATHE Africa Partnership (Biomass Reduction and Environmental Air Towards Health Effects) is now a well-established hub for expertise in air pollution research; the WHO has estimated that exposure to air pollution in the home through the burning of biomass fuels, results in the premature death of 4.3 million people worldwide. Partners collaborate to conduct high quality research into the impact of air pollution on health and to develop innovative and effective solutions. There are 4 BREATHE Africa PhD students researching air pollution topics. The Partnership is closely integrated with the recently funded LSTM-based NIHR Global Health Research Unit on Lung Health and Tuberculosis in Africa. The PATS MECOR research training programme has now been incorporated into the Unit to expand the opportunities available to junior researchers in Africa.

KEMRI/CDC in Kenya

LSTM has a growing collaboration in Kisumu, western Kenya, with the Kenya Medical Research Institute (KEMRI) and the US Centers for Disease Control and Prevention (CDC) with a focus on adolescent health research and malaria. These include a large intervention trial providing a menstrual cup or cash transfer to adolescent school girls led by Dr Phillips-Howard in 84 schools. The portfolio expanded this year by a new grant to monitor outcomes of DREAMS, a partnership to reduce HIV/AIDS in adolescent girls and young women. The malaria related studies led by Professor Feiko ter Kuile include multicentre trials of malaria chemoprevention in the post-discharge management of children with severe anaemia, which is ongoing in eight hospitals in western Kenya and Uganda, and two large chemoprevention trials for the control of malaria, sexually transmitted and reproductive tract infections in pregnancy scheduled to start in late 2017 in Kenya, Malawi and Tanzania. We are also in the second year of a new five-year cooperative agreement with CDC for joint malaria elimination and malaria vaccine studies in western Kenya. Professors Donnelly and Torr from Vector Biology have increased their collaboration with the entomology group in western Kenya looking at novel methods for entomological surveillance of malaria vectors and insecticide resistance. Six PhD students are currently enrolled as part of these studies.

Centre of Excellent in Infectious Diseases Research (CEIDR)

In January 2017, LSTM and the University of Liverpool launched CEIDR, a new joint centre which aims to address the urgent need to develop new antimicrobials and accelerate solutions for existing and emerging infections.

Translating research from across these two world-leading institutions, the Centre of Excellence in Infectious Diseases Research (CEIDR), has been created to develop innovative healthcare and medical technologies to improve healthcare at global and local levels. Utilizing a range of highly specialised facilities that accommodate the full lifecycle of discovery, development and deployment CEIDR will work with the NHS and industry to capitalise on the expertise and research within the institutions, allowing partners to simplify the R&D processes and reduce time and cost in order to accelerate new products into the marketplace.

CEIDR is based in the new £24m Liverpool Life Sciences Accelerator building.

The Liverpool-Guangdong Drug Discovery Consortium

The Liverpool-Guangdong Drug Discovery Consortium, is a collaboration with University of Liverpool and Guangdong University of Technology (GDUT), China. The consortium is focussed on the development of new drug therapies for the treatment of tuberculosis (TB), malaria, Neglected Tropical Diseases (NTDs) and other infectious diseases. The collaboration will not only bring results in terms of research, but will also provide some of the students involved from GDUT the opportunity to study in Liverpool.

MRC Confidence in Concept/Tropical Infectious Disease Consortium

LSTM's Research Centre for Drugs & Diagnostics (RCDD) manages the Medical Research Council (MRC) Confidence in Concept which brings together much of the UK's expertise in tropical infectious diseases into a single translational partnership, known as the Tropical Infectious Disease Consortium. The Consortium is between the Liverpool School of Tropical Medicine (LSTM), the London School of Hygiene and Tropical Medicine (LSHTM), the Jenner Institute at Oxford University and Public Health England, Microbiology Research Services, Porton Down (PHE), and is strategically placed to deliver an unprecedented portfolio of domain specific expertise in all the key research areas of interest.

The Global Alliance to Eliminate Lymphatic Filariasis (GAELF)

GAELF supports WHO's Global Programme to Eliminate Lymphatic Filariasis (GPELF) primarily by advocacy and communication. LSTM has hosted the GAELF Secretariat since 2004.

According to the latest WHO Weekly Epidemiological Record, since the launch of the GPELF in 2000, a cumulative total of 6.7 billion treatments have been delivered to >850 million people. In 2016, national programmes targeted >856million people and treated 556.2 million with a programme coverage of 74%. As of 2016 20 of the 73 endemic countries no longer require mass drug administration. In April 2017 GAELF held its 9th biennial meeting as a component of the WHO NTD Summit which hosted seven disease specific meetings plus several cross-cutting themed meetings including LF and onchocerciasis and LF and soil transmitted helminths.

University of Warwick (UoW)

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.

Part of 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, coordinated by UoW, acts as a point of contact to commission modelling to address questions concerning the elimination and control of NTDs.

Lancaster University

In 2016 a MRC-funded Translational and Quantitative Skills Doctoral Training Partnership (DTP) in Global Health was established between LSTM and Lancaster University.

In 2017, the DTP programme attracted further support from the RCUK National Productivity Investment Fund for 3 Industry-linked studentships, the MRC for 2 CASE industry-linked studentships and 5 PhD studentships from LSTM's newly established NHIR Global Health Research Unit on Lung Health & Tuberculosis in Africa. The LSTM-Lancaster DTP currently has funding to support over 30 PhD studentships, most projects involving co-supervision of PhD students between the two institutions for collaborative projects in all of LSTM's departments and along the entire translational research pipeline continuum. To support the DTP programme a new MRes in Quantitative & Translational skills in Global Health was launched in 2017 by Lancaster University and LSTM to support students through the first year of the programme.

The partnership was further strengthened this year by the successful award of MRC Skills Development Fellowships (SDF) in Translational and Quantitative Skills in Global Health. The programme will receive funding for two training fellowships per year initially. In addition, the partnership received a further UKRI Innovation/Rutherford Fund award for a training fellowship aligned to RCUK's Industrial strategy. These Fellowships will allow early and mid-career postdoctoral researchers to gain vital training in both quantitative and translational skills contributing to the global health-focused translational research environment of LSTM.

University of Liverpool

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 National Institute for Health Research (NIHR) Health Protection Research Unit (HPRU) in Emerging and Zoonotic Infections MLW; CEIDR; WTCGHR; LHP; CIDG; LIV-TB to name a few.

In August 2017 LSTM was awarded degree awarding powers which now means that new students starting in the academic year 2017/18 will be receive certificates from LSTM and not UoL which has previously acted as the awarding body.

Mersey Maritime

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; training and education.

Liverpool Knowledge Quarter

KQ Liverpool is a 450-acre urban innovation district and is home to some of the world's most influential players in science, health, technology, education, music and the creative and performing arts. With over £1bn of new developments underway – and a further £1bn in the pipeline – KQ Liverpool plans to attract further investment, increase the city's employment figures, improve graduate retention and attraction rates and establish Liverpool as a key player in the Northern Powerhouse. The mix of culture, science and medicine – including Liverpool's world-leading strengths in infection and materials chemistry has already attracted the Royal College of Physicians, who are building RCP North and Proton Partners International who are building the Rutherford Cancer Centre, at the centre of the Paddington Village development.

KQ Liverpool is tasked with defining, creating and promoting the area and is fully supported by all its founding partners: LSTM, Liverpool City Council, Liverpool John Moores University, The University of Liverpool and The Royal Liverpool and Broadgreen University Hospitals NHS Trust, The Visit Hope Street Community Interest Company and Liverpool Vision.

Liverpool Health Partners (LHP)

LSTM is a member of Liverpool Health Partners, a strategic partnership of 10 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

2017 has seen the delivery of the new Liverpool Life Sciences Accelerator building, jointly owned by LSTM and the Royal Liverpool and Broadgreen University Hospital Trust. The new building co-locates experts in resistance along with relevant SMEs and provides laboratory space for those looking for answers to the global health risks posed by insecticide and antimicrobial resistance.

The NHS is increasingly calling upon LSTM's expertise is increasingly. 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.

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 power current and future studies.

LIV-TB

LIV-TB is a cross-campus collaboration between LSTM and the University of Liverpool. It organises 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.

Public Health England

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

LSTM's Professor David Lalloo continues to chair PHE's Advisory Committee on Malaria Prevention in Travellers with Professor Hilary Ranson providing entomological support for the committee and Dr Nick Beeching, LSTM Senior Lecturer and Honorary Consultant at the Royal Liverpool University Hospital, is part of the PHE Imported Fever Service. David Lalloo and Rob Harrison also sit on the PHE committee which gives advice on the management of exotic envenoming in the UK.

PHE also partners in several research projects run by LSTM, including work led by Dr Tom Fletcher on viral haemorrhagic fevers.

NaTHNac

The National Travel Health Network and Centre (NaTHNaC), commissioned by PHE, continues to protect 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 based in London.

FEATURE ARTICLE

Applied Health

Applied Health research at LSTM includes a strong focus on taking interventions from regulatory approval through to field implementation, advocating for the improvement of policies and guidelines based on evidence, ensuring practices reflect the best possible outcomes and reduce the burden of morbidity and mortality in disease endemic countries.

CAHRD

The Collaboration for Applied Health Research and Delivery (CAHRD) has been instrumental in securing substantial grant funding for applied health research in Africa, which led to the NIHR Global Health Research Unit on Lung Health and Tuberculosis in Africa, as well as the EU funded TB-IMPACT programme in Nepal and Vietnam. CAHRD provides support to these programmes as well as cross-LSTM activities, including the LSTM health economics and modelling (HE&M) group.

CAHRD continues to support the MRC Doctoral Training Partnership PhD programme, most notably through the funding for five African PhD studentships linked to the NIHR Global Health Research Unit on Lung Health & TB and the recently funded MRC Skills Development Fellowship Programme. LSTM now has MRC-funded pathways for up and coming global health research clinicians and scientists from pre-doctoral to early post-doctoral phases of their careers.

Health Systems Strengthening Group

The health systems strengthening group at LSTM brings together diverse and complementary disciplines. It conducts operational and other empirical research with the common aims of strengthening health systems, bringing evidence into policy and ensuring impact that benefits health. We take a collaborative approach with many staff working across the different thematic areas and research grants detailed here.

Health systems and human resources

The health systems and workforce strengthening unit has developed an action research approach for strengthening management at district level, primarily to improve workforce performance. This approach was tested in the European Commission (EC) funded PERFORM programme under the FP7 scheme in Ghana, Tanzania and Uganda. The work continues in Ghana, Malawi and Uganda with a research grant under the EC's Horizon2020 programme. The project's research component includes costing and political economy analysis to monitor the scale-up process, not only supporting the expansion of the PERFORM approach, but also informing the scale up process for any health intervention.

Ghana rural hospital sign

ReBUILD, which is led by Tim Martineau and focuses on health systems strengthening in fragile contexts, has been extended by DFID for an additional two years. New studies include analysing approaches recruitment and deployment of health workers after the conflict in Timor Leste and analysing the experiences, opportunities and constraints faced by Sierra Leone's community health workers using life histories and photovoice. LSTM's research Capacity Strengthening Project (funded by EDCTP) led by Jo Raven in collaboration with the Sierra Leonean College of Medicine and Applied Health Sciences is bearing fruits.

Community health systems

We have expanded as a group this year and now have a team of 21 people, including doctoral students. Two new projects have started – one in collaboration with a clinical trial on new antiretrovirals for HIV in late pregnancy (DOLPHIN2) and one as part of the multidisciplinary IMPALA NIHR Unit on TB and lung health. Our five post-doctoral research assistants work in community health equity, community-led models of service delivery, community advocacy and engagement and on investigating referral and linkages between communities and health systems.


REACHOUT members at their last consortium meeting in Malawi

The REACHOUT network has published 11 papers this year on community health quality and continues its work with close-to-community providers in Malawi, Mozambique, Kenya, Ethiopia, Bangladesh and Indonesia. It has developed new methods and approaches to quality improvement, referral and supporting the interface role that close to community providers play in linking communities and health systems.


Community health worker in Bangladesh

Gender and health

The Research in Gender and Ethics: Building stronger health systems (RinGs) consortium has been awarded an additional two years contract from DFID. RinGs is a partnership which brings together four research networks encompassing 23 institutions across 26 countries to galvanise priority for gender and ethics in health systems research. Highlights include in a forthcoming special issue of Health Policy and Planning on gender and health systems; and tools and resources on gender equity and intersectionality which have been used in a range of fora globally, regionally and at the national level.

Research in Gender and Ethics
Building stronger health systems

Within COU**NTD**OWN we have been taking forward work on gender and equity in collaboration with NTD programmes. This has involved testing out new WHO guidelines on gender and NTDs in collaboration with Sightsavers in Nigeria and presenting the findings at the highest technical level in the WHO. With the Capacity Research Unit (CRU) we are exploring how to create gender equitable scientific career pathways as part of the Developing Excellence in Leadership, Training and Science (DELTAS) Learning Research Programme.

Research capacity strengthening

CRU is continuing its long-term collaboration with the Royal Society and DFID to support UK-African research consortia to identify and implement strategies to improve doctoral programmes and develop the universities' research environment, with a particular emphasis on laboratory capacity. The DELTAS Africa Initiative Learning Research Programme, in partnership with AESA at the African Academy of Science, is producing research-based learning about training and developing world-class researchers, fostering their careers and collaborations and promoting research uptake.

Increased funders' interest in maximising value for money and ensuring sustainability has seen several new major projects awarded to CRU in the last year, including collaborating on three new GCRF projects. It is also a partner on LSTM's new IMPALA Global Health Research Unit in Lung Health and TB, which will generate robust evidence about what works for fostering multi-disciplinary research.

Monitoring, evaluation, training and research
In 2017, Monitoring, Evaluation, Training and Research (METRe) continued its support to the Government of Bihar, India, and CARE International to strengthen and quality assure monitoring and evaluation systems for its ambitious maternal, neonate, child and reproductive health programme. 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 continued its support to the Ministry of Health by completing two major national studies. The first applies LQAS in 9 of 10 states to assess the key maternal, newborn, child, reproductive mothers, newborns and children. With DFID funding METRe has now begun its new activities in support of the Ministry of Health of Nepal to engage in M&E and operations research in support of its National Health System Strengthening Project (also funded in part by DFID). METRe has now developed a new method that brings together information from probability samples and recurrent information system to create hybrid prevalence estimators. It also has supported LSTM's NTD programme to assess Mass Drug Administration for Lymphatic Filariasis in sub-Saharan Africa.

Health Systems Global

LSTM is delighted to be part of the team hosting the prestigious Health Systems Global conference in Liverpool 8-12 October, 2018. This is the first time the conference will be held in the UK. The symposium theme has been agreed – "Advancing Health Systems for All in the SDG Era"; the website launched; and the Local Organising Committee established, which includes many members from across LSTM, ensuring the symposium has a local flavour.

Evidence Synthesis

Cochrane
Infectious Diseases

Congo-haemorrhagic fever, typhoid vaccines, cryptococcal meningitis and community programmes for deworming: just a few of the topics that The Effective Health Care Research Programme Consortium summarised evidence on for World Health Organization Guideline Development in 2017. Even more exciting was the fact that the WHO commissioned the group to lead the work generating the evidence reviews and summaries on which to base the Malaria Vector Control guidelines for their Global Malaria Programme.

One of the reviews we conducted in translational research of animal studies in relation to new TB vaccines was picked up by BBC Radio 4's File on 4 and taken further by the Daily Telegraph in an article about the quality of informed consent. The uncertainties and debates around this continue, but the Consortium is now part of the UK Expert Committee responsible for mandated guidelines for reporting animal research in this country.

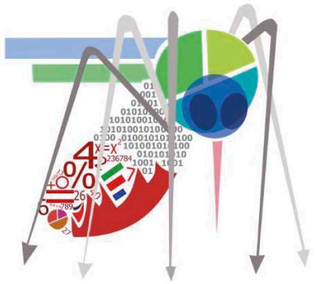
The Consortium's work on systematic review updating has now been formally accepted by the Cochrane Editor in Chief and adopted across the whole Collaboration, meaning all 7000 Cochrane reviews will now need to be classified against this system.

Health economics

LSTM's health economics & modelling group continues to grow covering health economics, operational research, health technology assessment, and related disciplines. It holds collaborations across all research departments of the LSTM and with over 20 partner institutions and LSTM-related project teams in Sub Sahara Africa and Asia, and provides academic support in even a larger number of settings across the world. These collaborations lead to additional funding, involvement in ongoing and new LSTM projects, and joint and stand-alone courses.

Projects relate to major and neglected tropical diseases, such as malaria, tuberculosis, HIV-infections, as well as chronic diseases such as diabetes, cardiovascular disease, lung health and cancers. Ongoing collaborative work on the 'Cholera Investment Case' with icddr,b in Bangladesh and on chronic diseases with Johns Hopkins University, USA, are of high global policy impact. 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.

The group's work on the interaction of poverty and disease will contribute to LSTM's REF profile, and to several other major LSTM projects. The group is currently involved in three NIHR funded projects: on Lung Health and Tuberculosis, HIV and non-communicable and snakebite in 14 African countries.



DDMS

The Disease Data Management System, a decision-support tool targeted to vector-borne disease control programmes, continues to be implemented in vector control programs in Africa, India, and South-East Asia. This year, it has also undergone a makeover. With enhanced functionality including interactive geo-dashboards, interoperability with other major health information systems, and intelligent dataset creation, DDMS Onyx will be released early in 2018. LSTM researchers are currently coordinating evaluation of the tool with several partners in sub-Saharan Africa.

"The funding allowed me to follow a programme which more than lived up to my expectations. When I go back and treat my patients, I have a better knowledge and understanding to help my patients.

- Giri Shan Rajahram (Malaysia), Merit Scholar, Diploma in Tropical Medicine & Hygiene

Community Liaison Team member Florence Chibwana with her husband near their home in Lauji Village, Malawi.

Community Liaison Team volunteers are a crucial 'bridge' between researchers at the Malawi-Liverpool-Wellcome Clinical Research Trust and study participants; their local knowledge and expertise is an important part of any community-based study.

This image was taken by Maria Wilson, a fellow resident of Lauji Village and a participant in the Cooking and Pneumonia Study (CAPS). Participatory photography was used as a method to understand how gender dynamics influence decisions regarding the use of clean cooking interventions in rural Malawian households.

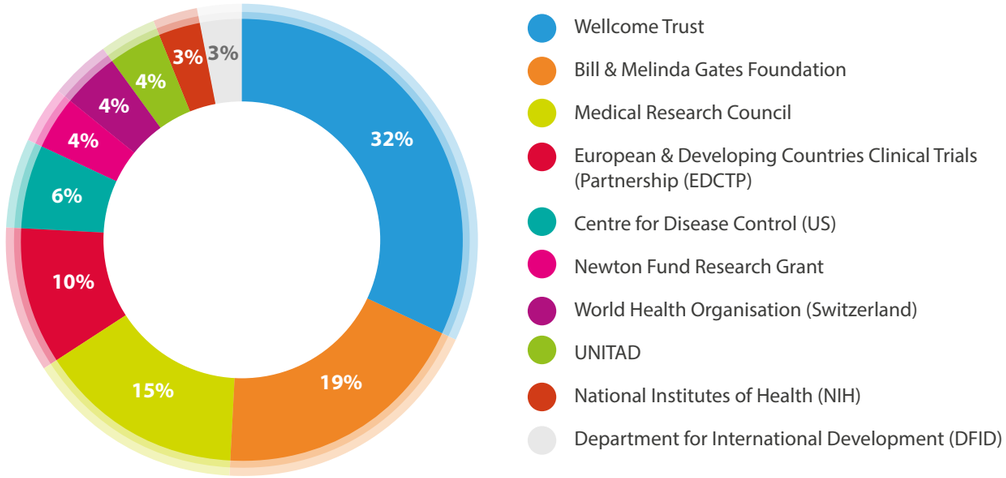
LSTM's top research funders

The tables below show the top funders in terms of total contract value (by ultimate source of funding) for LSTM during financial years 2015/16 and 2016/17.

The comparison of the two last financial years shows that the awards during the year largely remained the same: Bill & Melinda Gates Foundation; Wellcome Trust; Medical Research Council and UNITAID. In the financial year (FY) 2016/17, the top funder was the NIHR[2].

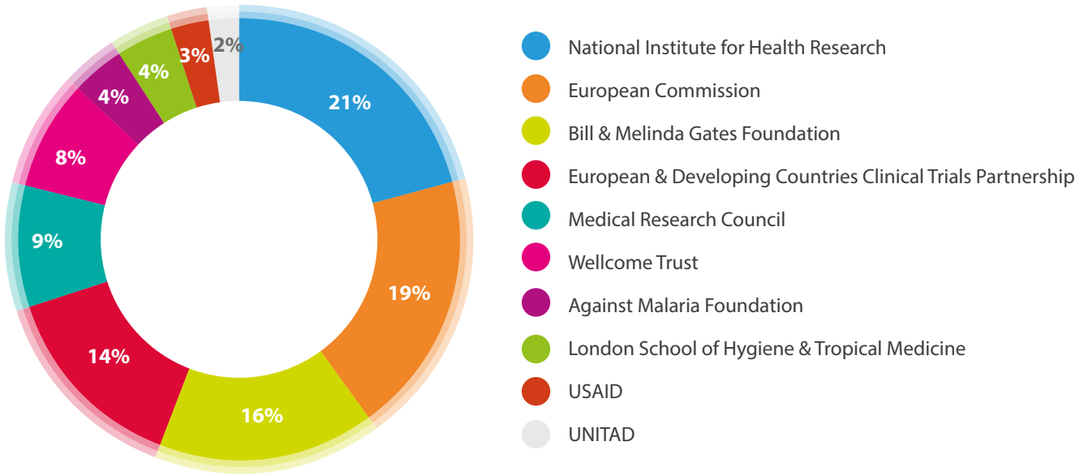
Top 10 research funders (by total contract value) - FY 2015/16

Source: *Advanced Analytics [15.09.2016]*



Top 10 research funders (by total contract value) - FY 2016/17

Source: *PowerBI [07.09.2017]*



[1]Top funders by total contract value, not number of applications awarded.
[2] LSTM successfully secured £11 million under the first wave of NIHR Global Health Research call.
[3] Lead recipient of BMGF grant which includes DREAMS (Kemri & CeSSHAR involvement)

Research Committee

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 Management Committee on the strategic direction of research, identifying priority areas for research, as well as developing and promoting policies and practices that stimulate research programmes.

Professor Giancarlo Biagini - Chair of the Research Committee

Following Professor Biagini's appointment as Chair and Dr Kevin Mortimer as deputy chair in 2016, the Research Committee (RC) revised its Terms of Reference to align with institutional strategic priorities and changed committee membership. This was approved by management and reconfirmed in July 2017.

During the past academic year, the RC released a new LSTM Publication Policy, which incorporates more detailed authorship guidelines in line with the International Committee of Medical Journal Editors (ICMJE) criteria. The policy also contains information regarding the depositing of papers on the LSTM Online Archive and the Open Access requirements.

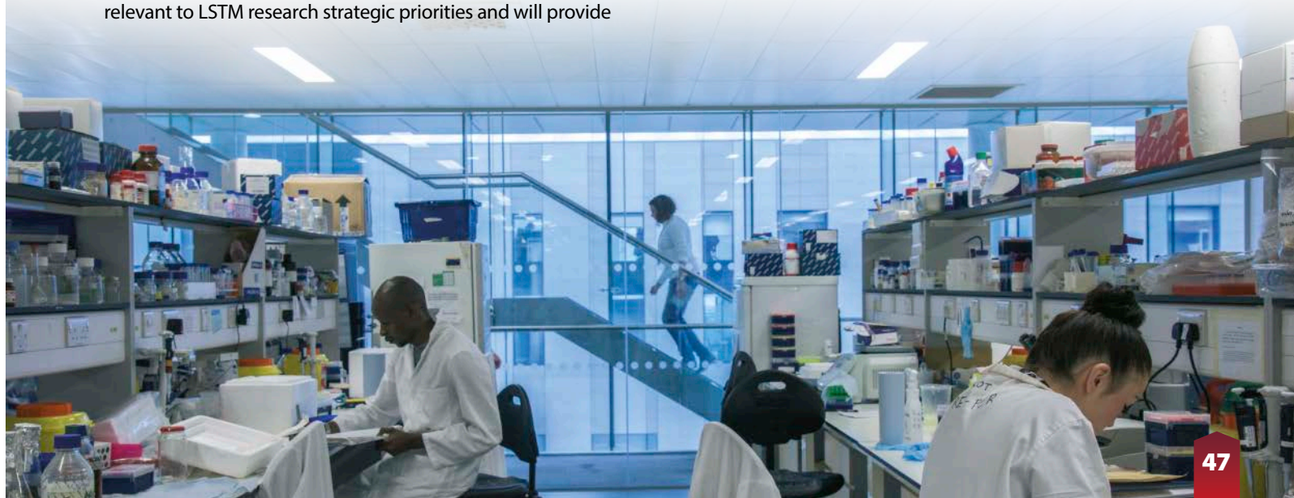
RC also has responsibility for overseeing the implementation of LSTM's Research Strategy at an operational level as well as monitoring achievement of its priorities. New benchmarking exercises were introduced in 2016/7 whereby institutional research outputs were collated and assessed against the sector. Data generated from these exercises have enabled evidence-informed decision making of how to improve LSTM's research outputs and research environment.

In 2016/17, the Research Committee launched the Director's Catalyst Fellowships with the aim to support early stage projects and innovation for early career researchers. The fund was introduced to support high-quality research projects relevant to LSTM research strategic priorities and will provide pump-priming for new and innovative ideas and projects. The awardees are to benefit from mentorship and support from senior academic colleagues, enabling to nurture LSTM's future research leaders.

The first inaugural round was highly competitive resulting in five fully-funded (£50,000) projects. The successful awardees and projects included the following:

- Dr Shaun Pennington, who will look at a novel model to study invasive Salmonella disease and assess novel treatment strategies
- Dr Thomas Edwards, who will look at a diagnostic tool to detect a range of AMR makers
- Dr Simon Jochems, who will look at the role of nasal monocytes in protecting against pneumonia in children
- Dr Jennifer Lord, who will look at improving experimental estimations of mosquito borne diseases
- Dr Stuart Ainsworth, who will assess the use of applying snakebite-inspired treatments to tackle necrotizing bacterial infections

These projects reflect the wide breath of translational research activities in Global Health being undertaken in LSTM, whilst also underlining our commitment to the future research leaders stemming from the internal talent pool.



Department of Education & Training

Over the 2016/17 academic year we have been focusing on two key milestones:

- Granting of degree awarding powers for Taught and Research Degrees
- Approval and launch of the Teaching Expansion Plan as a core priority area of LSTM's Strategic Plan 2017-2023

Dr Sue Assinder – Director of Education

We now have an unprecedented opportunity to transform the education agenda at LSTM. Our ambitious Teaching Expansion Plan is enabled by our Degree Awarding Powers, which in turn will enable LSTM to expand its teaching offer in an agile and flexible manner to increasingly dynamic market forces.

At the Council Chamber, Whitehall

THE 14th DAY OF AUGUST 2017

BY THE LORDS OF HER MAJESTY'S MOST HONOURABLE PRIVY COUNCIL

Their Lordships, in exercise of the powers conferred upon Them by section 76 of the Further and Higher Education Act 1992(a), are pleased to order, and it is hereby ordered, as follows:

Citation and commencement

1. This Order may be cited as the Power to Award Degrees etc (Liverpool School of Tropical Medicine) Order of Council 2017 and shall come into force on 14th August 2017.

Competence to grant awards

2. With effect from the date of this Order, Liverpool School of Tropical Medicine shall be competent to grant awards of the kind mentioned in paragraphs (a) and (b) of section 76(2) of the said Act.

Deputy Clerk of the Council

Degree awarding powers

LSTM was granted degree awarding powers by the Privy Council in August 2017 following a process of assessment over two years by the Quality Assurance Agency (QAA). This means that students who begin their studies from September 2017 will receive their degree certificates from LSTM and not the University of Liverpool, which previously acted as the awarding body. Our graduates have always been proud of their association with LSTM, and now their degree certificates will fully reflect that.

This was the final stage in a journey that began in 2013 with LSTM being granted status as an independent higher education institution. The process involved the QAA scrutinising over 1,000 documents, observing meetings, and getting feedback from staff and students as well as external examiners. While the excellence of teaching at LSTM has never been in question, LSTM needed to demonstrate that it had all the correct policies and processes in place, which is particularly difficult for an institution as small as LSTM. The report from the scrutiny team noted that external examiners speak highly of the academic standards required and achieved and highlighted the leadership qualities evident throughout the institution.

Michael Lurie – Director of International Education & Knowledge Exchange

Teaching expansion plan

We have undertaken significant research and engagement with key stakeholders to refine our areas of focus moving forward. This includes discussions with staff, external experts in the field of Global Health, industry experts, current, past and potential students, senior policy makers at governmental level across our key markets and an array of other partner organisations.

The outcomes of this activity enabled us to focus our portfolio around a Global Health context and strengthen LSTM as the 'go-to' institution for Global Health professionals and leaders. Our flagship programme will be an MSc Global Health that is innovative in its content and delivery model, and distinctive in its field-led and research-informed approach. The opportunity to study part of this programme outside the UK supports our ethos of working with regional partners in markets of need to ensure a truly global offering.

LSTM Annual Report 2016-17

The Teaching Expansion Plan is predicated on diversification across several areas:

- Delivery models

We will significantly increase our distance learning offering to enable a more accessible and flexible programme offering for our students. A range of face to face, fully online as well as blended learning programmes will be core to our offering.

- Programme portfolio

We will offer a continuum of learning opportunities from short courses to PhD level and we will provide conversion and pre-masters programmes for students looking to embark on a Global Heath pathway

- Study location

We will offer our programmes not only in the UK but also in other markets of need, including an incremental rollout into Africa, South East Asia and the Middle East.

Partnership initiatives

As part of our strategy to align ourselves with like-minded global players, we have formally launched and commenced development of our partnership with the international medical charity Médecins Sans Frontières (MSF) and the Humanitarian & Conflict Response Institute (HCRI) of the University of Manchester. It will deliver an educational programme designed to enhance the skills and knowledge of MSF's personnel for stronger operations and leadership in the field. This partnership provides an opportunity to showcase our offering to the wider NGO (Non-Governmental Organisation) market and will widen our footprint and impact in the global humanitarian context. Initial courses are scheduled to commence in 2018 with a full launch of the MSc Humanitarian Practice in early 2019.

The past year has seen us expand the partnerships with Royal Colleges. Our Diploma in UK Medical Practice has enrolled over 45 participants from across the globe. In addition to the existing partnership with the Royal College of Physicians, we have extended this initiative with the Royal College of Paediatrics and Child Health. Our first graduates have now returned to their home countries and will be able to disseminate and share best practice gained from their UK experience. This programme aims to maximise the opportunities presented by clinical training in the NHS to develop clinical competence and understanding of UK hospital medical practice. The partnership reinforces the complementarity of the Vision, Mission and Values of our institutions and our joint commitment to improve the health of communities across the globe. We will be seeking further collaborations with other Royal Colleges to deepen the collaborative opportunities.

LSTM online courses

In January 2017, we formally commenced delivery of our flagship online courses The Fundamentals of Tuberculosis (TB) and Travel Vaccination: Principles and Practice. We welcomed over 70 students in these cohorts from a wide range of backgrounds and countries. Feedback thus far has been extremely positive and these courses not only provide the latest knowledge in these areas, but also serve to enable professionals from around the globe to share best practice and network virtually.

These courses have been delivered on Brightspace, LSTM's virtual learning environment, which has been further developed and utilised to develop a bespoke LSTM online delivery model that is both engaging and flexible. Further online courses are in development, including Malaria Prevention in Travel Health. The rollout of online courses forms part of a key element of our Teaching Expansion Plan where we will offer numerous courses online and utilise our online pedagogical model as an example of best practice for the sector.

Supporting the student experience

LSTM students participated in two student surveys run by the Higher Education Academy. These national surveys allow us to benchmark LSTM's performance in delivering programmes against other UK institutions. In the Postgraduate Taught Experience Survey for MSc students, LSTM scored higher for no less than 33 of the 35 questions when compared with the combined average results from the other 'Small and Specialist' institutions. Our delivery of teaching gained a satisfaction score of 91%, compared to a sector average of 80%, and we also excelled on the quality of project supervision (87% versus 65% for the sector). Furthermore, LSTM is on an upward trajectory, improving on our own performance from last year for 30 of the questions. Special mention going to the Library for a spectacular jump from 50% to 80% satisfaction, reflecting the work that has gone into reconfiguring the Library space to create a vibrant student-centred environment to support individual and group work. Our overall satisfaction score was 86% (up from 77% last year). LSTM PhD students participated in the Postgraduate Research Experience Survey and again reported a very pleasing overall satisfaction score of 80%.

Supporting students

LSTM has 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 Government Postgraduate Loan scheme. In 2016-17, LSTM awarded over £100,000 in scholarship funds to students who would not otherwise have been able to pursue their studies.

LSTM also supported students from the humanitarian studies MSc programmes with financial support to organise a one-day national conference, which for 2016-17 was on the theme of 'Sustainability 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.

Promoting our teaching portfolio

Increasing the promotion of LSTM's teaching agenda remains a high priority. We have successfully held further Postgraduate Open Days that have showcased our offering to potential students and these have been celebratory events where all staff have been actively involved. The impact of these events has been significant and directly contributed to recruitment of new students.

We have started working on the development and implementation of an integrated Marketing Plan to reflect cross working and strong partnership with the Fundraising and Communications Teams at LSTM that will enable us to deliver on the ambitious targets set out in the Teaching Expansion Plan.

Outdoor teaching of MSc students at Preston Montford in sampling of freshwater

Visitors of the Open Day tour the Dagnal teaching lab

STUDENTS AND COURSES

TOTAL TAUGHT STUDENTS

606

RESEARCH STUDENTS 2016-17

TOTAL **142**

Overseas **80**

HEU (UK & EU) **62**

SHORT COURSES/ MODULES

138

Overseas **72**

HEU (UK & EU) **66**

ONLINE COURSES

74

Overseas **20**

HEU (UK & EU) **54**

MScs

MSc in International Public Health

TOTAL **22** — HEU (UK & EU) **13** — OVERSEAS **9**

MSc in Humanitarian Studies

TOTAL **14** — HEU (UK & EU) **13** — OVERSEAS **1**

Biology & Control of Parasites & Disease Vectors

TOTAL **17** — HEU (UK & EU) **15** — OVERSEAS **2**

Humanitarian Health Programme Management

TOTAL **3** — HEU (UK & EU) **2** — OVERSEAS **1**

MSc in Tropical & Infectious Diseases

TOTAL **9** — HEU (UK & EU) **6** — OVERSEAS **3**

Molecular Biology of Parasites & Disease Vectors

TOTAL **15** — HEU (UK & EU) **12** — OVERSEAS **3**

MSc in Tropical Paediatrics

TOTAL **4** — HEU (UK & EU) **1** — OVERSEAS **3**

PROFESSIONAL DIPLOMAS & CERTIFICATES

Diploma in Tropical Medicine & Hygiene

TOTAL **167** — HEU (UK & EU) **141** — OVERSEAS **26**

Diploma in Tropical Nursing

TOTAL **113** — HEU (UK & EU) **61** — OVERSEAS **52**

Diploma in Humanitarian Assistance

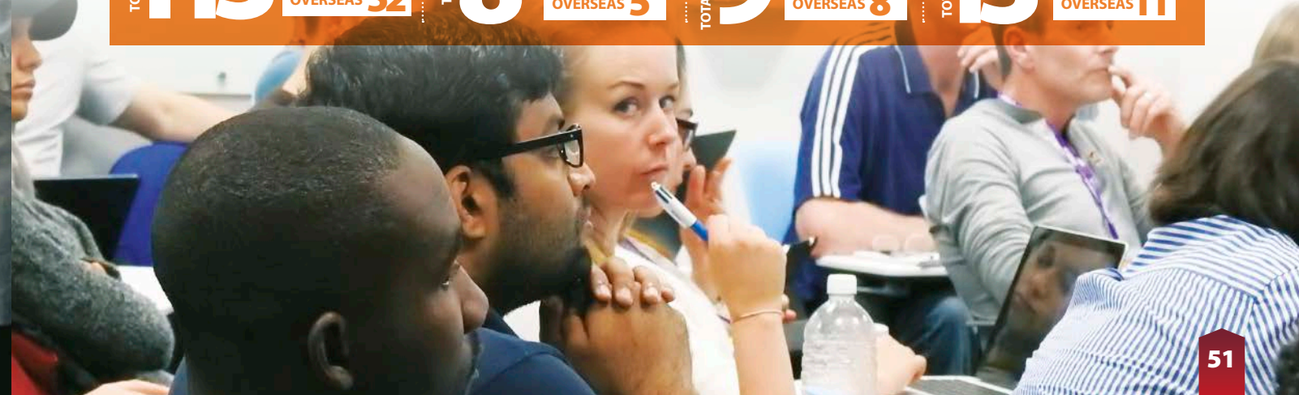
TOTAL **8** — HEU (UK & EU) **3** — OVERSEAS **5**

Diploma in Sexual & Reproductive Health

TOTAL **9** — HEU (UK & EU) **1** — OVERSEAS **8**

Certificate in International Health Consultancy

TOTAL **13** — HEU (UK & EU) **2** — OVERSEAS **11**



Clinical Diagnostic Parasitology Laboratory (CDPL)

The CDPL offers a referral service for the identification of a wide range of human parasites from clinical specimens. The team in the CDPL examined around 4000 clinical samples throughout this year.

Jayne Jones - Manager of CDPL

These samples were referred to the CDPL from NHS trusts and private clinics throughout the UK as well as those throughout Europe. The laboratory provides diagnostic testing for a full range of human parasitic infections including some of those that LSTM specialises in such as malaria, filariasis, schistosomiasis, strongyloides and African trypanosomiasis

This year was a major one for the Clinical Diagnostic Parasitology Laboratory (CDPL) with the achievement of UKAS accreditation to ISO15189:2012 International standard for all tests placed on scope of practice. The CDPL has been CPA accredited since 2012 and there has been a recent shift for all CPA accredited medical laboratories to move to UKAS accreditation before CPA ceases in 2018.

The focus for the CDPL throughout this year was to perform a gap analysis between CPA standards and International Standard ISO15189:2012 and work to address these gaps to ensure successful transition from CPA accreditation to UKAS accreditation.

October 2016 saw the UKAS team visit LSTM to carry out their assessment of the CDPL. The assessment looked at all areas of the laboratory including staffing, diagnostic procedures and quality management system. This assessment was a great success which resulted in UKAS accreditation being awarded for all tests placed on scope of practice following completion of some minor non-compliances. The CDPL received their offer of accreditation in May 2017.

The transition from CPA to UKAS accreditation was a large undertaking for a small non-NHS medical pathology laboratory specialising in Diagnostic Parasitology. The process was managed by the Laboratory & Quality Manager, Mrs Jayne Jones. This accreditation demonstrates the quality service provided by the CDPL to service users around the UK and Globally. Service users are assured that they are receiving a quality service, provided by professional staff who are using the tests appropriate to their user demographic.

The CDPL is enrolled in four national external quality assurance schemes for faecal parasitology, blood parasitology, parasite serology and malaria rapid. A variety of samples are sent throughout the year for diagnosis. Full marks have been gained within all four schemes throughout this year.

The team is managed by Jayne Jones who celebrated her 25th anniversary of working at LSTM in August 2017. Jayne is supported by biomedical scientists Iain Slack, Ann Marie Riley and Jessica Mason, and medical laboratory assistant Paula Wright, who has 34 years' service at LSTM. The team are therefore highly experienced in diagnostic parasitology.

This year has seen the CDPL integrate with LSTM's diagnostic research team led by Dr Emily Adams. This link will provide the mechanism for validation and verification of molecular tests that will enhance the portfolio of the diagnostic testing performed within the CDPL. This link will also strengthen the bonds between clinical work and research being performed within LSTM. Maintaining accreditation and enhancing the test repertoire we provide are both major objectives for the coming year.

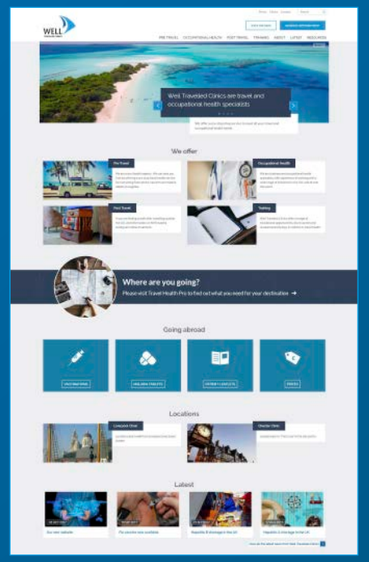
> *"My scholarship has afforded me the opportunity to learn in a world-leading research institute with outstanding academics, who have real-life work experience from my own setting: a resource poor setting."*
>
> ***- Rhoda Oluwabunmi Adebayo (Nigeria), Merit Scholar, MSc in Tropical Paediatrics***

Senior biomedical scientist Iain Slack examines patient's blood for malaria parasites

Well Travelled Clinics

Philippa Tubb - WTC Managing Director

Well Travelled Clinics (WTC) has had another stable year across its branches in Liverpool and Chester. In 2016-17 we saw around 9,500 clients and our turnover was on forecast. WTC is now in a strong position and the Board of Directors approved a new three-year business plan, whch will see our services continue to grow and develop.



As part of our continued growth, a new website has been developed which went live by the end of September 2017.

Occupational Health work continues to be a strong business line and now accounts for 16% of our revenue. WTC is continuing to develop its specialist clinical occupational health services, and have recently recruited an additional doctor to the team to increase our capacity to meet the needs of our clients going forward.

Our Chester branch continues to develop and following the success of increasing our opening hours over the last year, we now have plans in place to extend these again and will be opening 5 days a week (Tuesday to Saturday) from September 2017.

In January 2017, WTC launched a new online module: 'Travel Vaccination Principles and Practice', which was developed in conjunction with the Technology Enhanced Learning (TEL) Unit and education team at LSTM. The course ran three times in 2016-17 and there are now plans for the module to run 5 times per year. A further on-line module is now in development which will be released in November 2017 on 'Malaria Prevention in Travel Health'. WTC continues to run the 3-day classroom-based 'Introduction to Travel Health' course in February of each year.

WTC continues to provide specialist occupational travel health services to a number of organisations who send staff to work overseas. We work closely with 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 expanded the educational work we do for UKMED and now teach on their pre-deployment and deployment courses which run every month.

Over the past year, we have retained all our existing corporate members and gained some new clients, who are using our specilialist services.

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 LSTM's Department of Vector Biology years ago, it provides an efficient service to industrial partners to screen new chemicals against insecticide-resistant populations, using a variety of biological assays.

The LITE team moved into a bespoke designed new facility, which is part of in the new Liverpool Life Sciences Accelerator (LLSA) building. As of October 2017, this new facility will enable us to expand the services we offer and the range of clients we provide for, aiding us to achieve our vision of being the partner of choice for evaluating products to control insect disease vectors.

Our new facility will enable us to dramatically increase our mosquito rearing capacity and to implement additional bespoke methodologies including those to assess spatial repellent products and to investigate behavioural responses to insecticides.

LITE has also added HPLC (High Performance Liquid Chromatography) to its range of services, and once fully validated will be offered up for client testing to quantify insecticide residues on surfaces in 2018.

Once settled into the new facility and new processes embedded, an application will be made for Good Laboratory Practice (GLP) accreditation to the Medicines and Healthcare Products Regulatory Agency (MHRA).

LITE continues to collaborate with both industrial and research partners. A new partnership with IHII (International Healthcare Innovation Institute) in Jiangmen, China, has been established to assist with the set-up of new testing facility in China. LITE has also partnered in successful applications to the MRC Confidence in Concept Scheme to conduct the following projects:

- **Controlling malaria transmission using environmentally 'friendly' sugar baits**

Principal Investigator: Alvaro Acosta-Serrano, LSTM

Co-Investigators: Mark Paine (LSTM); Dr Rosemary Lees; Helen Williams (LITE-LSTM); Prof Pedro Oliveira (UFRJ, Brazil)

- **In vivo screening of resistance breaking compounds**

Principal Investigator: Gareth Lycett, LSTM

Co-Investigators: Rosemary Lee (LITE); Dave Malone (IVCC)

- **Development of smart materials for insect vector control**

Principal Investigator: Mark Paine (LSTM)

Co-Investigators: Prof Rasmita Raval (UoL, Interdisciplinary Research Centre); Helen Williams (LITE); Rosemary Lees (LITE/LSTM); Mark Rowland (LSHTM)

Environmentally controlled storage units for surfaces which are being tested at set timepoints to see if insecticide products still work

IVCC

IVCC is a Product Development Partnership (PDP) investing donor funds in research and development to deliver and enable vector control tools and solutions in challenged public health markets in the face of rising insecticide resistance.

Dr Nick Hamon - CEO of IVCC

Started originally by LSTM in 2005 through a grant from the Bill and Melinda Gates Foundation (BMGF), IVCC evolved into a stand-alone PDP with multiple funding partners and supported by its own Board of Trustees. Today, IVCC is the primary funder of the LITE facility at LSTM, purchases services and support from LSTM and works closely with many LSTM scientists on a wide range of projects from training through gaming to mechanisms of resistance.

Since 2008, research-based agrochemical companies have provided access to their chemical libraries, with 4.5 million chemical compounds reviewed for activity against public health vectors. After evaluating 27 classes of chemistry and several major synthesis programs, nine compounds from five chemical classes have been identified as having potential for vector control use. Within the next year, several compounds will be promoted to full development, eventually providing a suite of new chemical tools to support the malaria eradication.

Product development is a high risk and high reward enterprise, particularly the identification and development of novel active ingredients for vector control from bench to market. Few can afford to play the product development game: it takes vision, funding and a long-term view. Therefore, Product Development Partnerships (PDPs) such as IVCC play a vital role in challenged public health markets.

Success or failure is not just determined by good science, but also by other factors such as partner commitment and, somewhat surprising to many, luck! Adequate funding is also not a guarantee of success. An innovation partner, even when funded, may well consider the cost of capital and opportunity cost too great to want to proceed with a project, especially if they do not see any potential for positive disruption in a challenging market such as vector control.

Field trial sites in Moshi - Tanzania - where indoor residual spraying of insecticides is being tested.

IVCC works to encourage and support innovation partners through a wide range of initiatives. Its project portfolio contains both new and repurposed tools; the final toolbox of solutions for malaria eradication will likely be a combination of both product types, as well as others still in the proof of concept stage. The toolbox is slowly but surely starting to emerge; Syngenta's long lasting indoor residual spray, Actellic® 300CS, is having a demonstrated impact on transmission in areas of high insecticide resistance throughout Africa, with support from the Unitaid-funded NgenIRS program. Bayer's PolyZone is in use against a range of NTDs, Insecticide Quantification Kits (IQK) and Disease Data Management System (DDMS) are in use in Africa and India, BASF's Interceptor® G2, the first dual active ingredient LLIN and Sumitomo's Sumishield® should be available late this year or early next. Enabling initiatives such as Good Laboratory Practice (GLP) accredited African trials sites are gaining traction with the first accredited site established this year in Moshi, Tanzania, with up to six further sites planned for 2018/2019.

The original mission of IVCC was to maintain the gains in malaria decline made since 2000 by replacing current active ingredients in LLINs and LLIRS with new or repurposed chemistries to manage resistance and improved performance. Multiple classes of insecticide with different modes of action will facilitate vector control IRM in line with WHO Global Plan for Insecticide Resistance Management (GPIRM). However, to eradicate malaria, we need to go further and make available an integrated toolbox of solutions that include novel active ingredients and repurposed chemistry, insecticide resistance management (IRM) strategies, Integrated Vector Management (IVM), improvements in application technology as well as tools to prevent residual transmission or manage populations such as Attractive Targeted Sugar Baits (ATSBs) or Gene Drives. The 'impatient optimists' amongst us want to go faster, compressing the timeline to eradication, which means we need coordinated and optimized use of vector control products, drugs, vaccines and diagnostics) as well as the ability to identify and manage key potential sources of acceleration and delay in bringing new interventions to market.

As IVCC moves its product portfolio one step closer to market, old challenges are solved as new challenges emerge. However, ever-present is sustainable funding, which ties strongly to risk management. More funding helps to de-risk the highly risky product development process.

Estates

Estates continues to work with LSTM's education and research groups to facilitate responses to new opportunities, both in the UK and overseas, and identify where space may be used more efficiently.

Liverpool Life Sciences Accelerator (LLSA)

Research teams from the Faculty of Biological Sciences relocated into the state-of-art-laboratories within the Liverpool Life Sciences Accelerator (LLSA) building as of September 2017. The building is owned by LSTM in partnership with the Royal Liverpool University Hospital. LSTM occupies the top two floors of this building, which is rapidly being populated on other floors by SMEs with interests in our translational research agenda. Moving forward, Estates has responsibility for managing all operational aspects of the new building.

Liverpool Life Sciences Accelerator

The construction of the Accelerator fits in the wider plans for the so-called £2billion Knowledge Quarter Liverpool. LSTM is a founding partner and Board member of this initiative, together with the University of Liverpool, Liverpool John Moores University, The Royal Liverpool and Broadgreen University Hospitals NHS Trust, Liverpool City Council, Liverpool Vision and The Hope Street Community Interest Company.

Knowledge Quarter Liverpool

Where great discoveries are made

LSTM Liverpool campus

The capital refurbishment programme continued in the summer 2017 with the replacement of the Maegraith Wing roof covering and upgrading of the MSc teaching laboratory and seminar room environmental equipment and controls. Feasibility studies are ongoing for the remodelling of existing space and the potential use for the Pembroke House site, which was acquired in March 2017. Work commenced in October 2017 to repurpose several rooms on the first floor of Maegraith wing providing additional office accommodation for academic and professional services groups, as part of a phased expansion of LSTM's teaching estate.

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

Reception of MLW Learning and Training Centre

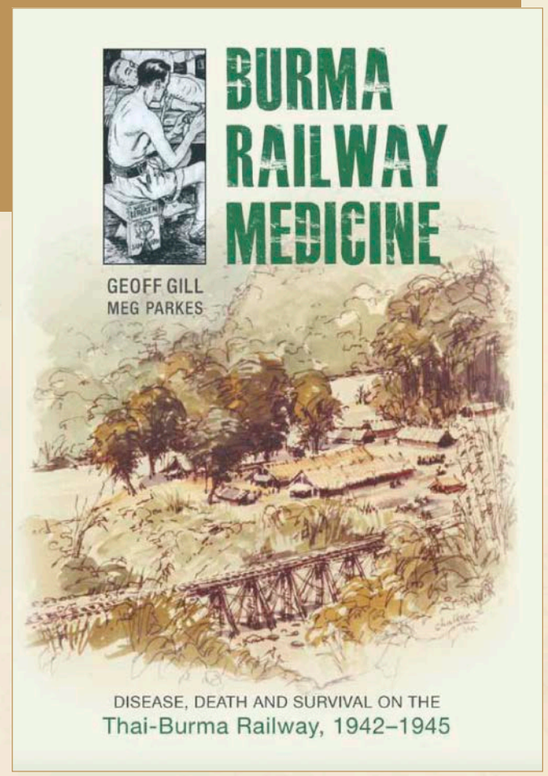
Both the Estates and Health and Safety teams based in Liverpool continue to work closely with colleagues in Malawi, exchanging ideas and providing advice and support on laboratory and general health and safety matters and overseas travel. Support has also been provided from Liverpool in the form feasibility and concept plans in support of future capital developments.

Estates structure

The structure of the Estates team (maintenance, facilities management, laboratory support and health and safety) underwent a review in September 2017. LSTM's estate has increased considerably in size and complexity over the last 10 years, both in terms of the infrastructure supporting the physical environment and specialist facilities supporting teaching and research. The new structure will ensure continued effective management of the estate in support of LSTM strategic objects, both home and abroad.

Far East Prisoners Of War (FEPOW) Project

Burma Railway Medicine, the much-anticipated companion volume to Captive Memories was published by Palatine Books in May 2017. It is based on Professor Geoff Gill's PhD thesis, and gives the first in-depth medical analysis, from a British perspective, of the medical crisis in camps on the Thai-Burma Railway 1942 – 1945.



Following the formal book launch in Liverpool in May, Burma Railway Medicine was the focus of a special event in London in June 2017. Co-hosted by LSTM and the Royal Society of Tropical Medicine and Hygiene and held at Chandos House in central London. LSTM Director, Professor Janet Hemingway, and Chair of LSTM's Board of Trustees, James Ross, welcomed over 70 guests to the event, which was chaired by broadcaster and LSTM vice-president Peter Sissons.

Among those attending were three veterans of Far East captivity: former Gunner, Fergus Anckorn (aged 98); former member of the Dutch Army and a medical orderly during captivity, retired ophthalmologist Dr Jan Bras (aged 95), and 105-year-old Dr Bill Frankland, who served as a Royal Army Medical Corps medical officer in Singapore.

Earlier in June LSTM hosted a second FEPOW history research conference. Legacies of Far East Captivity, a three-day event co-hosted by the Researching FEPOW History Group. It attracted 120 delegates and speakers from around the world, among them former child internee, Mrs Olga Henderson who, aged nine, had been interned in Singapore. Although no FEPOW veterans attended this time, delegates and speakers were delighted by the surprise visit of FEPOW Tom Boardman, aged 98, on Sunday afternoon.

From left Meg Parkes, Geoff Gill, Fergus Anckorn, Bill Frankland, Jan Bras, Janet Hemingway and Peter Sissons

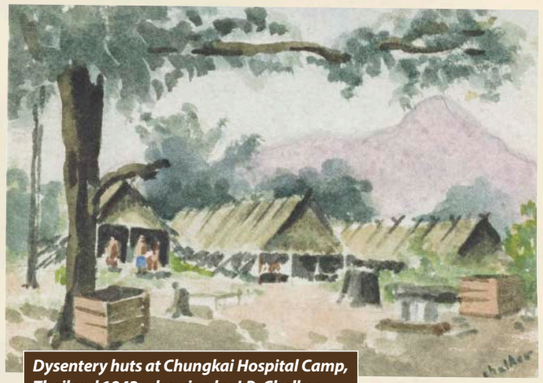
Professor Gill and Dr Nick Beeching led the conference's post-war health aftermath session, introducing guest speaker Dr Kamaluddin (Kamal) Khan. Dr Khan, a retired Merseyside psychiatrist, had worked closely with the LSTM FEPOW team for over 20 years. He was presented with leather-bound copies of both books in recognition of his invaluable work.

FEPOW history research continues at LSTM. Plans for a major art exhibition are underway, working in partnership with the University of Liverpool's Victoria Museum and Gallery. They have committed to host the exhibition, which will run late 2019 onwards. It will feature original contemporaneous documentary art work created by British servicemen, amateur and professionally-trained artists, held captive across the Far East, whose work has remained virtually "unknown" to the public for over seven decades. Their work will hang alongside examples from some of the well-known British FEPOW artists such as, Ronald Searle, Philip Meninsky and Jack Chalker. Much of their art was medical illustration and is of relevance to tropical medicine; paintings like Chalker's graphic watercolour depictions of tropical ulcers.


Tropical ulcer - drawing by J.B. Chalker

The significance of all FEPOW art work is underscored by the fact that it had to be created hurriedly and in secret and then kept hidden, as the Japanese had forbidden the keeping of writing or art materials, notes, diaries or medical reports.

Jack Chalker was a patient at LSTM in the mid-1980s when he attended for tropical disease investigations. At that time, he gave a significant photographic collection of his work to LSTM and contributed to FEPOW's oral history study.


Dysentery huts at Chungkai Hospital Camp, Thailand 1943 - drawing by J.B. Chalker

One of the most recent FEPOW artists to be discovered was a former Professor of Hygiene at LSTM, the late Dr Tom Wilson (LSTM 1961-70). In 1943, he, together with Major John Reid, compiled two secret and highly-detailed medical reports on malaria and malnutrition while at Sonkurai camp, Thailand. These were later published in medical journals.

Captain Wilson's ten drawings are the only known images of the medical facilities in Changi Gaol in 1944, after the remaining Allied POWs had been transferred there from the nearby Changi POW camp. This artwork needs to be shared with the wider public, if only to bring recognition to a small army of documentary artists who risked their lives to record what was happening around them. Over 70 years on, their work gives us a rare visual understanding of the contrasts of their captivity and their monumental struggle to survive.

> *Not only am I studying to become a public health expert with this scholarship, but I am also attending LSTM. A world-class institution with so many experts in the field, I feel blessed.*
>
> ***- Idebolo Ashibudike (Nigeria), Mamco Selab & Merit Scholar, MSc International Public Health***

Public Engagement

Over the past year, LSTM's researchers have engaged with artists, local radio, graphic novelists and science festival organisers to target new audiences within our community about its work.

Science Fridays - SciFri

Scifri, an LSTM initiative, is a BBC Radio Merseyside segment involving researchers across LSTM, Liverpool John Moores University (LJMU) and the University of Liverpool (UoL) which takes place every Friday morning. Staff members from LSTM discussed a wide range of research topics such as vector biology and antimicrobial resistance with radio presenter Tony Snell.

> *I had a surprisingly good time primarily because BBC Radio Merseyside staff are so fabulous. They are enthusiastic about learning and understanding our world, which creates a wonderful studio environment for science discussions.* ***– Dr Lee Haines, Department of Vector Biology***

Swab and Send at Thought Bubble Festival and Comic Convention

Dr Adam Robert's Swab and Send project was taken to the Thought Bubble Festival and Comic Convention in Leeds. This annual celebration of art, included everything from superhero comics to independent artists and writers. The Swab and Send team joined Sara Kenney, the creator of Surgeon X, a comic book series developed with guidance from Adam and set against the backdrop of an antibiotic apocalypse in near future London. The Thought Bubble audience were immersed into the futuristic world of Surgeon X, and with support from the Swab and Send team, helped in the search for new antibiotics as they headed towards an antibiotic apocalypse.

Bluedot festival

Bluedot is an annual festival of discovery that combines science, arts, music, and culture in one big celebration held at Jodrell Bank. This year, Vector Biology's Dr Mark Paine gave a Dot Talk entitled 'Malaria; of Man and Mosquito', which focused on how mosquitoes infect millions of people throughout the world with lethal diseases such as malaria, dengue and Zika.

> *The audience participation and general atmosphere was amazing. I've never had so many questions thrown at me. As a scientist that was extremely motivating and inspires more engagement with the public.*
> ***– Dr Mark Paine, Department of Vector Biology***

LSTM's research at Tate Liverpool

A pop-up art exhibition developed by the Artist Teachers Association and LJMU art students, inspired by the science and history of LSTM, was displayed at Tate Liverpool. The artists were shown imagery relating to LSTM's longest running collaborative project with the former Far Eastern Prisoners of War (FEPOW), their stories of survival and the beauty of the trypanosome parasites within tsetse flies and the patterns, colour and texture seen within insect wings and pupae. The final exhibition included sculptural pieces, the use of watercolour, laser-cut acrylic and the thought-provoking use of light and film.

Big Bang North West and LSTM's STEM Ambassadors Programme

LSTM's Respiratory Research team led by Simon Jochems, the A•WOL Consortium's Louise Ford and Kelly Johnston with support from Dr Emily Adams took part in this year's Big Bang North West.

Dr Emily Adams showing a tube full of mosquitoes to Bing Bang visitors

> *The more I learn about this topic [Ebola] the more interesting it becomes; this project has shifted my focus and I am now planning on doing a biology degree at university. I can only thank you for all the help you have given in making this possible!*
> ***– Izabelle Ashworth, A Level student at Winstanley College talking about advice provided by Dr Tom Fletcher regarding the Ebola outbreak.***

This STEM celebration, organised by All About STEM, is an opportunity for young people to discover the exciting and rewarding STEM-based careers available in their local area. LSTM's Respiratory Research team showcased their 'Breath-taking Pneumococcus' exhibit which used a giant floor-based Snakes and Ladders game to tell the story of the immune cells and bacteria present in people's nasal passages!

Vector Biology's Microbes to Mosquitoes Workshops at Centre 63

Vector Biology's Natalie Lissenden, with support from staff and students across LSTM, organised a series of monthly workshops at Centre 63, a youth centre in Kirkby. The project delivered high quality informal education to disadvantaged children and young people who may find it difficult to engage with STEM subjects.

Galkoff's and the Secret Life of Pembroke Place

LSTM and National Museums Liverpool are working together to preserve and display the heritage of two important sites on the LSTM campus. The iconic P. Galkoff kosher butcher shop, which opened in 1908 and is fronted with highly decorative green tiles, is located just a few doors away from the last remaining court housing in the city, typical of working class homes in mid-19th century Liverpool.

The project has been awarded a £291,300 grant from the Heritage Lottery Fund to remove and conserve the historic tiles from the façade of Galkoff's for display at the Museum of Liverpool. In addition, information obtained from the geophysical surveys conducted in and around the vicinity of the court housing will guide archaeological digs to uncover more remnants of the court housing and understand more about people's lives there.

An important aspect of LSTM's Public Engagement strategy supports collaborations with specialists in the arts to explore LSTM's research from different perspectives. As part of this LSTM hosted a visit by Wicked Fish, a local theatre and creative arts company which devises performances inspired by stories, history and personal experiences.

Staff from Wicked Fish theatre company visit LSTM's insectaries

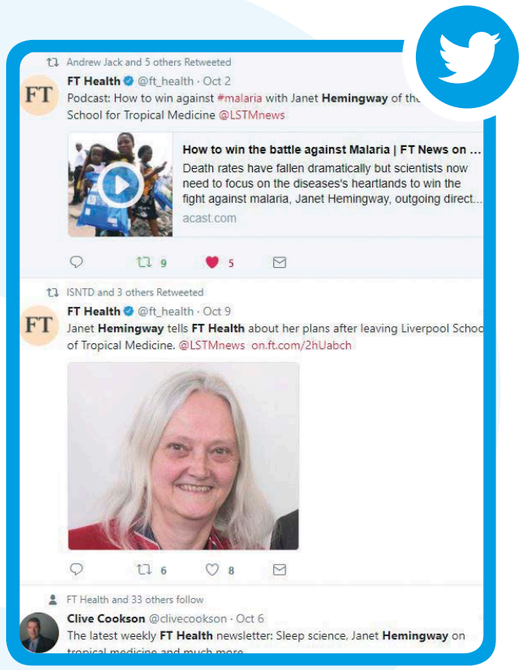
LSTM Annual Report 2016-17

LSTM in the media

Throughout 2016/17 LSTM continued to be called upon to provide media comment, interviews and editorials across a whole range of expertise to local, national and international media.

There have been numerous comment pieces in UK and international high impact journals such as the Lancet, Nature and the BMJ on various topics. Professor David Molyneux provided comment for Nature News and The Economist as well as being quoted in the special report by the Financial Times (FT) for the 5th anniversary of the London declaration on NTDs. Dr Alvaro Acosta Serrano was quoted in the FTs special report on leishmaniasis as well as being widely quoted after a CNN interview about Chagas disease.

The Financial Times also interviewed Professor Janet Hemingway on her announced retirement as Director of LSTM and how the battle against mosquito borne diseases has progressed during her time at LSTM. The podcast was widely disseminated by the FT over a period of several weeks.



There were also calls for experts from LSTM to comment on studies and papers by other academics. Professor David Lalloo was asked to comment by BBC Radio 4's Today Programme about a paper from LSHTM about four cases of imported malaria in the UK that failed to respond to treatment due to resistance. He was quoted extensively by the BBC and beyond. Dr Alvaro Acosta Serrano was interviewed by Associated Press about a study looking at why mosquitoes are more likely to bite people who were infected with malaria. He was quoted in numerous outlets including many in North America.

Throughout the year several academic papers have gained the interest of the wider media including one by Professor Richard Pleass about new ways to create and deliver medications for a wide range immune mediated neuropathies, which was featured in The Journal of Biological Chemistry. After being promoted significantly on social media and in specialist press he was commended by the journal for the exceptional visibility of his paper. Dr Nick Casewell of the Alistair Reid Venom Research Unit published a paper with colleagues in Australia about the opiate like toxins of the tiny Fang Blenny fish. The paper was picked up all over the world and Dr Casewell was interviewed by many media outlets including New Scientist, BBC, The New York times, National Geographic and Discovery. The video about the story on BBC Online was the most played video that week with over 1 million views.

A systematic review authored by Professor Paul Garner conducted about translational research of animals in relation to new TB vaccines prompted an investigation on BBC Radio Four's File on 4 and was taken further by the Daily Telegraph and the BMJ.

LSTM's Dr Adam Roberts gained substantial coverage with his antimicrobial research, his crowd funded citizen science initiative Swab and Send and the global issue of antibiotic resistance. He has been featured in Atlantic Magazine, The Times Magazine and on Radio 5 Live as well as taking part in Sci-Fri, the LSTM led initiative on BBC Radio Merseyside featuring a difference scientist from LSTM, University of Liverpool and Liverpool John Moores University each week.


Professor Mark Taylor filmed by Discovery Channel

Experts from LSTM have also been involved in several documentaries and television or radio programmes this year. LSTM was the subject of a programme about mosquito borne disease for the Discovery Channel. The programme sat among others about mosquitoes and the public health issues that they bring which included the show Mosquito, featuring Bill Gates. Infected Abroad: Mosquito Bites featured interviews with Dr Nick Beeching and Professors David Lalloo, Philip McCall, Mark Taylor and Janet Hemingway. It was scheduled several times in the UK as well as in the USA.

Professor David Lalloo was also featured in an episode of Celebrity Antiques Road Trip, when it featured LSTM in its historical segment about Liverpool and Lancashire. He spoke about history of LSTM, Sir Ronald Ross and Mary Kingsley as well as current research. The show has an average of 1.6 million viewers for its slot on BBC Two and the show has already been featured more than once. Dr Robert Harrison, Head of LSTM's Alistair Reid Venom Research Unit also appeared as an expert in an American made documentary Minutes to Die, which was about the global problem of snakebite and which had its European premiere at the Venoms 2017 symposium in Oxford earlier this year.

Dr Nick Beeching took part in a panel discussion about yellow fever on the BBC World Service radio programme The Forum. He spoke about LSTM's history in the field as well as current treatment in the UK for imported cases, while Professor Janet Hemingway was the feature of a Financial Times News podcast about how to win the battle against malaria.

Emeritus Professor Geoff Gill and Dr Nick Beeching advised behind the scenes on several scripts for BBC's Call the Midwife. LSTM's Centre for Maternal and Newborn Health (CMNH) continued its involvement with the B!RTH Project, highlighting various controversies around child birth through theatre plays. It showcased at the Edinburgh Fringe Festival followed by a debate about childbirth at Edinburgh Royal Society. The project was featured in various media outlets including the Scotsman on Sunday and BBC online.

LSTM has also featured many times in local and regional media. Professor Janet Hemingway appeared on BBC Sunday Politics North West talking about the potential problem if the academic "brain drain" from the north of England to London, Oxford and Cambridge and was also invited onto BBC Radio Merseyside to talk about LSTM as part of their series about influential women in Liverpool. Research Assistant Natalie Lissenden was interviewed and filmed by regional television channel Made in Liverpool to correspond with woman and girls in science day, talking about a typical day for her at LSTM as a way of encouraging girls to engage with science, while Dr Stuart Ainsworth from the Alistair Reid Venom Research Unit was invited onto the morning show on BBC Radio Lancashire to talk about his career path and encourage young people in his native Blackpool to realise how many scientific opportunities were on their doorstep in the North West.

Throughout the reporting period, LSTM generated 15 press releases and 127 news stories.

> *The scholarship has placed me in the position to be mentored and inspired by world leading health researchers*
>
> ***Ibrahim Swaray (Sierra Leone), Chevening scholarship, MSc Tropical and Infectious Diseases***

Registered with FUNDRAISING REGULATOR

Fundraising

Karen Brady - Director of Fundraising

LSTM was founded on philanthropy, and fundraising remains at the heart of our work to break the cycle of poor health and poverty. Donations enable LSTM to be agile in responding to emerging opportunities and challenges. This in turn means that we can be more responsive to the global health challenges facing the world's poorest communities, ensuring that our expertise remains focussed on helping those who need us the most.

Catalyst Fund and Merit Scholarships

To support the most talented students and early career researchers two exciting initiatives were launched in 2016/17: The Director's Catalyst Fund and our new Merit Scholarships. Both projects, supported through cash donations and our philanthropic endowments, enable us to directly seed-fund innovative new research projects, and attract the brightest students, regardless of their financial circumstances. This year, 28 students were supported with donor-funded scholarships, and the introduction of the Merit awards has resulted in the uptake of scholarships increasing from 40% to over 90%.

Heritage projects

Our fundraising efforts have enabled the progression of two heritage projects. A large grant from the Heritage Lottery Fund has supported the full development of Galkoff's and the Secret Life of Pembroke Place, a project which charts the lives of the many generations of people who inhabited the streets around LSTM. The project will ensure that the rare tiles on the former butcher's shop and the court housing, one of the UK's only surviving examples, will be moved and preserved at the Museum of Liverpool. An exhibition is due to open in 2018. A Far East Prisoners of War (FEPOW) exhibition, planned for 2019, has also been supported through donations from FEPOW groups. The exhibition will be hosted by the Victoria Gallery & Museum.

B!RTH

A donation from the Oglesby Charitable Trust has enabled the seed-funding of B!RTH, a three year project aimed to raise awareness of the inequality in health and health care for women across the world. It includes theatre plays aimed at influencers and policy makers in four different countries, alongside a programme of public engagement. Fundraising efforts for this project are continuing.

Research

A donation from Accuro Fiduciary Trust is supporting a project aiming to improve the Quality of Care for mothers and babies in Malawi. Additional donations are supporting research in respiratory issues in children in Africa, and research skills and methods for researchers working in Sub Saharan Africa.

A donation from the Uplands Trust also enabled LSTM to recruit Dr Adam Roberts, a specialist in antimicrobial resistance. Fundraising is integral to Adam's research as he is successfully crowd-funding his 'Swab and Send' initiative, which enables members of the public to participate in the hunt for new antibiotics.

Liverpool Life Sciences Accelerator

The Wolfson Foundation donated £1.1m towards world-class laboratory facilities in the new Accelerator building. This funding will increase our capacity to continue to lead the field in resistance and vector research, and will further increase opportunities for collaboration with industry.

Looking forward

LSTM's new fundraising strategy will focus on driving innovation in global health, in Liverpool and across the world. We will develop the next generation of leaders equipped to tackle the enormity of the global health challenges that face us now and in the future. We will work with our extensive network of partners to create an environment in which innovation can thrive.

"Thanks to this scholarship, I will be able to benefit my country in terms of ability to carry out research as well as my improved knowledge on clinical practice in the context of tropical

Farah Marumatakimanu (Samoa), Merit Scholar, MSc Tropical Paediatrics

LSTM Annual Report 2016-17

Social Mission

Christine Greenway - Director of Human Resources

LSTM's values shape its working practices and the furthering of a vision to save lives in resource poor countries through research, education and capacity building, recognising the relationship that LSTM has with its staff, students and stakeholders.

Human resources are a critical component of any organisation, particularly when the work is done in a global context and needs to meet the growing strategic and operational needs of the organisation. To keep pace with LSTM's vision, the HR team has expanded and restructured to offer a greater range of services and support. Complementing this commitment, staff across the organisation are providing a better environment for students, staff and LSTM stakeholders.

Recruitment and staff development

In recruitment and selection HR uses broadening methodologies to attract and interest new talent pools, building on our reputation as an employer within Liverpool, the UK and internationally. As new NGOs are set up in a growing number of countries we are broadening our knowledge, expertise and global reach. The ability to recruit is linked to valuing and developing staff, who are ultimately our greatest asset.

LSTM's Mentoring Scheme is encouraging participants to reach their full potential as self-reliant, self-confident and independent professionals. Regular workshops are proving very popular as those involved spread the news of the value of this activity.

Advancing gender equality

Athena SWAN Bronze Award

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. LSTM has achieved the Bronze Level at both organisational and faculty level. The Equality & Diversity Officer is helping drive forward the change management processes with staff.

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.

As a family-friendly employer and teaching institution, providing a supportive environment for employees, students and visitors, LSTM has opened new family-friendly facilities on its campus to better allow parents to care for infants in the main entrance area of the CTID building. While family friendly working practices, such as flexible working, have been taken up by an increasing number of staff.

Brexit

Since its foundation in 1898, LSTM welcomed colleagues from the EU and across the globe as part of our research and study community. We value their presence, be it for a short course or for permanent employment. LSTM has signed up to the **#weareinternational** campaign to show our commitment to remain open and inclusive to staff and students from across the world. Brexit will not change this, but we are faced with a period of uncertainty and unclarity what the impact will be on EU staff and students. LSTM will therefore continue to inform and update staff and students about the implications of Brexit and, through various representative bodies, to lobby with all relevant stakeholders to ensure the best possible outcome for all involved post Brexit.

STAFF OVERVIEW

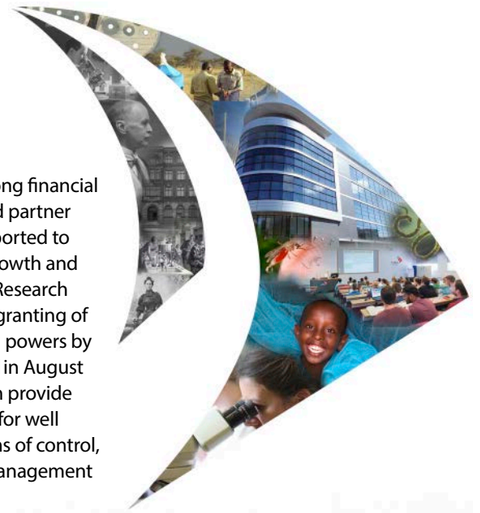
435 Staff members in the UK

37 Staff members overseas on an LSTM UK contract

472 TOTAL STAFF

Numbers as per 01/09/2017

Governance



LSTM has a long-established history in Liverpool and overseas, formally inaugurated in April 1899 and incorporated in January 1905. Through the commitment and dedication of successive Directors, leaders and staff, it became a charity in October 1963, now with additional deliverables and public benefit purpose. There are many exciting and challenging years ahead for LSTM but for now, we take the opportunity to reflect on the success of the past twelve months and the achievements at the end of the 2012-2017 strategic planning period.

Trustees responsibilities

The work of the Board of Trustees has never been more demanding, varied and enjoyable than it is currently. The Board has ultimate legal responsibility for LSTM and works to ensure good governance, with the help of its committees. The Board agrees the overall strategic direction and is our highest decision-making body. Its members are volunteers. They work alongside the leadership team, who are responsible for the implementation of policy and for the management of the day-to-day running of LSTM. The Board of Trustees are responsible for the sound governance of LSTM and include amongst their functions, the obligations to:

- establish a strategy and policies and plans to achieve the objectives of LSTM having regard to advice from the Director of LSTM;
- along with LSTM's accountable officer designated for these purposes, observe the terms and conditions set out in the HEFCE financial memorandum and establish a financial and budgetary framework within which LSTM shall operate;
- establish and oversee a framework of delegation and systems of control;
- establish policies for the assessment and management of risk and make decisions on all matters that may create significant financial risk to LSTM or which affect material issues of principle;
- monitor LSTM's performance in relation to the strategies, policies, plans, financial controls and budgets and other decisions of the Trustees;
- appoint (and if necessary remove) the Director of LSTM or other senior member of staff.

Review of activity 2016/17

The Board recognise the significant growth and expansion of LSTM during the last sixteen years under the Directorship of Professor Janet Hemingway, supported by the exceptional management team and staff within LSTM. This year, the significant headlines were in relation to the partnership development of the £24M Liverpool Life Sciences Accelerator building, the strong financial performance and partner collaboration reported to the Board, the growth and performance of Research Income and the granting of degree awarding powers by the Privy Council in August 2017, all of which provide strong evidence for well governed systems of control, reporting and management of risk.

A new Strategic Plan for 2017-2023 was developed through collaboration between the Board of Trustees, LSTM's Director and her team and was presented at the June 2017 Trustees and Senior Management Away Day, for discussion and formal approval. This culminates twelve-months of detailed discussions, where the views and contributions from LSTM departments, stakeholders and staff have been gathered and shaped into focus. As LSTM enters this new period of strategic focus, the Board will continue to work closely with the senior team to implement, operationalise and monitor performance against the plan, which will lead up to the 125th Anniversary of LSTM.

Board of Trustees membership

LSTM thanks retiring members, Mr Ian Jones, Mr Jonathan Brown, Dr Trevor Francis and Mr André Winter for their dedicated service and valued contribution to the Board of Trustees and other reporting committees they supported. Also, thanks to Ms Jessica Owugha as the outgoing Student Trustee, who stepped down after completing her studentship with LSTM. All outgoing members of the Board have led and shaped LSTM through their contributions and LSTM acknowledge and thank them individually and wish them all the very best for the future.

LSTM welcomed new members to the Board of Trustees, with the appointment of Mr John O'Brien, Ms Sue Russell and our Student Trustee, Ms Rebecca Nightingale. John O'Brien brings significant experience of advising clients on strategic, operational and transactional activity; as a partner at KPMG he led radical change, reshaping his business areas by merger, acquisition and significant recruitment. Sue Russell is a solicitor specialising in mergers and acquisitions; she is a member of Hill Dickinson LLP, an international law firm based in Liverpool. Rebecca is a respiratory physiotherapist who is currently a PhD MRC DTP student at LSTM. She has an interest in lung disease among 'hard to reach' populations and is splitting her PhD studies between the UK and Malawi. Rebecca has an MSc in Global Health and Development from UCL and an MRes from the University of Liverpool.

Officers 2016/17

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PRESIDENT
Sir Richard Evans CBE

CHAIRMAN
James Ross OBE

DIRECTOR
Professor Janet Hemingway CBE BSc PhD DSc FRS NAS (Foreign Associate) FMedSci FRCP (Hon) FRES (Hon) FAAM Hon FFPH

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BOARD OF TRUSTEES

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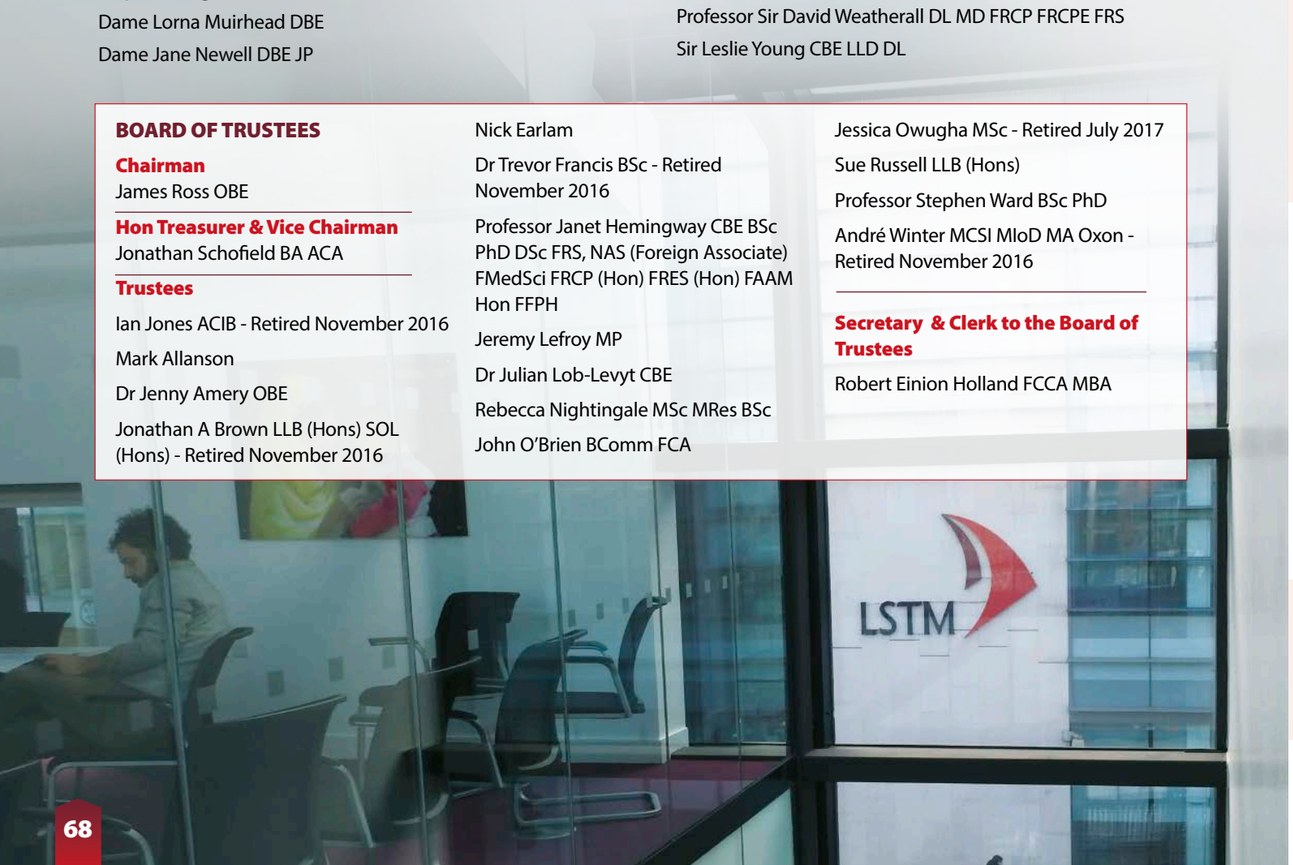
Hon Treasurer & Vice Chairman
Jonathan Schofield BA ACA

Trustees
Ian Jones ACIB - Retired November 2016
Mark Allanson
Dr Jenny Amery OBE
Jonathan A Brown LLB (Hons) SOL (Hons) - Retired November 2016
Nick Earlam
Dr Trevor Francis BSc - Retired November 2016
Professor Janet Hemingway CBE BSc PhD DSc FRS, NAS (Foreign Associate) FMedSci FRCP (Hon) FRES (Hon) FAAM Hon FFPH
Jeremy Lefroy MP
Dr Julian Lob-Levyt CBE
Rebecca Nightingale MSc MRes BSc
John O'Brien BComm FCA
Jessica Owugha MSc - Retired July 2017
Sue Russell LLB (Hons)
Professor Stephen Ward BSc PhD
André Winter MCSI MIoD MA Oxon - Retired November 2016

Secretary & Clerk to the Board of Trustees
Robert Einion Holland FCCA MBA



Awards and Honours

In November 2016, LSTM Director, Professor Janet Hemingway, received an honorary degree of Doctor of Science (DSc) from the University of Chester in recognition of her outstanding contribution to biochemistry and molecular biology and for her services to the control of tropical disease vectors.

The COU**NTD**OWN consortium received the International Society for Neglected Tropical Diseases (ISNTD) Water Award in November 2016. The prize recognised COU**NTD**OWN's work, which has integrated WASH (Water, Sanitation and Hygiene) in its attempts to control schistosomiasis and soil-transmitted helminthiasis in its partner countries (Cameroon, Liberia, Ghana).

Also in November, LSTM's Edward Thomsen won a Bill & Melinda Gates Foundation funded Grand Challenge Award to build an open-source software platform tailored to support efforts to eliminate malaria by amalgamating desirable features from two existing disease data management platforms.

LSTM MSc student Joseph Pryce won the RSTMH poster prize in December 2016. The poster highlighted the expansion of existing self-care training activities to incorporate new disease types. The study evaluated the possibility of expanding existing leprosy self-care training groups in south-east Nepal to include lymphatic filariasis (LF) patients. Although both conditions are highly stigmatised, the majority of LF and leprosy patients stated that they would attend an integrated self-care training group, revealing the potential to provide affordable LF care services in the community.


Professor Tchuem Tchuenté

In January 2017, LSTM's ambassador for Neglected Tropical Diseases (NTDs), Professor Louis-Albert Tchuem Tchuenté, was raised to the dignity of Commander of the National Order of Valour by the President of Cameroon, for his tireless work on NTDs and improving health within Cameroon. Professor Tchuem-Tchuenté works with the LSTM based COU**NTD**OWN Research Consortium, as one of the Cameroon country partners. He is the coordinator of Cameroon's National Programme for the Control of Schistosomiasis and Intestinal Helminthiasis, and the Director of the Centre for Schistosomiasis and Parasitology.

LSTM's Engaging Tools for Communication in Health (ETCH) team won the International Society for Neglected Tropical Diseases (ISNTD) Gaming Award in February 2017. The team won for education and innovation in disease control using games.

Also in February Dr Ben Morton has won the Research Student of the Year award at the 2017 North West Coast Research and Innovation Awards. The awards aim to celebrate the success and excellent work being undertaken across the region in clinical research and innovation in health.


Dr Charles Ameh

In March 2017, Dr Charles Ameh, Deputy Head of LSTM's Centre for Maternal and Newborn Health (CMNH), became a Fellow of the Royal College of Obstetricians and Gynaecologists (RCOG). He was invited to become a Fellow honoris causa following a unanimous wish by the Council of the College. It is an acknowledgement of what they describe the highest levels of dedication and achievements in clinical care and his support to the development of women's healthcare service, particularly in low and middle-income countries. Dr Ameh and several other new fellows took part in an admission ceremony during the RCOG World Conference held in Cape Town, South Africa, in April.

In April, PhD student Amy Marriott won best poster prize from the British Society for Parasitology (BSP), sponsored by PLOSNTD, for her work on long-term in vitro culture of adult Brugia malayi parasites.

PhD student Menno Smit won the best Oral Presentation at the LSTM PhD Student Conference in May.

In June, Dr Mary McCauley from LSTM's Centre for Maternal and Newborn Health (CMNH) won an award from the Northern Ireland Medical and Dental Training Academy (NIMDTA). She got the award for the second year running at the annual 'Educational Excellence - Dare to Excel' award ceremony in Belfast, Northern Ireland, for her Outstanding Contribution to Society for her work in implementing the pioneering work of LSTM to improve the health of women and their babies in low resource settings.

Also in June, LSTM won the Liverpool Echo Regional Business Awards, Knowledge Business of the Year 2017, after entering the awards for the first time. The awards recognise businesses and individuals from across all sectors who have driven innovation and contributed to the economic landscape throughout the region.

Professor Richard Pleass was commended by the Journal of Biological Chemistry for the exceptional high visibility of his paper "Engineering the fragment crystallizable (Fc) region of human IgG1 multimers and monomers to fine-tune interactions with sialic acid-dependent receptors", which was published in June. Within two months his paper was viewed 342 times.

Lectures and Seminars

LSTM Seminar Series

After a successful launch in the previous academic year, the Seminar Series continued in 2017 with a wide range of external and internal speakers. The Series, which runs for three months during each semester, is supported by LSTM's Research Committee. It provides 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 and students and external audiences via the live stream and recording provided.

Dr Jocalyn Clark, executive editor of The Lancet

Dr Sheena Cruickshank, University of Manchester

External speakers included BMJ's Editor in Chief Fiona Godlee on 'why you should not believe what is written in medical journals'; Jocalyn Clark, executive editor of The Lancet on the medicalisation of Global Health; Dr Sheena Cruickshank, University of Manchester's lead for public engagement and senior lecturer in immunology, on the challenges and delights of doing public engagement as a researcher, and Dr Catherine Moyes from the University of Oxford on geospatial modelling of malaria vectors.

Leverhulme Lecture

Dr S. Patrick Kachur, chief of the malaria branch at the US Centers for Disease Control and Prevention (CDC), delivered in June 2017 the prestigious LSTM Leverhulme Lecture.

His lecture was entitled 'Fetish or fulcrum: the appeal of commodities in 21st-century global malaria efforts' and was introduced by LSTM's Chairman James Ross OBE to an audience of staff, students and invited guests.

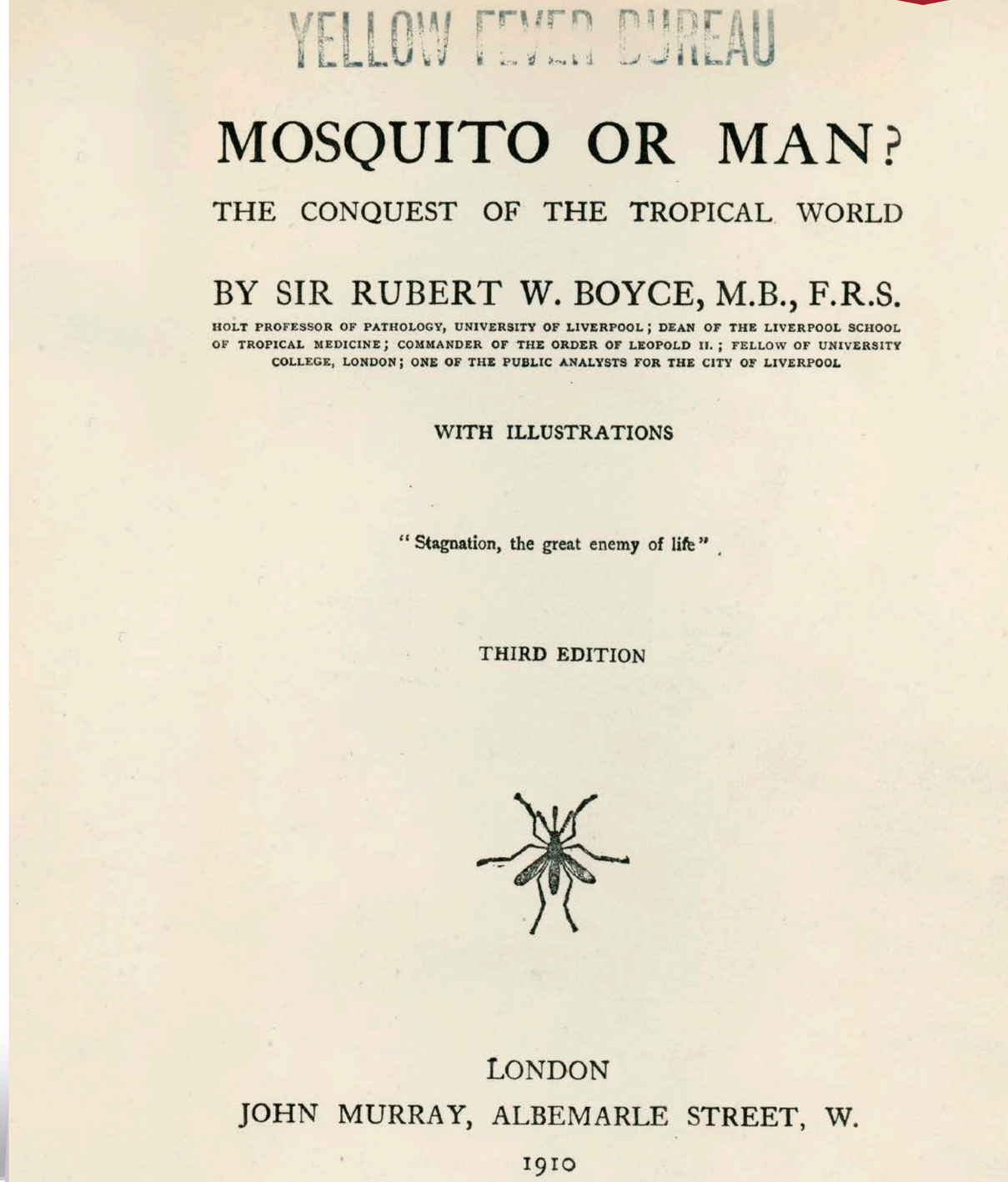
Dr Kachur highlighted the role, since 2001, of billions of mosquito nets, treatment drugs and diagnostic tests that have contributed to reducing the global burden of malaria and saving nearly 7 million lives. He reflected on the implementation science and advocacy efforts that helped ignite and accelerate this progress and consider the unique appeal that 'life-saving commodities' have for malaria control programs, their development partners, advocates, private markets and consumers, alike. He explored some of the vulnerabilities of this commodity-based approach as well as opportunities to pivot toward investments that favour human knowledge, skills and institutions.

Following the lecture, Dr Kachur received the Leverhulme Medal from LSTM's Director, Professor Janet Hemingway.

Dr Patrick Kachur receives the Leverhulme medal

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

All seminars and lectures can be accessed via the LSTM website's homepage -> News & Events -> Seminars and Lectures


YELLOW FEVER BUREAU

MOSQUITO OR MAN?

THE CONQUEST OF THE TROPICAL WORLD

BY SIR RUBERT W. BOYCE, M.B., F.R.S.

HOLT PROFESSOR OF PATHOLOGY, UNIVERSITY OF LIVERPOOL; DEAN OF THE LIVERPOOL SCHOOL OF TROPICAL MEDICINE; COMMANDER OF THE ORDER OF LEOPOLD II.; FELLOW OF UNIVERSITY COLLEGE, LONDON; ONE OF THE PUBLIC ANALYSTS FOR THE CITY OF LIVERPOOL

WITH ILLUSTRATIONS

"Stagnation, the great enemy of life".

THIRD EDITION

LONDON
JOHN MURRAY, ALBEMARLE STREET, W.
1910

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

A•WOL

Developing new drugs against onchocerciasis and lymphatic filariasis.
Funded by: Bill and Melinda Gates Foundation
Web address: www.awol.lstmed.ac.uk

COUNTDOWN

Investigating solutions to control and eliminate the seven most common NTDs by 2020.
Funded by: UK Department for International Development
Web address: www.countdownonntds.org

EHCRC

Focusing on evidence in malaria, TB, child health, maternal health, and health systems. Preparing and updating Cochrane Reviews. LSTM hosts the Cochrane Infectious Disease Group.
Funded by: UK Department for International Development
Web addresses: www.evidence4health.org and www.cidg.cochrane.org

IMPACT

Strengthening the evidence around cardiac safety and drug-drug interactions with Arvs.
Funded by: European Union/EDCTP2
Web address: www.lstmed.ac.uk/research/collaborations/impact

IMPPACT

Translating global malaria in pregnancy policy to country-level policies and clinical guidelines.
Funded by: European Union/EDCTP2
Web address: www.lstmed.ac.uk/research/collaborations/imppact

IMPACT TB

Finding and treating TB cases in communities in Nepal and Vietnam.
Funded by: European Union/Horizon2020
Web address: http://impacttbproject.org/

Malaria in Pregnancy
(ended July 2017)

Improving the control of malaria in pregnancy in Africa, Asia and Latin America
Funded by: Bill and Melinda Gates Foundation, European Union and the European and Developing Countries Clinical Trials Partnership
Web address: www.mip-consortium.org

Malaria in Insecticide Resistance Africa (MIRA)

Quantifying the public health impact of insecticide resistance and estimate the finances required to meet malaria control targets in high burden countries where malaria is persistent.
Funded by: Wellcome Trust Collaborative Award
Web address: www.mira.lstmed.ac.uk

Perform2Scale

Scaling up health management strengthening interventions
Funded by: European Union/Horizon2020
Web address: www.perform2scale.org

REACHOUT

Strengthening the vital work of close-to-community providers of healthcare in Africa and Asia.
Funded by: European Union
Web address: www.reachoutconsortium.org

ReBUILD

Exploring approaches to health system development in conflict affected countries in Africa and Asia.
Funded by: UK Department for International Development
Web address: www.rebuildconsortium.com

LSTM Pioneers

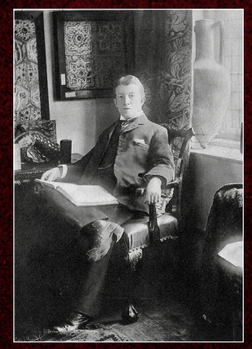
Professor Rubert William Boyce FRS

1863 – 1911

Professor of pathology at the University College Liverpool and friend of LSTM founder and shipping magnate Sir Alfred Jones, Rubert Boyce was LSTM's first dean from 1899 to 1911.

One of his very first tasks was arranging lecture rooms and laboratory space to the first classes in tropical medicine. Rubert Boyce was instrumental in recruiting LSTM's first lecturer Ronald Ross, a leading figure in the study of tropical medicine and soon to be awarded the Nobel Prize for Medicine in 1902 for his work on malaria transmission.

From its very beginning LSTM's curriculum reflected Boyce's interest in public hygiene and preventative medicine. In 1898 he was appointed as Liverpool's city bacteriologist, the first such post in the UK, organising a systematic examination of water and food materials.



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.

Editorial team: Clare Bebb; Diderik van Halsema (coordination)

Contributors: Emily Adams; Jane Ardrey; Stephen Allen; Sue Assinder; Imelda Bates; Clare Bebb; Daniel Bennett; Giancarlo Biagini; Karen Brady; Nynke van den Broek; Mike Coleman; Luis Cuevas; Billy Dean; Martin Donnelly; Daniela Ferreira; Kevin Francis; Paul Garner; Geoff Gill; Nicholas Goldup; Stephen Gordon; Christine Greenway; Diderik van Halsema; Nick Hamon; Jenny Hill; Shabbar Jaffar; Jayne Jones; David Lalloo; Chris Larkin; Michael Lurie; David Molyneux; Louis Niessen; Meg Parkes; Hilary Ranson; Adam Roberts; Martina Savio; Hazel Snell; Bertie Squire; Miriam Taegtmeyer; Mark Taylor; Sally Theobald; Phil Tubb; Joseph Valadez; Helen Williams; Elli Wright

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Athena SWAN Bronze Award

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