TROPICAL DISEASE RESEARCH REGIONAL COLLABORATION INITIATIVE (AUSTRALIA, INDONESIA, MALAYSIA, PAPUA NEW GUINEA)

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Strengthening regional research collaboration in the prevention and containment of multidrug-resistant tuberculosis and malaria

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Contents

List of Acronyms and Abbreviations 3
Executive Summary 5
Summary of Conclusions/Recommendations 6
1. Description and Analysis of the Progress of the Activity 8
1.1 Tuberculosis Studies: T1 PNG 8
1.2 Tuberculosis Studies: T2 Malaysia and Indonesia 10
1.3 Tuberculosis Studies: T2 PNG 16
1.4 Malaria Studies: M1 Malaysia and Indonesia 18
1.5 Malaria Studies: M2 Indonesia 22
2. Finance 26
2.1 Statement of the funds provided and spent 26
2.2 The amount (if any) remaining in the account referred to in clause 6.3 26
3. Annexes 27
3.1 Annex 1 Asset Register 28
3.2 Annex 2 List of Stakeholders 34
3.3 Annex 3 List of published reports, promotional material, media publicity, pamphlets and other documentation relevant to the Activity 35
3.4 Annex 4 Map of study site locations 41

LIST OF ACRONYMS AND ABBREVIATIONS

ACRONYM/ABBREVIATION	NAME IN FULL
ACIAR	Australian Centre for International Agricultural Research
ACROSS	Study: Community and facility assessment to determine populations at risk of malaria and primaquine induced haemolysis
APMEN	Asia Pacific Malaria Elimination Network
BMU	Basic Management Unit
Burnet	Burnet Institute, Australia
CHS	Centre for Health Security
CPHL	Central Public Health Laboratory
CQI	Continuous Quality Improvement
DFAT	Department of Foreign Affairs and Trade, Australia
DoH	Department of Health
DR-TB	Drug resistant tuberculosis
DS-TB	Drug sensitive tuberculosis
EIMB	Eijkman Institute for Molecular Biology, Indonesia
EMRS, Bahmni	Electronic Medical Records System, Bahmni
FETP	Field Epidemiology Training Program
FST	Fluorescent spot test
G6PD	Glucose-6-phosphate dehydrogenase
HDR	Higher Degree by Research
HHISP	Health and HIV Implementation Services Provider
IDSKKS	Infectious Disease Society Kota Kinabalu Sabah, Malaysia
IMPROV	Study: Improving the radical cure of vivax malaria: a multicentre randomised, placebo-controlled comparison of short and long course primaquine regimens
IMR	Institute of Medical Research, PNG
IPT	Isoniazid Preventive Therapy
ITM	Institute of Tropical Medicine, Belgium
MDR-M	Multi drug-resistant malaria
MDR-TB	Multi drug-resistant tuberculosis
Menzies	Menzies School of Health Research, Australia
MKA	Sabah State Reference Laboratory
MMV	Medicines for Malaria Venture
MoH	Ministry of Health
NDOH PNG	National Department of Health, Papua New Guinea
NeHIS	National electronic health information system, PNG

NMCP	National Malaria Control Program
NTP	National Tuberculosis Program
OR	Operational Research
PCR	Polymerase chain reaction
PHC	Primary Health Centre
PMDT	Programmatic Management of Drug-Resistant Tuberculosis
PNG	Papua New Guinea
QEH	Queen Elizabeth Hospital, Malaysia
RDT	Rapid Diagnostic Test
REDCap	Secure web application for building and managing online databases
RID-TB	Burnet DFAT-funded TB project
RSMM	Rumah Sakit Mitra Mayarakat – Community Hospital Timika
SORT-IT	Structured Operational Research Training IniTiative
STRATUM	Strong Health Systems for Multidrug-resistant Tuberculosis and Malaria
TB	Tuberculosis
TDR	The Special Programme for Research and Training in Tropical Diseases
TRIPI	Study: A randomised controlled trial on malaria primaquine treatment in Timika, Indonesia
UGM	Universitas Gadjah Mada, Indonesia
UI	University of Indonesia
UMS	University of Malaysia, Sabah
UPNG	University of Papua New Guinea
USU	University of Sumatera Utara, Indonesia
WHO	World Health Organisation
WTSI	Wellcome Trust Sanger Institute
Y1	Year One
Y2	Year Two
YPKMP/PHCDF	Yayasan Pengembangan Kesehatan Masyarakat Papua, Indonesia (Papuan Health and Community Development Foundation)

EXECUTIVE SUMMARY

This document is the final report of the Australian Department of Foreign Affairs and Trade (DFAT) funded Tropical Disease Research Regional Collaboration Initiative (TDRRCI). The TDRRCI's primary aim was to strengthen research collaboration and capacity to tackle tropical diseases which have the potential to threaten the health security of Australia and the region.

As defined by the Final Design Document, and reinforced by the contract between Menzies and DFAT, the TDRRCI's purpose was to contribute to:

1. Increase the capacity and expertise of research institutions in the region on tropical disease research through collaboration and information exchange.

2. Foster tropical disease research with a health system focus and impact including best practice and evidence on how new technologies and innovations should be implemented in low and middle-income countries, with consideration of systemic factors such as leadership and governance, financing, planning, surveillance, workforce, cross-border regional approaches, and engaging the private sector.

3. Contribute to efforts to prevent and contain tropical diseases that constitute public health threats in Southeast Asia and the Pacific.

These overarching objectives are further categorised under four aims:

1. Strengthen capacity within National Malaria Control Programs (NMCP) to Australia's near north to apply novel tools for molecular surveillance of drug resistant malaria (M1) (aligns with objectives 1 & 2).

2. Determine models for implementation of new tools for safe and effective radical cure of malaria, to eliminate the latent stages of malaria and prevent onward transmission (M2) (aligns with objective 3).

3. To develop, in Papua New Guinea (PNG), a tuberculosis (TB) operational research (OR) agenda for the program in South Fly District, Western Province and conduct structured OR training for key staff from research and service delivery institutions (T1) (aligns with objectives 1 & 2).

4. Strengthen the capacity of TB programs to measure the impact of programmatic interventions for TB and evaluate pilot models of care, to enable scale-up (T2) (aligns with objective 3).

SUMMARY OF CONCLUSIONS/RECOMMENDATIONS

Strengthening health systems to prevent and reduce drug-resistant (DR)-tuberculosis

T1 PNG: To develop in PNG a Western Province DR-TB operational research (OR) agenda and conduct structured OR training for key staff from research and service delivery institutions.
It is recommended that: 1. TB research governance via a steering committee receive continued support to embed processes and enhance sustainability; 2. health workers and clinicians continue to be engaged in operational research in order that the researchers leading or implementing programs can also facilitate the practice and policy change processes; and 3. the delivery of the Structured Operational Research Training IniTiative (SORT-IT) program be continued and its scope is broadened beyond TB.
T2 PNG: *In Daru, PNG we will strengthen the health information systems by implementing electronic data systems for TB that can be utilised to generate knowledge, evaluate and inform program planning.*
1. The implementation of an Electronic Medical Records System (EMRS) has been a critically important component of the response to the multidrug-resistant (MDR) TB outbreak in Daru and recommended/recognised by the World Health Organization's (WHO's) regional Green Light Committee. 2. Ongoing support to adapt and expand the EMRS for TB and other diseases in PNG should be provided, in line with existing plans for a National electronic health information system (NeHIS). 3. Provide support to address the legal and policy framework around health information systems in PNG.
T2 Malaysia and Indonesia: Strengthen the capacity of TB programs to measure the impact of programmatic interventions for TB and evaluate pilot models of care, to enable scale-up (TB programmatic interventions).
1. Ongoing scale-up to build and strengthen local capacity is required. The TDRRCI has demonstrated that, with support, and through collaboration with local partners, significant improvements in the management of childhood TB is achievable. 2. In Sabah, it is recommended that the electronic online tool for data management of child contact tracing is used to improve collaboration between health inspectors and staff at TB clinics.
M1 Malaysia and Indonesia: Strengthen capacity within National Malaria Control Programs (NMCP) to Australia's near north to apply novel tools for molecular surveillance of drug resistant malaria.

1. Current artemisinin-based combination therapy, now the first-line treatment for all uncomplicated malaria species in Sabah, remains efficacious and should continue to be recommended in state and national policy for this purpose.
2. Malaysia's national malaria elimination agenda aims to eliminate the human-only species (*P. falciparum* and *P. vivax*) by 2020, but ongoing molecular surveillance will be vital to accurately differentiate their elimination from an increasing burden of zoonotic malaria due to the monkey parasite *P. knowlesi*.
3. In Indonesia, laboratory protocols and quality assurance processes have been established for typing drug resistant isolates at the Eijkman Institute for Molecular Biology (EIMB), and important progress has been made to develop high throughput molecular typing using new generation sequencing. A network of collaborators, including three members of the National Malaria Advisory committee have shown a keen interest to maintain parasite molecular surveillance from across the country. The development of a biobank and standard methodologies to ensure contemporary sampling will be key to ongoing surveillance.

M2 Malaysia and Indonesia: Determine models for implementation of new tools for safe and effective radical cure of malaria, to eliminate the latent stages of malaria and prevent onward transmission.

1. TDRRCI has helped to establish an internationally recognised Glucose-6-phosphate dehydrogenase (G6PD) reference centre at EIMB and built links with other centres in the USA, Thailand and Bangladesh. This centre of excellence has allowed us to validate a new G6PD biosensor which will be crucial for wide deployment of tafenoquine (a new single dose radical cure treatment entering the market) and short high dose primaquine regimens.
2. Our studies have highlighted the significant issues of adherence to a 14-day regimen, and the need for intervention to improve this, including deployment of shorter course primaquine and single dose tafenoquine. These regimens will require prior G6PD testing and these are now validated and entering the market. Future work should look at ways these can be implemented safely and effectively in remote areas.

1. Description and Analysis of the Progress of the Activity

1.1 Tuberculosis Studies: T1 PNG

T1: To develop, in PNG, a tuberculosis (TB) operational research (OR) agenda for the program in South Fly District, Western Province and conduct structured OR training for key staff from research and service delivery (aligns with objectives 1 & 2).

Research is a key pillar of the WHO End TB Strategy and central to a successful TB response in PNG. In PNG, current challenges include the operational issues for TB control and patient-centred care including the low proportion of TB cases with bacteriological confirmation, the high proportion registered as extrapulmonary TB, the large numbers of TB in children and the high numbers of treatment outcomes reported as lost-to-follow-up or not evaluated. Operational research is fundamental to providing baseline data, identifying the gaps and challenges, and to evaluating the implementation of tools and strategies for improved case detection, treatment outcomes and prevention.

A. Evidence that the Activity has been completed, and the Milestones have been achieved

The focus of TDRRCI activity under this aim was to build capacity to conduct research that supports surveillance of drug resistant TB in PNG. The program supported the delivery of structured OR training for staff in key agencies and the coordination of a research agenda through the formation of a research governance steering group.

A series of workshops designed to build understanding of TDRRCI and its objectives were conducted with the National TB Emergency Response Task Force in Port Moresby and the Western Province TB Core Group. The final workshops on research prioritisation for TB were held in Daru (Yr1, Q2 and Q3) enabled the development of the operational research agenda for TB in Western Province. This was subsequently incorporated into government planning documents (Western Province TB Strategic Plan and South Fly District TN Implementation Plan) in 2017 and revised in 2018 and 2019. The Research Agenda was endorsed by the Western Province TB core group and the National Department of Health (NDOH).

The Structured Operational Research Training IniTiative (SORT-IT) course was delivered in accordance with WHO TDR endorsed model. Twelve participants from seven provinces, representing NDOH, PNG Institute of Medical Research (PNG IMR), University of PNG (UPNG), Port Moresby General Hospital, Central Public Health Laboratory (CPHL), Western Province Health Office, Daru General Hospital and provincial health offices / hospitals from 5 other provinces (Gulf, Southern Highlands, East New Britain, New Ireland, West Sepik), participated in the training and 11 of the 12 completed all three modules and 4 milestone assessments. The other two participants completed two of the milestones. Participant feedback was excellent: 93% rated course content as good or excellent and 94% would recommend the course to a colleague.

Twelve original manuscripts have been submitted for publication in a dedicated supplement in Public Health Action. As of February 2019, 10 of the 12 have been accepted for publication. All 12 course participants presented their research at the project dissemination meeting held in June 2018, to an audience that included senior policy makers and health leaders from PNG institutions. Nine

participants presented their research findings at the Annual PNG Medical Symposium, two being awarded prizes for best oral presentations at this event. One participant presented at the World Congress on Lung Health in The Hague, Netherlands. Burnet researchers presented the OR program and research capacity building at the PNG Public Health Association Symposium. There was widespread recognition from the PNG medical society, Public Health Association and NDOH of the success of the OR program.

The strengthening of governance in TB research in PNG is a key outcome of this activity. The engagement of the National TB Program in research stewardship and the strengthening of collaboration between the Burnet Institute, the PNG IMR and UPNG will support both delivery of and capacity for TB research. Leadership has been developed through the training of participants, who will be able to disseminate research best practices to their health services and colleagues.

B. Any highlights, breakthroughs or difficulties encountered

This activity led to the establishment of a research enabling environment for TB research in PNG. This was achieved through the co-design process and consultation, governance (formation of steering group) and implementation of the SORT-IT course with tangible outputs (milestones, publications, presentations and participant feedback). A TB research steering committee will continue to meet, supported through activity of the STRATUM grant.

At an individual level, this was the first time each participant had led and conducted a research project from protocol development to publication, and importantly, dissemination. The methodology of the program was highly valued and accepted in the PNG context.

The activity resulted in the identification of a research champion (Dr Lavu) who has enrolled in a PhD and 3 research fellows (Drs Taune, Maha and Hiasihri) who will conduct further research. Ongoing leadership development will occur through the STRATUM grant, RID-TB project (DFAT) and DFAT CHS-ACIAR One Health program.

The research topics contributed to generating knowledge to inform the TB response in PNG in the areas of active case-finding, contact tracing, treatment, community-based models of care, new TB drug implementation (important with the new WHO guidelines), TB-HIV care, paediatric TB and TB laboratory and diagnostic systems. The research activities made a significant contribution to the response to the DR-TB outbreak in Daru and were part of the implementation plan agreed by government and partners. These projects evaluated best-practice models for contact tracing and treatment, informing further scale-up in PNG.

Complex logistics, issues of safety of the high cost of goods and services in PNG means that program implementation is challenging. In remote areas unreliable flights and poor communications, including internet, impacted on data collection. In the course of this activity, research being conducted in the southern Highlands was suspended when researchers were evacuated due to escalating violence and safety concerns; two participants in the SORT-IT program were unable to complete their research as unreliable internet resulted in the lack of progression to module 3, as data were not able to be collected; Whilst two training modules were successfully held in Daru, enabling participants to visit the program with best practice models of care; operational issues with internet and reliable flights

meant module 3 delivery was changed to Port Moresby where it is significantly more expensive to run training and workshops.

There were some initial challenges with approval to proceed with the model as there was a perceived duplication with the Field Epidemiology Training Program (FETP) within NDOH. Briefings and meetings effectively resolved the issue to the satisfaction of all parties.

The research ethics approval board in PNG has infrequent and often cancelled committee meetings, resulting in delays to research. There is also no channel for low-risk research approach. This was mitigated through engagement of the ethics committee and aligning the modules with their timing.

C. Recommendations arising from the Activity

TB research governance via a steering committee receive continued support to embed processes and enhance sustainability.

Health workers and clinicians continue to be engaged in operational research in order that the researchers leading or implementing programs can also facilitate the practice and policy change processes.

The delivery of the SORT-IT program be continued and to consider broadening its scope beyond TB.

1.2 Tuberculosis Studies: T2 Malaysia and Indonesia

T2: Strengthen the capacity of TB programs to measure the impact of programmatic interventions for TB and evaluate pilot models of care, to enable scale-up (aligns with objective 3).

In Timika and Sabah the aims of the TDRRCI T2 project were to:

1. Improve contact investigation among sputum positive TB cases.
2. Improve preventive treatment among children aged <5 years in close contact with a TB patient.
3. Measure the impact of project to TB program.
4. Develop an implementation model to support scale up to other health facilities.

A. Evidence that the Activity has been completed, and the Milestones have been achieved

Capacity Development and Knowledge Dissemination

In each location the TDRRCI identified and supported a Research Champion and a Research Fellow, aiming to build local capacity and enhance the sustainability of the interventions tested and implemented.

Research Fellow Dr Trisasi Lestari, based in Timika, came to the project with 10 years research experience in childhood TB and strengthening health systems. She is currently completing her PhD with Charles Darwin University where she was awarded a three-year scholarship to support her research in Timika. Her supervisors include a number of TDRRCI investigators: Assoc. Prof A Ralph, Prof S Graham, Prof R Bailie and Dr R Triasih, the TDRRCI Research Champion in Timika.

The TDRRCI employed four research nurses and a data entry clerk to provide direct support to clinic staff. Dr Lestari, Dr Triasih and the Continuous Quality Improvement (CQI) Coordinator provide on the job training to the nurses to ensure implementation of contact treatment policy, accurate record-keeping, and engagement with data to track progress towards targets.

As a result, TB prevention through implementation of investigation and management of household contacts has risen from zero implementation prior to the study commencing, to 200 individuals being commenced on preventive therapy (see figures) and a further 26 being identified as having active TB (who have then been appropriately notified and linked to care).

Figure 1: Roll out of contact investigation and management since study commencement. Implementation activities commenced Sept 2017.

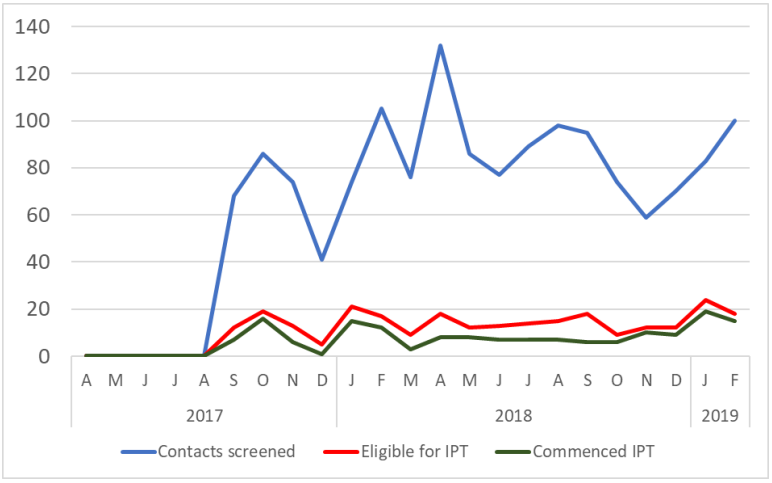
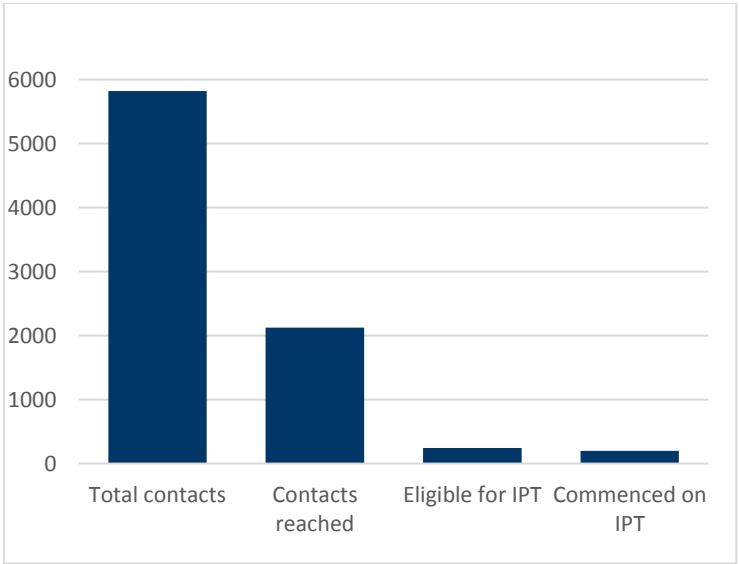


Figure 2: 'Cascade of care': Household contacts of TB cases



In Timika key achievements include:

- Nearly all patients assessed as requiring TB preventive therapy are now being prescribed preventive therapy (Figure 2)
- Engagement with the District Health Office is strong, with the District Health Office encouraging further scale-up of the project to replicate successes elsewhere throughout the district
- The project has led to the district TB program being recognised by the Ministry of Health as one of the top-performing programs nationally

Specific activity highlights include:

- Collected and completed electronic TB records for the period 2015 to 2019 at five health facilities (2 hospitals and 3 Primary Health Centres (PHCs))
- Supported outreach services including house to house visits and Child TB screening at schools
- With support from Investigator Ralph and Research Champion Triasih, Dr Lestari and her team delivered 14 sessions focused on contact investigation and preventive treatment at PHCs, training 239 health care staff including TB nurses and doctors. Other training initiatives led by Dr Triasih include:
    - a TB budgeting workshop for clinic managers, finance staff and TB program coordinators that, with the adoption of a standard annual budget template for clinics, has improved financial planning for TB programs at the clinics
    - refresher training with a focus on training materials, evaluation of training performance and train-the-trainer sessions. Four TB nurses were selected and trained to be TB trainers for nurses and allied health workers, an important step in implementing sustainable scale of activity. These four TB nurses have subsequently delivered in-house training to staff from seven clinics and one hospital
    - using smart phones to create health promotion videos
    - TB data analysis and presentation

In December 2018, TB training for physicians was implemented in Timika in collaboration with Indonesian Medical Doctors Association and the District Health office. About 100 physicians participated. The research findings associated with these activities have been presented at conferences and published in peer reviewed journals (Refer Annex 3.3).

In Sabah, Malaysia Dr Michelle Goroh, TDRRCI Research Fellow, has over the two years of the project completed her Master of Public Health and in 2018 enrolled in a PhD at the University of Malaysia, Sabah (UMS), continuing her TDRRCI based research with support from the TDRRCI investigators and Menzies. Dr Goroh's research has focussed on identifying the barriers to contact investigation. She has surveyed 237 contacts of index cases and consulted 34 health inspectors and TB clinic staff to identify barriers. For the duration of her studies Dr Goroh is on leave from her position as assistant to the Director of the TB Control Unit in the Sabah State Health Department. Her colleagues within the Department of Health are very supportive of her research and she is well placed to ensure that research findings will inform policy development. There is already evidence that her research is bring together stakeholders in TB treatment and management from different ministries and it is expected to improve delivery of services.

Dr Ke Juin Wong has been an active and influential Research Champion, supporting TDRRCI program implementation. Dr Wong is a member of the Sabah State TB technical level committee, a body that can adapt, formalise and incorporate operational research strategy in government plans at the State level. Key achievements supported by TDRRCI include the updating and dissemination of latent TB management flow chart, development of educational resources, facilitation of several knowledge transfer workshops and provision of five sessions of Continuous Medical Education at participating clinics.

The TDRRCI has supported two research nurses, covering the three clinics participating the in study. As in Timika, clinic staff were trained and encouraged to improve record keeping and data management, ultimately using a REDCap database to secure data and provide better version control. A total of seven CQI workshops were held over 24 months, allowing staff to see the upward trend in the number of patients commenced on preventative therapy, to discuss complex cases and trouble shoot barriers to screening and treatment.

A knowledge transfer workshop was held to improve delivery of TB contact screening and management for TB clinics in Kota Kinabalu. Thirty-seven participants, comprising Family Medical Specialists, TB clinic Medical Officers, TB Nurses and clinic pharmacists, attended the workshop.

TDRRCI also supported the relocation of a GeneXpert machine to Sabah Women's and Children's Hospital in Likas, Sabah, and associated training for technical and laboratory staff, enabling improved diagnostics of complicated TB cases.

In both Timika and Sabah, the Research Champions have established social media platforms to provide TB clinic doctors, General Practitioners and nurses with expert advice and guidance in a timely and easy to access format.

A range of teaching and practical resources have been developed by the Sabah and Timika research teams. These are detailed in Annex 3.3

Members of the research teams from Timika and Sabah attended the Union World Lung Health conference in The Hague, Netherlands, in October 2018. The Conference provided an opportunity for project stakeholders, investigators, the Indonesian TB Fellow, the two Regional Research Champions and other interested third parties to meet and to share and discuss knowledge gained from the Conference and from TDRRCI studies. The information and insights gained at this and other conferences have been shared with the research teams on site, ensuring knowledge is widely disseminated.

B. Extent to which the Activity achieved the Outcomes

The intervention has averted many potentially life-threatening cases of TB and has provided clinic staff with access to timely, expert advice. This has been achieved both through delivery of preventive medication, and through detection of missed cases of active TB. Each case prevented has flow-on effects in terms of prevention of onward transmission.

In Timika the number of children with access to TB preventive therapy (ITP) has increased from zero at the start of the study, to 98 in 2017 and 197 by the end of 2018. These figures include five children

exposed to drug-resistant TB. Four hundred index cases have had their contacts screened, with 1,339 contacts identified.

In 2017 five facilities started to provide preventative treatment, increasing to 13 facilities in 2018. Most of the children accessing treatment (69%) were in the intervention sites.

In Sabah there has been a ninefold increase in the number of children commencing preventive treatment for treatment from the three study clinics: 18 in 2017 to 161 in 2018.

The study has shown that more focus on contact tracing improves contact investigation and ITP prescription. CQI meetings demonstrated that transferring paper records to electronic databases resulted in better record keeping and data management. The use of REDCap has improved reporting on contact tracing and is being regularly used to monitor progress and impact. The updated flow chart for latent TB management has reduced the number of clinic visits required for proper diagnosis and treatment, which in turn will reduce the number of contacts being lost during follow-up.

C. Any highlights, breakthroughs or difficulties encountered

In Timika, scale up from five to twelve sites was possible because of support from local collaborators in the hospitals and clinics and crucially, from the Ministry of Health District Health Authority whose staff were active participants in workshops and CQI activities.

Following a visit to Timika by representatives of the Indonesian Paediatric Association and the Ministry of Health to evaluate management of childhood TB, contact investigation and IPT, the team has approval for a follow-up study to roll out and scale up the TB contact management policy to other health centres in the region. Results of the contact investigation study are being used to plan ongoing studies and scale up (supported by DFAT Stronger Health Systems for Multidrug-Resistant Tuberculosis and Malaria [STRATUM] grant).

There is greater capacity for surveillance of MDR-TB, MDR-TB models of care and appropriate contact management of cases with MDR-TB.

The District has been selected by the National Tuberculosis Program as having one of the top four TB programs in Indonesia. During the period September 2017 to November 2018, one of the study sites reached the global target of TB contact investigation, investigating more than 90% of TB cases.

Dr Lestari secured a sustainable supply and distribution of 100mg isoniazid tablets, more amendable to tailored paediatric dosing than the previous 300mg formulation, in Papua Province. She also found creative ways to motivate clinic staff to distribute it directly to people's homes, running competitions and providing awards at Tuberculosis Day ceremonies. Dr Lestari has also succeeded in establishing a reliable internet connection at the Timika Research facility, further supporting the research and extending the reach of the intervention.

There has been significant progress in the management of childhood TB during TDRRCI. On-going scale up to build and strengthen local capacity is however required.

Clear challenges remain – such as the limited capacity to reach all contacts (Figure 2) due to resourcing constraints. This has been brought to the attention of the District Health Office through regular

meetings with study implementers; as a consequence, the District Health Office has mobilised funds to support additional staff, and position descriptions have been updated, to ensure that outreach services to identify and screen contacts can be further upscaled.

In Sabah, after the initial challenge of finding good candidates, excellent local doctors took up the positions of TB Fellow and PhD student, and Regional Research Champion. Their input and effective collaboration with local Ministry of Health (MoH) contacts contributed enormously to the successful and timely completion of activities and outputs of the study. Both researchers are committed to further strengthening the capacity of the local TB program.

Improved data management: Collecting data from the paper records of national TB forms in the clinics to enter in the electronic database had the indirect effect of improving staff record-keeping and resulted in increased focus on better data management.

The TDRRCI has contributed to the contact investigation response in Kota Kinabalu and is informing planning for further activities:

- The data management system, developed in REDCap. Prospective data will continue to be collected at participating study clinics and feedback provided to the TB staff during regular CQI meetings.
- The Sabah State Health Department has approved access retrospective TB data from 2006 - 2016 which will provide solid baseline data.

In August 2018, Dr Michelle was awarded 'Best Research Project' for the Master's in Public Health Program at University of Malaysia, Sabah.

In Sabah, during TDRRCI implementation fire destroyed one of the TB study clinics. This created some delays with data collection until a new site was selected and included in the study.

One of main barriers identified for contact investigation during discussions at CQI meetings and workshops, was the relationship between health inspectors (who visit households to conduct TB contact contacting) and staff at TB clinics. The nature of the relationship between inspectors and clinic staff, hierarchy and continuous education are issues that have been raised and are being addressed through the conduct of joint training workshops. The workshop provided an important opportunity to further improve TB contact management through guided discussions between the different participants and promote the approach of the study.

D. Conclusions or recommendations (if any) arising from the Activity.

The TDRRCI has made a significant contribution to strengthening local capacity in the study sites to deliver the National TB Program in Timika. When the study started, the capacity to consistently manage childhood TB, conduct contact investigation and provide IPT was poor. Prior to the TDRRCI intervention there had been no coherent review of the National Tuberculosis Program's (NTP's) implementation in the study sites.

Ongoing scale-up to build and strengthen local capacity is required. The TDRRCI has demonstrated that, through collaboration with local partners, significant improvements in the prevention of TB, most particularly in children, is achievable.

In Sabah, it is recommended that the electronic online tool for data management of child contact tracing is used to improve better collaboration between health inspectors and staff at TB clinics.

1.3 TUBERCULOSIS STUDIES: T2 PNG

T2: Strengthen the capacity of TB programs to measure the impact of programmatic interventions for TB and evaluate pilot models of care, to enable scale-up (aligns with objective 3).

In Daru, PNG the aims of the TDRRCI T2 project were to strengthen the health information systems by implementing electronic data systems for TB that can be utilised to generate knowledge, evaluate and inform program planning.

A. Evidence that the Activity has been completed, and the Milestones have been achieved

The electronic medical records system (EMRS, Bahmni) was installed, configured (adapted to the program in Daru) and implemented in Daru. A field data capture tool (REDCap) was configured and implemented for monitoring and evaluation of the TB patient education and counselling program. However, a decision was taken in year 2 to only proceed with Bahmni.

Data captured in the EMRS was utilised in the four Daru-based operational research projects as part of the SORT-IT course. The established EMRS is now used for the routine entry and review of patient information for drug-resistant (DR) TB patients, drug-sensitive (DS) TB patients, contact screening and preventive therapy components of the program. Further, the system is also now regularly used to support research analyses produced for formal briefing documents and reports, as well as internal analyses to identify areas for health system improvement (e.g. service delivery) within the Basic Management Unit (BMU).

In addition to individual patient management and review, Bahmni is now used at the programmatic level for routine cohort management activities in Daru BMU, such as generation of patient clinic appointment lists and pathology requests. It also now provides much of the data required for the submission of National Tuberculosis Program, BMU and Programmatic Management of Drug-Resistant TB (PMDT) reports.

Two data officers (research assistants) were recruited and trained to use the EMRS and one government officer was trained as a supervisor.

B. Details of the extent to which the Activity achieved the Outcomes.

The implementation of the EMRS has provided the template for evaluation of the public health interventions in the response to the MDR-TB outbreak in Daru. The implementation of these interventions is supported by DFAT, via Burnet (RID-TB project) and partners, World Vision and the Health and HIV Implementation Services Provider (HHISP). The use of this EMRS in PNG is novel in a government health system and can be applied beyond TB for individual patient care, programmatic reporting and operational research. It is a key initiative in strengthening the health facility and district level health system, through the provision of health information and improving quality of care.

The key innovations that the TDRRCI has supported have been the pilot and testing of models of care for: (1) New treatments of DR-TB with the implementation of bedaquiline-containing regimens. These

have been evaluated to be effective, safe and will form the new standard of care in the new WHO guidelines (2019); (2) Household contact screening and preventive therapy as a community-based delivered system. The expansion of preventive therapy beyond young children with DS-TB to all contacts, including MDR-TB will be a key intervention in the outbreak response in Daru. This will be tested and implemented as research in the STRATUM grant, with broad applications to MDR-TB outbreak responses in PNG and the region.

C. Any highlights, breakthroughs or difficulties encountered

The introduction of Bahmni represents one of the first implementations of an open source, configurable electronic medical records system in PNG. Its implementation in Daru has demonstrated benefits for facilitating patient management and making reporting, monitoring and analysis simpler and more reliable. The benefits of such a system are significant and could be applied in other programs and other parts of PNG.

Sensitivities relating to health information have presented a major challenge. The absence of clear policies and legislation at national and subnational level has precluded the possibility of definitive normative compliance. Issues such as storage of data on a server, remote access to electronic medical records and data security have been raised. It has been challenging to determine how to resolve the opinions of different stakeholders and decision-makers in directing the setup of data systems solutions, due to varied levels of understanding of the issues. We have mitigated this through providing written and verbal briefing, application and compliance with DFAT and Australian policies, obtaining ethical clearance and obtaining approval letters. The DFAT post in PNG provided further invaluable support to work through these issues with NDOH, recognising their importance. They have been mitigated for the implementation of the TDRRCI but do remain a risk to monitor and proactively address in further initiatives.

D. Conclusions or recommendations (if any) arising from the Activity

The implementation of an EMRS has been a critically important component of the response to the MDR-TB outbreak in Daru and recommended / recognised by the WHO's regional Green Light Committee during their review. It improves patient care, with the accurate and timely return of result and information to clinicians; allows the analyses of program indicators for evaluation and decision-making and can be used to conduct operational research, that in turn results in program and policy improvements.

Ongoing support to adapt and expand the EMRS for TB and other diseases in PNG could be explored, in line with existing plans for a National electronic health information system (NeHIS), noting that the EMRS provides patient level data, whilst the NeHIS is aggregate. The EMRS is crucial to high quality research and capacity building and systems strengthening initiatives. Further support will be required to address the legal and policy framework around health information systems in PNG.

1.4 Malaria Studies: M1 Malaysia and Indonesia

M1: Strengthen capacity within national malaria control programs (NMCPs) to Australia's near north to apply novel tools for molecular surveillance of drug-resistant malaria (aligns with objectives 1 & 2).

A. Evidence that the Activity has been completed and that milestones have been achieved

The main focus of malaria (M1) activities under the TDRRCI has been to build molecular capacity by developing i) quality assured molecular detection of low level parasitaemia and speciation; ii) exploring the prevalence of known molecular markers of drug resistance; iii) developing novel strategies for high throughput processing of field isolates; and iv) creating an online resource sharing platform for engaging with policy makers and researchers.

i) Quality assured molecular detection of low level parasitaemia and speciation

Submicroscopic parasitaemia is often asymptomatic and recognised as an important contributor to malaria transmission. Molecular speciation also allows confirmation of parasites which can be misdiagnosed by microscopic examination.

In Indonesia, TDRRCI, has helped to strengthen molecular diagnostic facilities at the Eijkman Institute of Molecular Biology (EIMB). The molecular apprentice (Agatha Puspitasari) visited Darwin in March 2017 to undertake training in PCR quantification of circulating parasites below the detection threshold for routine microscopy. Menzies staff have worked with EIMB to help standardise these processes. EIMB is now registered with WHO external quality assurance program for nucleic acid amplification-based tests.

In Sabah, Malaysia, routine molecular analysis has been established at the Sabah State Reference laboratory (MKA), including PCR evaluation of state-wide trends. This has enabled the demonstration of the near-elimination of human-only malaria due to *P. falciparum* and *P. vivax* in Sabah, but a rise in *P.knowlesi* . These findings have recently been published (refer Annex 3.3, Cooper et al CID 2019).

ii) Exploring the prevalence of known molecular markers of drug resistance

Under TDRRCI we have engaged with partners in Indonesia and Malaysia to gather field samples from diverse locations to gain insights into the evolution and spread of parasites with known drug resistance genotypes.

In Indonesia: TDRRCI has helped establish a collaborative partnership with the Eijkman Institute of Molecular Biology (Dr Rintis Noviyanti), Universitas of Gadja Mada (UGM, Dr Rini Poespoprodjo), the University of Indonesia (UI, Dr Inge Sutanto) and The University of Sumatera Utara (USU, Dr Ayodhia Pasaribu). With support of the National Malaria Control Program (Dr Minerva), field studies were conducted at key locations across the country to gather resistance data from cross sectional surveys and clinical efficacy trials. The surveys adopted the Asia Pacific Malaria Elimination Network (APMEN) design and laboratory protocols at two TDRRCI sites, one in Boking Island and another in Batu Barra, North Sumatra.

Indonesian parasite isolates for genetic analysis were also made available from patients enrolled into a therapeutic efficacy study of DHA-piperaquine conducted in Southern Papua in 2016 and large clinical primaquine trials in north and south Sumatra. In total 425 *P. falciparum* isolates and 1028 *P. vivax* isolates have been collected and are ready for analysis. The initial analysis of low level parasitaemia is now complete and the isolates are now awaiting molecular analysis of drug resistance markers using novel high throughput genotyping methods being developed (See below).

In Sabah Malaysia TDRRCI funding has fostered strong collaboration with the head of Malaysia's malaria control program, Dr Jenarun Jelip, and our principal Malaysian investigator Dr Timothy William. This collaboration has enabled broader malaria state-wide surveillance activities through a collaboration with the Sabah State Reference Laboratory (MKA) and the Infectious Disease Society Kota Kinabalu Sabah (IDSKKS). Parasite samples have been collected as part of state-wide surveillance and prospective clinical efficacy trial. The results of these studies have been published (Grigg et al Mal Journal 2018, refer Annex 3.3) and made available in open access data repositories (NCBI PubMed and GenBank respectively). Results of the study demonstrated no evidence of *P. falciparum* resistance to artemisinin derivatives or the current major partner drugs, with important implications for the ongoing efficacy of current first line malaria treatment guidelines as public health efforts intensify in the pre-elimination stage of *P. falciparum* in Sabah. Methodology and results of this work have undergone feedback to relevant Sabah stakeholders including those involved from the state reference laboratory.

The results of our molecular studies in Indonesia and Malaysia have been fed back to the National Malaria Control Programs, involving discussions around appropriate future measures for drug resistance surveillance, as well as effectiveness of current national guidelines for malaria treatment. The ultimate aim is for the surveillance to be integrated into national and state malaria public health programs and into global open access databases (NCBI GenBank) of drug resistance markers. For *P. falciparum* these activities also link with the Wellcome Trust Sanger Institute's (WTSI's) "SpotMalaria" initiative which is working across the across the Greater Mekong area and wider Asia Pacific region to evaluate the spread and population structure of resistant parasites, particularly artemisinin and piperaquine resistance.

iii) Developing novel strategies for high throughput processing of field isolates

The future of malaria drug resistance surveillance will involve genomic analysis and high throughput systems using next generation sequencing.

In Indonesia, EIMB has installed two next generation sequencing machines (MiSeq and NexSeq). To facilitate capacity building and knowledge transfer, Menzies scientists have been working with the TDRRCI Molecular Fellow (Hidayat Trimarsanto) and collaborators at the WTSI to undertake advanced genomic analyses on more than 350 *P. falciparum* isolates and 1000 *P. vivax* isolates. The data have generated a comprehensive analysis of known resistance markers and a platform for exploring novel molecular markers of drug resistance. The whole genome analysis is undertaken at WTSI in the UK, but the aim is to use these data to develop a more parsimonious genotyping method (barcode). The barcode has now been designed is undergoing optimisation at EIMB using next generation sequencing. Another major objective is identifying the molecular determinant of chloroquine resistant *P. vivax*, the

epicentre of which is in Papua province. Using field isolates from Papua with known response to treatment a genome wide association study is underway.

In Sabah, TDRRCI has strengthened the collaboration between MKA, IDSKKS and WTSI. A whole genome analysis of *P. vivax* has a marked diversity of the parasite at the end stages of elimination including intense selection of genes associated with drug resistance (published in Auburn et al Nat Coms 2018, refer Annex 3.3).

iv) Creating an online resource sharing platform for engaging with policy makers and researchers.

To facilitate data sharing and dissemination of the results of molecular analysis, TDRRCI has enabled several important activities.

In Indonesia, the EIMB-Menzies collaboration has resulted in enhanced bioinformatics capacity at EIMB and an online data sharing platform called Vivax Gen (http://vivaxgen.menzies.edu.au/, Trimarsanto et al, PLoS NTD 2017, at Annex 3.3). The aim of this platform is to standardise analysis of micro-satellite data generated by different scientists. The online platform currently houses data from 2400 parasite isolates from 7 locations across Indonesia. Samples collected from Malaysia have also been included. These data have led to pooled analysis of the population genetic structures that inform dynamics and early warnings of parasite clonal expansion that can precede malaria outbreaks (Pava et al PlosONE, 2017, at Annex 3.3).

The next generation sequencing described above, produces different molecular data (single nucleotide polymorphisms). With TDRRCI funding, the Molecular Fellow has adapted VivaxGen to accommodate the barcode data and this process is nearing completion.

B. Details of the extent to which the Activity achieved the outcomes

The TDRRCI activities have been instrumental in fostering closer collaborations with established partners and brokering new partnerships. These collaborations have promoted the importance of antimalarial drug resistance and novel molecular approaches that are now becoming available. These ties have been made not only within country but have also linked in-country partners with key international research partners and networks.

TDRRCI-funded field activities at diverse sites allowed the collection of contemporary parasite isolates for molecular typing. Four surveys were undertaken – one in Papua (associated with a clinical trial), 2 cross sectional surveys in Boking and Batu Barra (~1000 individuals at each site), and a two-year state-wide surveillance in Sabah. The sampling strategies have been standardised and the development of a comprehensive biobank is now underway, including isolates from complementary clinical trials and surveys undertaken by our Indonesian and Malaysian collaborators. Once high throughput sequencing has been established, this biobank will form an important ongoing resource for quantifying the extent and speed with which drug resistant parasites are spread.

Capacity Building and knowledge transfer have been central to the TDRRCI:

- In March 2017, Ms Agatha Mia Puspitasari and Mr Histayat Trimarsanto visited Darwin to undergo training in molecular methods to determine Kelch 13 and plasmepsin II copy number. These techniques were transferred back to Jakarta and established at the EIMB.
- In October 2017 Ms Puspitasari and Mr Trimarsanto attended training at a molecular workshop held at the Mahidol Oxford Research Centre in Bangkok. This enabled identification of potential sentinel sites and discussion of patient sampling strategy, development of protocols for laboratory analysis and advanced training in genomic data management and analysis.
- In June 2018 Mr Trimarsanto spent 2 weeks with collaborators at the WTSI, Cambridge developing informatics skills in whole genome sequencing data analysis. He also presented the data sharing platform (VivaxGEN) at the Genomic Epidemiology of Malaria Conference
- In July 2018 Dr Rintis Noviyanti and Mr Trimarsanto (EIMB) and Dr Jelip and Puan Rashidah Mohammed (head of molecular and malaria diagnostics at MKA) attended the 1st World Malaria Congress, presenting on their genotyping and population genetic analyses. There was also a workshop to build on TDRRCI activities including sharing progress and lessons learned with other regional collaborators.
- In Sabah, molecular workshops were held in 2018 and 2019, involving the Sabah State Reference Laboratory, IDSKKS, and University of Malaysia Sabah staff. Ms Angelica Tan, a current IDSKKS employee, has been enrolled as an international PhD student at Menzies School of Health Research and Charles Darwin University. She commenced her studies in Sabah in March 2019.
- In late 2018 Ms Tan and Mr Lew Yao Long (the IDSKKS Sabah molecular scientist), both travelled to Darwin for further training in molecular detection methods for ongoing state-wide malaria surveillance activities.

C. Any highlights, breakthroughs or difficulties encountered

In Indonesia and Malaysia, laboratory capacity has been enhanced for molecular resistance typing. But the future will bring new opportunities for high throughput affordable sequencing, allowing comprehensive analysis of multiple gene markers. In view of the imminent availability of amplicon sequencing at EIMB, most of the parasite isolates were not typed using older conventional molecular methods, since it was deemed to be more efficient and affordable to bulk process these once they become available in 2019.

In Sabah and Jakarta, new collaborations were established with national laboratories and the SpotMalaria team at the Sanger Institute, UK. These will link Indonesia and Malaysia into a regional network for monitoring antimalarial drug resistance.

Clinical trials and molecular analysis are reassuring in both Sabah and Papua, Indonesia and did not demonstrate early signs of resistance to artemisinin or piperaquine, but ongoing vigilance must be maintained.

D. Conclusions or recommendations arising from the Activity

In Indonesia, laboratory protocols and quality assurance processes have been established for typing drug resistant isolates at the EIMB, and important progress has been made to develop high throughput

molecular typing using new generation sequencing. A network of collaborators, including three members of the National Malaria Advisory Committee have shown a keen interest to maintain parasite molecular surveillance from across the country. The development of a biobank and standard methodologies to ensure contemporary sampling will be key to ongoing surveillance.

In Sabah, TDRRCI activities have enabled a comprehensive state-wide assessment of molecular malaria drug resistance markers. Artemisinin-based combination therapy remains efficacious and should continue to be recommended in state and national policy for this purpose. Malaysia's national malaria elimination agenda aims to eliminate the human-only species (*P. falciparum* and *P. vivax)* by 2020, but ongoing molecular surveillance will be vital to accurately differentiate their elimination from an increasing burden of zoonotic malaria due to the monkey parasite *P. knowlesi*.

1.5 Malaria Studies: M2 Indonesia

M2: Determine models for implementation of new tools for safe and effective radical cure of malaria to eliminate the latent stages of malaria and prevent onward transmission (aligns with objective 3).

Measuring the effectiveness of novel interventions will provide valuable evidence for policy makers in their efforts to contain and eliminate malaria.

A. Evidence that the activity has been completed and that milestones have been achieved

The main aim of the TDRRCI implementation activities (M2) has been to promote safe and effective radical cure of malaria by i) exploring the field utility of novel G6PD point of care of diagnostics; ii) establishing EIMB as a reference centre for G6PD; iii) quantifying the problems of adherence to a 14-day primaquine regimen; and iv) promoting the adoption of routine G6PD testing into clinical practice. These activities were undertaken solely in Indonesia.

i) Explore the field utility of novel G6PD point of care of diagnostics

In the last few years, several new G6PD diagnostics have become available. Working with collaborators at EIMB we have evaluated two quantitative point of care devices that are now on the market: one from Accessbio/Carestart (USA) and one from SDBiosensor (ROK). The Accessbio/Carestart device was evaluated in Papua, the SDBiosensor device on the island of Boking. In addition, in the course of the TRIPI clinical trial (Papua, n=126) and the ACROSS survey (Boking, n=296) G6PD activity was measured by the experimental biosensor and the gold standard UV-spectrophotometry. Data analysis is ongoing.

ii) Establish EIMB as a reference centre for G6PD.

TDDRCI has been fortunate to have a superb collaborative partner at EIMB (Dr Ari Winasti Satyagraha) who has been our G6PD champion.

TDDRCI has allowed us to extend the collaborative partnership to include PATH (Seattle) who are coordinating, on behalf of the Gates Foundation, the evaluation of novel point of care G6PD diagnostics. The expertise of PATH has allowed us to develop quality control systems at EIMB and formalise standard operating procedures.

Our TDDRCI funded survey in Timika helped establish gold standard spectrophotometry at the Timika Research Facility so that patient isolates can be assessed directly in the field. Development and implementation of procedures and quality control systems in Timika was facilitated by the local G6PD Champion (Dr Winasti Satyagraha) and the G6PD Fellow (Mr. Hisni Rahmat). These activities have enhanced the working relationship between the site and the G6PD Champion. As a consequence, Dr Winasti Satyagraha is now planning additional studies related to the evaluation of G6PD diagnostics in Timika in collaboration with Menzies and other international partners. To facilitate training of the G6PD Champion, Dr. Satyagraha attended the annual meeting of the American Society of Tropical Medicine and Hygiene in the USA as well as the World Malaria Congress (Australia) with funding from the TDRRCI.

iii) Quantify the problems of adherence to a 14-day primaquine regimen

Over the last 15 years we have gathered evidence from 168,000 people treated with malaria attending the Rumah Sakit Mitra Mayarakat (RSMM) hospital, Timika (funded from a previous AusAid grant). In 2017 we published results from this study suggesting that the effectiveness of a 14-day unsupervised regimen of primaquine was at best 12% (Douglas et al PlosMed 2017, refer Annex 3.3). This paper has been pivotal for exposing the serious issues of poor adherence that led to the prospective clinical trial (co-funded by TDRRCI) to understand how adherence could be improved (TRIPI Study). TDRRCI funded a control arm and qualitative questionnaires to identify barriers for adherence and possible strategies to overcome these.

The qualitative component of this study was conducted in collaboration with the Institute of Tropical Medicine (ITM), Belgium and a local PhD student (Annisa Rahmalia). The main objectives were understanding belief and perceptions around malaria and standard malaria treatment that would impact on treatment adherence. The study followed a mixed methods approach, combining data from qualitative data collection with quantitative data from the TRIPI trial and additional data collected through standardized questionnaires. The results of this exercise are currently being analysed and will be published in the coming months.

These findings are complemented by gathering cost data from sites in North Sumatra, South Sumatra and Timika. These have quantified healthcare provider costs of screening tests (malaria rapid diagnostic tests (RDT), microscopy, G6PD RDT, Haemocue™) and treatment (blood stage and radical cure). For the household costs, data were collected on treatment seeking and travel for malaria. Finally, we have information on the number of days patients and their carers were unable to do usual activities. These costs provide crucial insights into the economic burden of vivax malaria, that are now being extrapolated to model the regional and global burden of vivax malaria and the cost effectiveness of different interventions.

iv) Promote the adoption of routine G6PD testing into clinical practice.

A major aim of TDRRCI is to build a collaborative network and provide evidence for the benefits of G6PD testing. However, our surveys in Papua, demonstrated a low prevalence of G6PD deficiency, mainly due to the majority of patients being ethnic highlanders. The perceived risk of primaquine induced haemolysis remains low. Until recently the only field applicable test available has been the fluorescent spot test (FST) which is expensive and not appropriate for point of care diagnosis.

In the two years of TDRRCI study, we have identified suitable novel G6PD tests, explored barriers for routine G6PD testing and established a dynamic dialogue with national policy makers. We did not succeed to get G6PD testing into routine clinical practice but following review of the findings at the 2018 Jakarta workshop, the national committee has, for the first time, considered adopting routine testing and laid out additional evidence that they would like to see in order to make an informed decision. The latter will be integrated into our current health systems strengthening DFAT grant (STRATUM).

B. Details of the extent to which the activity achieved the outcomes

Dr Winasti Satyagraha, our TDRRCI G6PD Champion has successfully implemented G6PD reference testing by spectrophotometry in Timika, Papua, led cross sectional and hospital-based surveys to assess the prevalence of G6PD deficiency on the island of Boking, and was co-investigator on a survey in North Sumatra. She attended two international malaria meetings and established good relationships with FIND, which resulted in a new collaboration between her and Menzies on future diagnostic evaluation studies.

At the 2017 APMEN annual meeting, a satellite meeting funded by TDDRCI, was convened to discuss standardisation of methods for regional surveillance projects (ACROSS) and how these could be applied to explore markers of drug resistance in malaria isolates and the prevalence of G6PD deficiency across the Asia Pacific. The meeting was attended by members of national malaria control programs and research institutions from 7 countries (Nepal, Bangladesh, India, Laos, Vietnam, China and Indonesia). During the meeting, survey design and laboratory procedures were finalised by consensus, and subsequently implemented at 3 Indonesian sites funded through TDRRCI and 3 countries (Nepal, Bangladesh and China) funded by APMEN. In 2019 four additional countries (Pakistan, Laos, Vietnam and India) will use a similar design (funded by APMEN).

A TDRRCI Symposium was held in conjunction with the 1st World Malaria Congress (Melbourne, July 2018) and attended by representatives of the Indonesia and Australian research community as well as our Indonesian and Malaysian TDRRCI collaborators. A series of presentations laid out the results of our TDRRCI-related activities in Indonesia and Malaysia, covering clinical, molecular and social science aspects of these activities. Group discussions helped define existing data and knowledge gaps and develop an agenda for the following years to address these gaps.

A highlight of the G6PD activities was an international workshop convened in August 2018 at EIMB. This was attended by more than 60 international and Indonesian scientists as well as key members of the Indonesia expert committee on National Treatment Guidelines. The meeting was co-chaired by Dr Benedikt Ley and Dr Ari Winasti Satyagraha. The main objectives were to provide an update on the most recent findings in the area of G6PD diagnostics, identify knowledge gaps related to the diagnosis of G6PD deficiency as well as effective ways of introducing routine G6PD testing into national policy to guide 8-aminoquinoline based radical cure for vivax malaria. The two-day workshop consisted of a series of presentations on recently published as well as unpublished results and subsequent group discussions among all participants.

In the course of this meeting Menzies (Australia), the EIMB (Indonesia) and the WTSI (UK) agreed to develop a high throughput platform to genotype large numbers of blood samples for the G6PD gene.

This approach will help advance simple and cost-effective identification of populations at risk of primaquine induced haemolysis that will inform screening strategies.

C. Any highlights, breakthroughs or difficulties encountered

We have successfully set up a reference centre for the diagnosis of G6PD deficiency at EIMB (Jakarta) with the help of our Indonesian G6PD Champion. Establishing remote testing at our field site in Papua will allow us to assess novel G6PD diagnostics in remote communities.

Our G6PD diagnostic evaluation studies, have shown that SD Biosensor has better performance than the AccessBio bionsensor. FIND (a Swiss not for profit organization) have agreed to support additional research on the field applicability of this device in Timika, West Papua.

Qualitative studies on primaquine adherence have been completed and are being analysed. These will be an important baseline for designing interventions to improve treatment adherence and effectiveness not only in Papua, but hopefully in other malaria endemic locations.

Unfortunately, we were not able to introduce routine quantitative G6PD testing into the local treatment guidelines in Timika, West Papua. However, our subsequent studies have shown significant challenges of 14-day primaquine. Complementary clinical trials in Sumatra (IMPROV study) have shown that a 7-day primaquine regimen may be a suitable alternative, but this would require prior G6PD testing. Further studies are underway to explore this option.

D. Conclusions or recommendations arising from the activity

TDRRCI has helped to establish an internationally recognised G6PD reference centre at EIMB and built links with other centres in USA, Thailand and Bangladesh. This centre of excellence has allowed us to validate a new G6PD biosensor which will be crucial for wide deployment of tafenoquine (a new single dose radical cure treatment entering the market) and short high dose primaquine regimens.

Our studies have highlighted the significant issues of adherence to a 14-day regimen, and the need for intervention to improve this, including deployment of shorter course primaquine and single dose tafenoquine. These regimens will require prior G6PD testing and these are now validated and entering the market. Future work will look at ways these can be implemented safely and effectively in remote areas.

2. FINANCE

2.1 STATEMENT OF THE FUNDS PROVIDED AND SPENT

Expenditure by Activity – Menzies and Burnet combined

	Y1 + Y2 Budget	Total Y1+Y2 Actual
	$	**$**
Salary	374,698	**375,833**
Capacity Development	401,000	**425,853**
Equipment	68,000	**30,379**
Field Work	759,323	**755,051**
Knowledge Transfer	298,000	**314,905**
Other	26,000	**24,619**
Travel	72,805	**73,360**
TOTAL	**1,999,826**	**2,000,000**

Total funds dispersed and expended by Menzies

	$	**Comment**
Funds Received	$2,000,000	Received in four tranches
Funds Distributed to Burnet Institute	$632,378	Paid in four tranches
Funds Expended (Q1-Q2)	$33,715	
Funds Expended (Q3-Q4)	$327,680	
Funds Expended (Q5-Q6)	$199,430	
Funds Expended (Q7-Q8)	$292,975	Reported in two acquittals
Funds Expended (Q9-Q10)	$513,822	
Total funds disbursed and expended (Q1-Q10)	2,000,000	

2.2 THE AMOUNT (IF ANY) REMAINING IN THE ACCOUNT REFERRED TO IN CLAUSE 6.3

$0.00

3. ANNEXES

3.1 Annex 1 Asset Register

3.2 Annex 2 List of Stakeholders

3.3 Annex 3 List of published reports, promotional material, media publicity, pamphlets and other documentation relevant to the Activity

3.4 Annex 4 Maps of study site locations

3.1 ANNEX 1 ASSET REGISTER

DESCRIPTION	LOCATION	ASSET NUMBER	PURCHASE DATE	PURCHASE PRICE AUD	REASON FOR ACQUISITION	DISPOSAL INFORMATION	OWNERSHIP STATUS (assets over $2,000)
ACER LAPTOP C/W STD ACC - FARRAH	MENGGATAL/LUYANG, SABAH	IDSKKS/OE/2017/019	13-Oct-17	1,097.77	SUPPORT FOR DATA AND RESEARCH	n/a	
CANON MF635CX PRINTER/SCANNER	KK OFFICE, SABAH	IDSKKS/OE/2018/023	22-May-18	608.76	OFFICE EQUIPMENT	n/a	
DELL LAPTOP C/W STD ACC - SITI AZIZAH	INANAM CLINIC, SABAH	IDSKKS/OE/2018-026	18-Jul-18	748.58	SUPPORT FOR DATA AND RESEARCH	n/a	
DELL LAPTOP C/W STD ACC - FARRAH	MENGGATAL/LUYANG, SABAH	IDSKKS/OE/2018-027	10-Dec-18	1,580.56	SUPPORT FOR DATA AND RESEARCH	n/a	
4 UNIT STEEL FILE'S RACK	MENGGATAL CLINIC, SABAH	IDSKKS/FF//2018/034 (KKM)	28-Dec-18	908.81	FILE MANAGEMENT	n/a	
2 UNITS 3X3 BOOK CASE	LUYANG CLINIC, SABAH	IDSKKS/FF//2018/026-027 (KKL)	24-May-18	137.74	FILE MANAGEMENT	n/a	
OFFICE TABLE	LUYANG CLINIC, SABAH	IDSKKS/FF//2018/027(KKL)	24-May-18	61.95	OFFICE EQUIPMENT	n/a	
PLASTIC CHAIR	LUYANG CLINIC, SABAH	IDSKKS/FF//2018/028(KKL)	24-May-18	7.23	OFFICE EQUIPMENT	n/a	
4X4 BOOK CASE	MENGGATAL CLINIC, SABAH	IDSKKS/FF//2018/029(KKM)	04-Jul-18	61.95	FILE MANAGEMENT	n/a	
CEILING FAN + INSTALLATION CHARGES	LUYANG CLINIC, SABAH	IDSKKS/FF//2018/030(KKM)	04-Jul-18	61.95	OFFICE EQUIPMENT	n/a	
4X4 BOOK CASE	INANAM CLINIC, SABAH	IDSKKS/FF//2018/031(KKI)	31-Jul-18	51.91	FILE MANAGEMENT	n/a	
OFFICE TABLE	INANAM CLINIC, SABAH	IDSKKS/FF//2018/032(KKI)	01-Aug-18	51.91	OFFICE EQUIPMENT	n/a	
PLASTIC CHAIR WITH ARM REST	INANAM CLINIC, SABAH	IDSKKS/FF//2018-033 (KKI)	01-Aug-18	29.76	OFFICE EQUIPMENT	n/a	
FLASH DRIVE SANDISK BLADE 32GB	RSUD, TB OFFICE	DFAT 1 TB 01-2017	03-Apr-17	24.96	FILE MANAGEMENT	n/a	

FILING CABINET	RSUD, TB OFFICE	DFAT 1 TB 02-2017	03-Apr-17	219.66	FILE MANAGEMENT	n/a	
DESK	RSUD, TB OFFICE	DFAT 1 TB 03-2017	03-Apr-17	64.90	OFFICE EQUIPMENT	n/a	
HP NOKIA	RSUD, TB OFFICE	DFAT 1 TB 04-2017	03-Apr-17	35.74	COMMUNICATIONS	Item was lost	
LAPTOP ACER ASPIRE	RSUD, TB OFFICE	DFAT 1 TB 05-2017	05-Apr-17	589.09	SUPPORT FOR DATA AND RESEARCH	n/a	
LAPTOP ACER ASPIRE	YPKMP TIMIKA	DFAT 1 TB 06-2017	05-Apr-17	589.09	SUPPORT FOR DATA AND RESEARCH	n/a	
EXTENSION CABLE	RSUD, TB OFFICE	DFAT 1 TB 07-2017	05-Apr-17	5.99	OFFICE EQUIPMENT	n/a	
TERMINAL POWER	RSUD, TB OFFICE	DFAT 1 TB 08-2017	10-Jun-17	7.49	OFFICE EQUIPMENT	n/a	
DESK	RSUD, TB OFFICE	DFAT 1 TB 09-2017	12-Jun-17	180.72	OFFICE EQUIPMENT	n/a	
MODEM	RSUD, TB OFFICE	DFAT 1 TB 10-2017	05-Jul-17	47.93	OFFICE EQUIPMENT	n/a	
PRINTER	RSUD, TB OFFICE	DFAT 1 TB 11-2017	05-Jul-17	227.65	OFFICE EQUIPMENT	n/a	
DISPENSER MIKAYO	RSUD, TB OFFICE	DFAT 1 TB 12-2017	19-Jul-17	23.66	OFFICE EQUIPMENT	n/a	
RACK FOR DISPENSER	RSUD, TB OFFICE	DFAT 1 TB 13-2017	19-Jul-17	29.95	OFFICE EQUIPMENT	n/a	
KEY PAD	RSUD, TB OFFICE	DFAT 1 TB 14-2017	25-Jul-17	16.97	OFFICE EQUIPMENT	n/a	
RAK SERBAGUNA	RSUD, TB OFFICE	DFAT 1 TB 15-2017	06-Nov-17	6.99	OFFICE EQUIPMENT	n/a	
APC UPS 650 VA	YPKMP TIMIKA	DFAT 1 TB 16-2018	20-Apr-18	84.87	OFFICE EQUIPMENT	n/a	
MACBOOK PRO 13" 2.3GHZ 8GB RAM 256 FLASH STORAGE	YPKMP TIMIKA	DFAT 1 TB 17-2018	08-Jun-18	1,984.00	SUPPORT FOR DATA AND RESEARCH	n/a	

PC - AIO HP20 (Desktop PC all-in-one)	YPKMP (Admin room)	DFAT 1 TB 18-2018	03-Aug-18	439.22	SUPPORT FOR DATA AND RESEARCH	n/a	
2X MOUSE USB	DATA ENTRY ROOM RSUD	DFAT 1 TB 19 & 20-2018	15-Aug-18	11.98	OFFICE EQUIPMENT	n/a	
EXTENSION CABLE	DATA ENTRY ROOM RSUD	DFAT 1 TB 21-2018	15-Aug-18	6.49	OFFICE EQUIPMENT	n/a	
KEYBOARD USB GENIUS KB 110	DATA ENTRY ROOM RSUD	DFAT 1 TB 22-2018	15-Aug-18	24.96	OFFICE EQUIPMENT	n/a	
APC UPS 650 V & STEKER POWER	YPKMP ADMIN ROOM	DFAT 1 TB 23 & 24-2018	15-Aug-18	89.86	OFFICE EQUIPMENT	n/a	
VAST BE 1200 (FILE RACK)	DATA ENTRY ROOM RSUD	DFAT 1 TB 25-2018	29-Nov-18	84.87	FILE MANAGEMENT	n/a	
PRJ EPSON EB-X450 PROJECTOR	YPKMP TIMIKA	DFAT 1 TB 26-2018	30-Nov-18	589.09	PROJECTOR EQUIPMENT	n/a	
HD4TB MYPASS-WDHD WD EXTERNAL 4 TB	YPKMP TIMIKA	DFAT 1 TB 27-2018	30-Nov-18	197.69	FILE MANAGEMENT	n/a	
AIO ASUS V222 GAK (BA141IT)	YPKMP TIMIKA	DFAT 1 TB 28-2018	30-Nov-18	484.25	SUPPORT FOR DATA AND RESEARCH	n/a	
GENSET MATSUMOTO	LAB YPKMP	DFAT 1 TB 29-2018	19-Dec-18	1,877.10	SUPPORT FOR DATA AND RESEARCH	n/a	
APPLE MAGIC MOUSE 2	BURNET, MELBOURNE	TDRRCI2017-001	07-Sep-17	109.00	NEW MOUSE REQUIRED	n/a	
DELL LAPTOP	BURNET, MELBOURNE	TDRRCI2017-003	17-Nov-17	2,322.10	SUPPORT FOR DATA AND RESEARCH	n/a	Transferred to STRATUM Program (Grant Agreement 74431) as approved by DFAT via email to Menzies 14/02/2019.
DELL LAPTOP 7280	DARU, PNG	TDRRCI2017-005	06-Jun-17	2,006.57	RESEARCHER COMPUTER	n/a	Request to transfer this asset to

							Burnet's RID-TB Program currently under consideration by DFAT
DELL LAPTOP 7280	DARU, PNG	TDRRCI2017-006	06-Jun-17	2,006.57	RESEARCHER COMPUTER	n/a	Request to transfer this asset to Burnet's RID-TB Program currently under consideration by DFAT
R630 SERVER PNG PROGRAM	DARU, PNG	TDRRCI2017-007	10-Jan-17	5,300.00	SERVER FOR DARU	n/a	Request to transfer this asset to Burnet's RID-TB Program currently under consideration by DFAT
MACBOOK PRO 13" 2.3 GHZ 15/8G MPXT2X/A	BURNET, MELBOURNE	TDRRCI2017-008	04-Jul-18	2,020.00	SUPPORT FOR DATA AND RESEARCH	n/a	Transferred to STRATUM Program (Grant Agreement 74431) as approved by DFAT via email to Menzies 14/02/2019.
COMMS EQUIPMENT SORT-IT	DARU, PNG	TDRRCI2017-009	14-Aug-17	2,110.00	SORT-IT COURSE EQUIPMENT	n/a	Passed onto Daru General Hospital
IN94207 DATA SYSTEM	DARU, PNG	TDRRCI2017-010	15-Aug-17	1,500.00	DATA SYSTEM	Software expired Aug-18	

MULTIMEDIA PROJECTOR	DARU, PNG	TDRRCI2017-011	06-Sep-17	736.36	PROJECTOR EQUIPMENT	n/a	
SATECHI TYPE C PRO HUB THUNDERBOLT 3	BURNET, MELBOURNE	TDRRCI2017-012	10-Jul-18	127.26	LAPTOP ADAPTER	n/a	
SOFTWARE LICENCES WinSvrSTCCore SNGL LicSAPk OLD 2 Lic NL CoreLic	DARU, PNG	TDRRCI2017-013	16-Aug-17	689.20	SOFTWARE LICENCES	n/a	
LENOVO TAB 2 A10-30 16GB	DARU, PNG	TDRRCI2017-014	20-Jul-17	196.00	DATA ENTRY	n/a	
LENOVO TAB 2 A10-30 16GB	DARU, PNG	TDRRCI2017-015	20-Jul-17	196.00	DATA ENTRY	n/a	
UPS	DARU, PNG	TDRRCI2017-016	06-Dec-17	5197.40	SUPPORT FOR DATA AND RESEARCH	n/a	Request to transfer this asset to Burnet's RID-TB Program currently under consideration by DFAT
DATA CABINET	DARU, PNG	TDRRCI2017-017	02-Mar-17	4701.77	SUPPORT FOR DATA AND RESEARCH	n/a	Request to transfer this asset to Burnet's RID-TB Program currently under consideration by DFAT
UPS	DARU, PNG	TDRRCI2017-018	02-Mar-17	4701.77	SUPPORT FOR DATA AND RESEARCH	n/a	Request to transfer this asset to Burnet's RID-TB Program currently under

							consideration by DFAT
SNMP CARD	DARU, PNG	TDRRCI2017-019	02-Mar-17	1080.00	SUPPORT FOR DATA AND RESEARCH	n/a	

3.2 ANNEX 2 LIST OF STAKEHOLDERS

Menzies School of Health Research (Menzies) http://www.menzies.edu.au/

The Burnet Institute (Burnet), https://www.burnet.edu.au/

Asia-Pacific Malaria Elimination Network

Eijkman Institute of Molecular Biology (Eijkman/EIMB), Indonesia http://www.eijkman.go.id/

Eijkman Oxford Clinical Research Unit (EOCRU) http://www.eijkman.go.id/units/eocru

The Infectious Diseases Society, Kota Kinabalu, Sabah (IDSKKS), Malaysia

Institute of Tropical Medicine, Belgium (ITM) www.itg.be

National Malaria Control Program, Ministry of Health, Indonesia

National Malaria Control Program, Ministry of Health, Malaysia

Papua New Guinea Institute of Medical Research (IMR), Goroka, Papua New Guinea http://www.pngimr.org.pg/

Sabah State Reference Laboratory, Kota Kinabalu, Malaysia

Sabah State Department of Health, Malaysia

The Papua New Guinea National Department of Health (PNG NDoH), Port Moresby, Papua New Guinea

The Papuan Health and Community Development Foundation (PHCDF/YPKMP), Timika, Papua Province, Indonesia

Queen Elizabeth Hospital, Kota Kinabalu, Sabah, Malaysia

University Gadjah Mada (UGM), Jakarta, Indonesia https://ugm.ac.id/en/

University of Malaysia, Sabah (UMS) http://www.ums.edu.my/v5/

University of Papua New Guinea (UPNG), Port Moresby, Papua New Guinea www.upng.ac.pg/

Wellcome Trust Sanger Institute (WTSI) http://www.sanger.ac.uk/

3.3 ANNEX 3 LIST OF PUBLISHED REPORTS, PROMOTIONAL MATERIAL, MEDIA PUBLICITY, PAMPHLETS AND OTHER DOCUMENTATION RELEVANT TO THE ACTIVITY

Peer Reviewed Journal Articles

M1 & M2 Publications arising from TDRRCI activities:

Auburn S, Benavente ED, Miotto O, Pearson RD, Amato R, Grigg MJ, Barber BE, William T, Handayuni I, Marfurt J, Trimarsanto H, Noviyanti R, Sriprawat K, Nosten F, Campino S, Clark TG, Anstey NM, Kwiatkowski DP, Price RN. Genomic analysis of a pre-elimination Malaysian Plasmodium vivax population reveals selective pressures and changing transmission dynamics. Nature Communications, 9(1):2585, Jul 3, 2018.

Cooper DJ, Rajahram GS, William T, Jelip J, Mohammad R, Benedict J, Alaza DA, Malacova E, Yeo TW, Grigg MJ, Anstey NM, Barber BE. Plasmodium knowlesi malaria in Sabah, Malaysia, 2015-2017: ongoing increase in incidence despite near-elimination of the human-only Plasmodium species. Clinical Infectious Diseases. 2019.

Devine A, Kenangalem E, Burdarm L, Anstey NM, Poespoprodjo JR, Price RN, Yeung S. Treatment-seeking behavior following implementation of a unified policy of dihydroartemisinin-piperaquine for the treatment of uncomplicated malaria in Papua, Indonesia. American Journal of Tropical Medicine and Hygiene, 98(2), 543-550, 2018.

Douglas NM, Poespoprodjo JR, Patriani D, Malloy MJ, Kenangalem E, Sugiarto P, Simpson JA, Soenarto Y, Anstey NM and Price RN. Unsupervised primaquine for the treatment of Plasmodium vivax malaria relapses in southern Papua: a hospital-based cohort study. PLoS Medicine, 14(8): e1002379, 2017.

Grigg MJ, William T, Piera KA, Rajahram GS, Jelip J, Aziz A, Menon J, Marfurt J, Price RN, Auburn S, Barber BE, Yeo TW, Anstey NM. Plasmodium falciparum artemisinin resistance monitoring in Sabah, Malaysia: in vivo therapeutic efficacy and kelch13 molecular marker surveillance. Malaria Journal Dec 12;17:463. 2018.

Pava Z, Noviyanti R, Handayuni I, Trimarsanto H, Trianty L, Burdam FH, Kenangalem E, Utami RAS, Tirta YK, Coutrier F, Poespoprodjo JR, Price RN, Marfurt J, Auburn S. Genetic micro-epidemiology of malaria in Papua Indonesia: Extensive P. vivax diversity and a distinct subpopulation of asymptomatic P. falciparum infections. PLoS One, 2017 May 12;12(5):e0177445, 2017.

Trimarsanto H, Benavente ED, Noviyanti R, Utami RAS, Getachew S, Kim JY, Goo YK, Wangchuck S, Liu Y, Gao Q, Dowd S, Cheng Q, Clark TG, Price RN, Auburn S. VivaxGEN: A Platform for Comparative Analysis of Short Tandem Repeat Genotyping Data in Plasmodium vivax Populations. PLoS Neglected Tropical Diseases, 11(3): e0005465, 2017.

T1 & T2 Publications arising from TDRRCI activities:

Lestari T, Graham S, van den Boogaard C, Triasih R, Poespoprodjo J, Ubra R, Kenangalem E, Mahendradhata Y, Anstey N, Bailie R, Ralph A. Bridging the knowledge-practice gap in tuberculosis contact management in a high-burden setting: a mixed-methods protocol for a multicenter health system strengthening study. Implementation Science: IS, 14(1):31, 2019.

The following articles are currently in press:

Aia P, Majumdar SS, Pomat W, Tefuarani N, Graham SM, Dakulala P. Building operational capacity for tuberculosis in Papua New Guinea (Editorial). Public Health Action, Vol. 9, Supplement 1. Foundations for Pillar 3 of the End TB Strategy in Papua New Guinea: building capacity in operational research. 2019 (in press)

Viney K, Bissell K, Hill PC, Marks GB. Operational research capacity building in PNG and the Pacific Islands (Editorial). Public Health Action, Vol. 9, Supplement 1. Foundations for Pillar 3 of the End TB Strategy in Papua New Guinea: building capacity in operational research. 2019 (in press)

Apis V, Landi M, Graham SM, Islam T, Amini J, Sabumi G, Mandalakas A, Meae T, du Cros P, Shewade H, Welch H. Outcomes in children treated for tuberculosis with the new dispersible fixed-dose combinations in Port Moresby. Public Health Action, Vol. 9, Supplement 1. Foundations for Pillar 3 of the End TB Strategy in Papua New Guinea: building capacity in operational research. 2019 (in press)

Banamu J, Lavu EK, Johnson K, Moke R, Majumdar SS, Takarinda K, Commons RJ. Impact of GxAlert on management of rifampicin-resistant tuberculosis patients, Port Moresby, Papua New Guinea. Public Health Action, Vol. 9, Supplement 1. Foundations for Pillar 3 of the End TB Strategy in Papua New Guinea: building capacity in operational research. 2019 (in press)

Honjepari A, Madiowi S, Madjus S, Burkot C, Islam S, Chan G, Majumdar SS, Graham SM. Implementation of screening and management of household contacts of tuberculosis cases in Daru, Papua New Guinea. Public Health Action, Vol. 9, Supplement 1. Foundations for Pillar 3 of the End TB Strategy in Papua New Guinea: building capacity in operational research. 2019 (in press)

Hapolo E, Ilai J, Francis T, du Cros P, Taune M, Chan G. Tuberculosis treatment delay associated with drug resistance and admission at Daru General Hospital in Papua New Guinea. Public Health Action, Vol. 9, Supplement 1. Foundations for Pillar 3 of the End TB Strategy in Papua New Guinea: building capacity in operational research. 2019 (in press)

Kelebi T, Takarinda KC, Commons RJ, Sissai B, Yowei J, Gale M. Gaps in tuberculosis care in West Sepik Province of Papua New Guinea. Public Health Action, Vol. 9, Supplement 1. Foundations for Pillar 3 of the End TB Strategy in Papua New Guinea: building capacity in operational research. 2019 (in press)

Lavu EK, Johnson K, Banamu J, Pandey S, Carter R, Coulter C, Aia P, Majumdar SS, Marais BJ, Graham SM, Vince J. Drug-resistant tuberculosis diagnosis since Xpert MTB/RIF introduction in Papua New Guinea (2012-2017). Public Health Action, Vol. 9, Supplement 1. Foundations for Pillar 3 of the End TB Strategy in Papua New Guinea: building capacity in operational research. 2019 (in press)

Maha A, Majumdar SS, Main S, Phillip W, Witari K, Schulz J, du Cros P. The effects of decentralisation of tuberculosis services in the East New Britain Province, Papua New Guinea. Public Health Action, Vol. 9, Supplement 1. Foundations for Pillar 3 of the End TB Strategy in Papua New Guinea: building capacity in operational research. 2019 (in press)

Morris L, Hiasihri S, Chan G, Honjepari A, Tugo O, Taune M, Aia P, Dakulala P, Majumdar SS. The emergency response to multidrug-resistant tuberculosis in Daru, Western Province, Papua New Guinea, 2014-2017. Public Health Action, Vol. 9, Supplement 1. Foundations for Pillar 3 of the End TB Strategy in Papua New Guinea: building capacity in operational research. 2019 (in press)

PNG SORT-IT. Participants and Manuscripts

	Participant	Title of Manuscript	Lead Facilitator
1	Verlyn Apis	An evaluation of treatment outcomes in children treated for tuberculosis at Port Moresby General Hospital, PNG	Steve Graham
2	Jennifer Banamu	Impact of GxAlert on time to treatment initiation and patient outcomes for drug-resistant tuberculosis patients in Port Moresby, Papua New Guinea, 2014 to 2016.	Rob Commons
3	Alice Honjepari	Evaluation of pilot DR-TB household contact screening in Daru Island, Western province over a one year period.	Steve Graham
4	Emmanuel Hapolo	Timeliness of diagnosis and treatment initiation for TB patients diagnosed at Daru General Hospital in Western Province, PNG	Geoff Chan
5	Trevor Kelebi	Clinical characteristics, treatment outcomes and risk factors for poor outcome among drug sensitive tuberculosis patients in West Sepik Province, Papua New Guinea, 2014 - 2016	Marianne Gale
6	Evelyn Lavu	Drug-resistant tuberculosis diagnosis since Xpert MTB/RIF introduction in Papua New Guinea (2012-2017)	Steve Graham
7	Al Maha	The effect of integrated clinical outreach and awareness to peripheral health facilities on health service utilization and TB treatment outcomes in East New Britain Province, Papua New Guinea.	Philipp du Cros
8	Lucy Morris	The Emergency Response to Drug-Resistant Tuberculosis in South Fly District, Western Province, 2014-2017	Suman Majumdar
9	Iraingo Moses	Clinical characteristics and treatment outcomes of TB patients treated with first line therapy in Kerema district hospital in Gulf province, 2016	Marianne Gale
10	Magdelene Taune	First experience of Bedaquiline-containing regimens to improve DR-TB patients' outcomes in Daru, Western Province in Papua New Guinea.	Suman Majumdar
11	Kenneth Sodeng	An evaluation of linkages to TB care and quality of TB treatment in Kavieng Provincial Hospital, New Ireland Province, PNG	Philipp du Cros
12	Kabe Vakadem	A clinico-epidemiological mortality review of adult tuberculosis patients in a provincial hospital in Papua New Guinea, 2015 to 2017.	Rob Commons

Conference Posters

Grigg, MJ, Willimas, T, Piera, KA, Jelip, J, Rajahram, GS, Bargerm BE, Menon, J, Auburn, S, Price, R, Yeo, TW, Anstey, NM. 2018. *Plasmodium falciparum* artemisinin resistance monitoring in Sabah, Malaysia: *in vivo* therapeutic efficacy and K13 molecular marker surveillance. SMART Study Poster, American Society of Tropical Medicine & Hygiene Annual Scientific Meeting, 28th Oct – 1st Nov 2018, New Orleans, Louisiana, USA.

Lestari T, van den Boogaard C, Poespoprodjo JR, Trisasih R, Mahendradhata Y, Samuel M, Kamaludin, Ubra R, Bailie R, Graham S, Ralph A. 2018. Implementation of tuberculosis contact investigation and isoniazid prevention treatment in Mimika, Indonesia. 4-5 November 2018, TB National Conference, Poster, Makassar, Indonesia.

Lestari, T, van den Boogaard, C, Trisasih, R, Poespoprodjo, JR, Mahendradhata, Y, Ubra, R, Bailie, R, Graham, S, Ralph, A. 2018. Designing and tailoring interventions to improve implementation of tuberculosis contact investigation and prevention treatment in Papua, Indonesia. 7-12 October 2018, Health System Research conference, Liverpool, UK.

Ralph, A, Graham, SM, Anstey, NM, Toole, M, Mahedrahata, Y, Poespoprodjo RJ, William, T, Bailie, R, Triasih, R, Kenahgalem, E, Lestari, T, van den Boogaard, SHA, Majumdar, S. 2017. Tropical Disease Research Regional Collaboration Initiative (TDRRCI) on Tuberculosis and Malaria. Poster, Australia Society of Infectious Diseases, 29 March 2017, Sydney. Poster 129.

van den Boogaard CHA, Lestari T, Goroh MMD, Triasih R, Wong KJ, Bailie R, Anstey NM, Graham SM, Ralph AP. 2018. Are barriers to successful IPT uptake the same everywhere? A comparison between two Asia-Pacific countries. The 49th Union World Conference on Lung Health. 24-27 October 2018. The Hague, The Netherlands. Poster A-0996-0013-02217.

Presentations

Lestari, T. 2017. Implementation Research to improve Tuberculosis Contact Screening in Timika, Indonesia. 6th Annual TB CRE Symposium, 2nd June 2017, Woolcock Institute, Sydney, Australia.

Lestari, T. Strengthening health systems to improve tuberculosis contact investigation in Timika, Indonesia. HOT NORTH Annual Scientific Symposium, 24th May 2018, Darwin, Australia.

Lestari, T, Ralph, A, van den Boogaard, C, Graham, S. 2018. Child contact screening and management in high TB setting in Papua Province. The 49th Union World Conference on Lung Health. 24-27 October 2018. The Hague, The Netherlands. Presentation A-0996-0015-01795.

Ralph, A. 2018. Tuberculosis research program, Indonesia. Menzies School of Health Research Seminar Series, 10th May 2018, Darwin, Australia.

Dissertations

Goroh, MMD (2018) Barriers to tuberculosis contract investigation in two primary health clinics in Kota Kinabalu, Sabah. Faculty of Medicine and Health Sciences, University of Malaysia, Sabah.

Resources

Sabah

- TB Flipchart (Patients)
- Flyer - Latent TB in children (Patients)
- Flyer – TB Contact (Patients)
- Flowchart for latent TB management in Sabah (Health Care Workers)
- Video - Gastric Lavage (Health Care Workers)
- Video – Preparation of IPT solution (Health Care Workers)

Timika

- Training material (presentations) – Child TB, contact investigation and preventive treatment (Health Care Workers)
- Outreach kit – allowing Health Care Workers to conduct home visits
- Flowchart – Clinical pathway for child TB diagnosis (Health Care Workers)
- Form – Scoring child TB (Health Care Worker)
- Form – Visit reminder (Health Care Worker)
- Brochure – TB preventive treatment (Patients)
- Flyer – TB infected lung (Patients)
- Poster – TB awareness (Patients)
- Poster – TB symptoms (Patients)
- Poster – TB transmission
- Video series – TB education
- Flowchart and Management Table for Child TB (Health Care Workers)
- Flyer – Sputum Induction Procedure (Health Care Workers)
- Video – Sputum Induction Demonstration (Health Care Workers)

In consultation with the Mimika District Health Office, the following Standard Operating Procedures were updated:

- SOP – TB contact investigation (Health Care Workers)
- SOP – TB preventive treatment for children (Health Care Workers)

Reports

TDRRCI-Malaysia: TB Stakeholders Update January 2019

3.4 ANNEX 4 MAP OF STUDY SITE LOCATIONS