Report of the first WHO global meeting on skin-related neglected tropical diseases

Geneva, Switzerland, 27–31 March 2023

World Health Organization

Report of the first WHO global meeting on skin-related neglected tropical diseases

Geneva, Switzerland, 27–31 March 2023

World Health Organization

Report of the first WHO global meeting on skin-related neglected tropical diseases, Geneva, Switzerland, 27-31 March 2023

ISBN 978-92-4-009133-7 (electronic version)
ISBN 978-92-4-009134-4 (print version)

Suggested citation. Report of the first WHO global meeting on skin-related neglected tropical diseases, Geneva, Switzerland, 27-31 March 2023. Geneva: World Health Organization; 2024. Licence: CC BY-NC-SA 3.0 IGO.

Cataloguing-in-Publication (CIP) data. CIP data are available at https://iris.who.int/.

This publication contains the report of the first WHO global meeting on skin-related neglected tropical diseases and does not necessarily represent the decisions or policies of WHO.

Cover photo: WHO Director-General Dr Tedros Adhanom Ghebreyesus addressing the first global meeting on skin-related neglected tropical diseases. © WHO/Priya Pathak

Contents

Figures and tables

Acknowledgements

The World Health Organization (WHO) extends its heartfelt appreciation to all those who participated in the first WHO global meeting on skin-related neglected tropical diseases held at WHO headquarters on 27–31 March 2023. The theme of the meeting was “integration for greater impact”. The meeting was organized by the WHO Global Neglected Tropical Diseases Programme (WHO/NTD).

Main contributors

WHO is grateful to the session chairpersons, whose dynamic leadership fostered an environment conducive to knowledge exchange: Esther Freeman (International Alliance for Global Health Dermatology, Boston, United States of America), Claire Fuller (International League of Dermatological Societies, London, United Kingdom of Great Britain and Northern Ireland), Roderick Hay (King’s College London, United Kingdom), Roch Christian Johnson (Raoul Follereau Foundation, Paris, France), Lydia Mosi (University of Ghana, Accra, Ghana), Michele Murdoch (International Foundation for Dermatology, United Kingdom), Ghislain Sopoh (University of Abomey-Calavi, Littoral, Benin), Ymkje Stienstra (University Medical Center Groningen, Groningen, Netherlands (Kingdom of the)), Tim Stinear (University of Melbourne, Parkville, Australia) and Rie Yotsu (Tulane School of Public Health and Tropical Medicine, New Orleans, United States of America).

The presenters are gratefully acknowledged for their comprehensive and engaging presentations, particularly the keynote speakers: Isra Cruz (Carlos III Health Institute, Madrid, Spain), Gail Davey (Brighton & Sussex Medical School, Falmer, United Kingdom), Claire Fuller (International League of Dermatological Societies, London, United Kingdom), Roderick Hay (King’s College London, London, United Kingdom), Iñigo Lasa (Anesvad Foundation, Bilbao, Spain), Michael Marks (London School of Hygiene & Tropical Medicine, London, United Kingdom), Richard Phillips (Kwame Nkrumah University of Science and Technology, Kumasi, Ghana), Tim Stinear (University of Melbourne, Parkville, Australia) and and Wim van Brakel (NLR International, Nieuwegein, Netherlands (Kingdom of the)). Their stimulating presentations provoked thoughtful discussions and enhanced the scholarly depth of the meeting.

Writers, reviewers and rapporteurs

The report was drafted by Ruth Nyagacha (Kenya Medical Research Institute, Nairobi, Kenya) and Priya Pathak (WHO/NTD) and reviewed by Kingsley Asiedu (WHO/NTD), Samantha Bolton (Consultant, WHO/NTD), Daniel Argaw Dagne (WHO/NTD) and José Antonio Ruiz Postigo (WHO/NTD).

The rapporteurs were Bernadette Agbavor (WHO/NTD), Esai Anagonou (University of Abomey-Calavi, Atlantique, Benin), Yves Barogui (WHO Regional Office for Africa), Abate Beshah (WHO Regional Office for Africa), Andrew Buultjens (University of Melbourne, Melbourne, Australia), Ronaldo Carvalho (WHO Regional Office for the Americas), Victoria Cox (Royal Darwin Hospital, Darwin, Australia), Laura Dean (Liverpool School of Tropical Medicine, Liverpool, United Kingdom), Josefina Joao (Disease Control, Ministry of Health, Dili, Timor-Leste), Augustin Kadima (WHO Regional Office for Africa), Zaw Lin (WHO Regional Office for South-East Asia), Raphael N'dri (WHO Country Office, Côte d'Ivoire), Santiago Nicholls (WHO Regional Office for the Americas), Venkata Pemmaraju (Global Leprosy Programme) [retired], Benedict Quao (National Leprosy Elimination Programme, Cape Coast, Ghana) and Ghislain Sopoh (University of Abomey-Calavi, Atlantique, Benin). Technical oversight was provided by Kingsley Asiedu (WHO/NTD).

Guidance from Ibrahima Socé Fall (Director, WHO/NTD) was instrumental in navigating the meeting towards success.

The meeting was financially supported by the Anesvad Foundation, Spain, and Sanofi, France.

Abbreviations and acronyms

AI	artificial intelligence
BU-LABNET	Buruli Ulcer Laboratory Network
COVID-19	coronavirus disease
DHIS2	district health information system version 2
DMDI	disease management, disability and inclusion
EQA	external quality assessment
ICF	WHO International Classification of Functioning, Disability and Health
MDA	mass drug administration
MMDP	morbidity management and disability prevention
NTD	neglected tropical disease
PCR	polymerase chain reaction
WASH	water, sanitation and hygiene
WHO	World Health Organization

Executive summary

The World Health Organization (WHO) held its inaugural global meeting on skin-related neglected tropical diseases (skin NTDs) on 27–31 March 2023, convening more than 800 global experts, stakeholders and partners. The aim of the meeting was to discuss the progress and challenges of integrating control and management of skin NTDs at the country level, in alignment with the NTD road map 2021–2030 ("the road map") and the companion road map document on skin NTDs ("the skin NTD framework").

Skin diseases rank among the top reasons for outpatient visits and often lead to long-term disability, stigmatization and mental health issue and half of the 20 NTDs present with skin manifestations.

The objectives of the meeting were centred on sharing experiences in country-level integration, showcasing research advances, implementation of the skin NTD framework and strengthening networking among experts. Participants included skin NTD specialists, representatives of health ministries, nongovernmental organizations, academic institutions and WHO. Key messages highlighted the importance of the NTD road map, emphasizing three implementation pillars: accelerating programmatic action, intensifying cross-cutting approaches, and changing operational models and culture to support country ownership.

Key actions arising from the meeting were to enhance advocacy and visibility of NTDs, their inclusion into critical global policy documentation and in global health mechanisms. The global community was urged to increase NTD investments to meet the road map targets for 2030, emphasizing digital technologies, enhanced diagnostics and advances in new treatments. The second global skin NTD meeting is scheduled for March 2025 at WHO headquarters in Geneva.

The path forward is clear: we must strengthen collaborations and amplify efforts towards the 2030 NTD road map targets.

Introduction

The World Health Organization (WHO) organized the first global meeting on skin-related neglected tropical diseases (skin NTDs) at its headquarters in Geneva, Switzerland on 27–31 March 2023. This 5-day hybrid meeting brought together more than 800 global experts, stakeholders and partners from 86 countries to consider a wide range of topics and enable participants to share best practices in implementing integrated skin NTD activities at country level. The theme of the meeting was "integration for greater impact". The agenda is included as Annex 1. The participants are listed in Annex 2. The demographics of participants are shown in Annex 3. A photo gallery is presented as Annex 4. More than 54 oral presentations were made and over 200 posters on the themes related to the sessions were displayed digitally during the course of the 5-day meeting. The book of abstracts (WHO, 2023a) and the webinar recordings (WHO, 2023b) are available on the WHO NTD website.

Skin NTDs are a major public health problem. Overall, skin conditions are estimated to affect 1.8 billion people at any point in time. In tropical and resource-poor settings, skin infections, which can be of bacterial, viral, fungal or parasitic origin, constitute about 10% of skin diseases. It is therefore important that countries in which these diseases are endemic adopt holistic, community-oriented approaches to address comprehensively skin NTDs and all other skin conditions in order to leave no one behind.

The participants called for greater investments in interventions against NTDs to accelerate efforts to achieve the road map targets for 2030. Of the skin NTDs, yaws is targeted for eradication, leprosy and onchocerciasis for elimination (interruption of transmission) and lymphatic filariasis (lymphoedema and hydrocele) for elimination as a public health problem. Buruli ulcer, cutaneous leishmaniasis, mycetoma, chromoblastomycosis and other deep mycoses (including sporotrichosis), post-kala-azar dermal leishmaniasis, scabies and other ectoparasitoses (including tungiasis) are targeted for control.

In 2016, WHO conceived the integrated approach to control and management of skin NTDs on the basis of their similar geographical distribution, epidemiological characteristics and social impact, and on the premise that training, community mobilization, case detection and management strategies can be integrated to optimize use of resources. In 2020, the integrated control and management of skin NTDs was included as an example of a strategic approach to illustrate the cross-cutting, holistic shifts advocated in *Ending the neglect to attain the Sustainable Development Goals: a road map for neglected tropical diseases 2021–2030)* (WHO, 2020a) ("the road map"). In 2022, WHO published a companion document to the road map, *Ending the neglect to attain the Sustainable Development Goals: a strategic framework for integrated control and management of skin-related neglected tropical diseases* (WHO, 2022) ("the skin NTD framework"), to guide countries and partners in implementing integrated public health interventions.

Without early diagnosis and treatment, complications from skin NTDs may lead to disability, social stigma, mental health conditions, restricted social participation and other forms of exclusion. These factors combined have a profound impact on the mental well-being of persons affected by skin NTDs as well as their families and have a serious economic impact. There are limited data on the socioeconomic effects of skin NTDs and a great underestimation of their true burden. The WHO *International classification of functioning, disability and health: ICF* (WHO, 2001) is very useful

as a conceptual framework for managing morbidity, preventing disability and fostering inclusion at the field level. Psychosocial support including patient-centered initiatives and economic empowerment programmes are critical in reducing stigma. Health education campaigns also play a key role in reducing public stigma and reinforce accurate understanding of the disease, while dispelling or confuting misconceptions.

The transmission dynamics of some skin NTDs, for example Buruli ulcer and mycetoma, are still largely unknown. Great strides have however been made for instance in the case of Buruli ulcer; scientific evidence has shown that *Mycobacterium ulcerans* − the causative organism of the disease − may be transmitted to humans by mosquitoes in Victoria, Australia. The genome sequences of *M. ulcerans* from humans, opossum droppings and mosquitoes were found to be identical. In addition, the evidence so far suggests that Buruli ulcer could be a zoonosis. To better understand the mode of transmission and identify effective ways to prevent and control the disease, research is ongoing to close these gaps.

The integrated skin NTD intervention approach is a powerful strategy to address the burden of multiple NTDs with dermatological presentations as well as other skin diseases. Commitment to cross-cutting collaboration and pooling of expertise and resources for broader impact is vital while taking advantage of existing health programmes and funding mechanisms. Challenges include inadequate human resources at country level, lengthy and inflexible financial processes, and limited supplies and funding to ensure timely implementation. For mass drug administration (MDA), challenges include multiple tablets to be taken at the same time, poor adherence to treatment, weak pharmacovigilance systems and heavy logistic arrangements. These challenges can be overcome by regular coordination meetings, joint planning and preparation by teams implementing the skin NTD integrated approach. To ensure sustainable implementation of interventions, mapping of co-endemicity, integrated national plans, capacity-building of health-care workers, strong referral systems and patient-centered approaches are key. In addition, integrated strategies should be based on scientific evidence, country context and government ownership. Countries should lead the operation, prioritizing NTDs as part of their national health priorities and investing in them sustainably.

There is critical need for support to address operational and research needs identified at this meeting, such as laboratory diagnostics, antimicrobial resistance, health system strengthening, costings, integrated training, emphasis of e-tools and artificial intelligence (AI) to support front-line workers on the ground and in-person training.

Importantly, the meeting heard that the priorities for skin NTDs within the broader context of NTD programmes, primary health care and universal health coverage include raising advocacy and visibility, engaging partners with the involvement of existing and new partners, costing work to estimate what is needed to implement the road map, and monitoring and evaluation for credibility. Activities should be integrated across sectors, for stronger, more consistent, and sustainable programmatic support and funding.

The objectives of the meeting were:

- to share progress and challenges in the implementation of integrated activities on skin NTDs at the country level;
- to present advances in research of skin NTDs;
- to plan the implementation of the skin NTD framework; and
- to strengthen networking among disease experts and cross-cutting groups.

This report summarizes the presentations, issues raised during discussions and key action points of the meeting.

Session 1. Opening remarks and introductory presentations

The first session was chaired by Dr Claire Fuller (International League of Dermatological Societies).

Dr Daniel Argaw Dagne (WHO/NTD) welcomed the participants to the meeting. He recalled that half of the 20 NTDs present with significant skin manifestations and that WHO, in response, has been promoting an integrated approach for the control and management of skin NTDs since 2016. The integrated approach has been well articulated following the launch of the road map. The skin NTD framework, a companion document to the road map, was launched in June 2022 to guide countries and partners in implementing integrated public health interventions, and has since gained momentum and wider acceptance. Dr Dagne recognized and appreciated partners including academia, nongovernmental organizations and donors for supporting the skin NTD framework and encouraged them to continue to support endemic countries in moving towards sustainability. He emphasized that integration did not mean competing for resources, but rather keeping the specificity of diseases while improving access to service delivery through common platforms that combine similar activities.

Dr Kingsley Asiedu (WHO/NTD) summarized the objectives and the agenda of the meeting. The objectives were: to discuss the medical, socioeconomic and research aspects of the 10 NTDs with skin manifestations[1]; review lessons learnt on the ground and in the laboratory; strengthen integrated approaches; and contribute to advancing research, prevention and clinical care for patients worldwide, thereby accelerating progress towards the 2030 road map targets. He noted the significant burden of skin NTDs in the WHO regions and emphasized the importance of the hybrid meeting with such a wide range of attendance from over 86 countries.

Dr Ibrahima Socé Fall (WHO/NTD) outlined the current priorities of the Global Neglected Tropical Diseases Programme and the need for the recognition of NTDs in the global health architecture. He highlighted the overall success of the Programme while noting specific challenges including the coronavirus disease (COVID-19) pandemic and the accompanying shifts in priorities by countries, which have impacted implementation of interventions against NTDs. He added that the road map is a blueprint for action as we move towards reaching the 2030 targets. The road map aligns with the United Nations Sustainable Development Goals and thereby gives a clear focus of the role that NTD interventions play in promoting primary health care and universal health coverage. He recalled the two key strategic shifts advocated in the road map:

- country ownership, whereby countries lead operations, prioritizing NTDs as part of their national health priorities and investing in them in a sustainable way; and
- commitment to cross-cutting collaboration and pooling of expertise as well as resources for broader impact.

[1] The skin NTDs include Buruli ulcer; cutaneous leishmaniasis; leprosy (Hansen's disease); lymphatic filariasis; mycetoma, chromoblastomycoses and other deep mycoses (including sporotrichosis); onchocerciasis; post-kala-azar dermal leishmaniasis; scabies and other ectoparasitoses (including tungiasis); and yaws.

Dr Fall emphasized the importance of an integrated approach to interventions against skin NTDs as a powerful resource to address the burden of at least 10 NTDs with dermatological presentations, as well as other skin diseases. He emphasized the need to work in cross-cutting areas not just in specific diseases but also in a broader health agenda taking advantage of existing health programmes and funding mechanisms. He noted that the priorities for the Programme include advocacy and visibility, partner engagement with the involvement of existing and new partners, costing work to estimate what is needed to implement the road map, monitoring and evaluation for credibility as well as showing impact, and the departmental functional review. He echoed that investment in NTDs is an investment in many of the priorities on the public health agenda.

Professor Roderick Hay (King's College London) presented the global view of skin NTDs in particular and skin diseases in general, which collectively affect over 1.8 billion people at any single time. Several skin diseases such as bacterial skin infection, eczema, acne, fungal infection and pigmentary skin diseases are prevalent and co-endemic with many of the NTDs. The response to these diseases requires prompt recognition (to prevent the risk of disability and death) through training, improved access to services, inclusion of skin diseases in national primary health care systems, and promotion of integration and synergy during treatment, wound management, disability management and community engagement.

Dr Rie Yotsu (Tulane School of Public Health and Tropical Medicine) presented an overview of the skin NTD framework (WHO, 2022), one of the companion documents to the road map. The framework was developed through an extensive consultative process from 2019 to 2022 until its launch on 8 June 2022. It is intended to guide endemic countries in the implementation of integrated approaches to control and manage skin NTDs and to provide practical guidance on integrated interventions to achieve the goal of reducing associated morbidity, disability and psychosocial impacts. Skin NTDs have an impact not only on individuals but also on families and communities; they affect education, work and social lives and thus require a comprehensive approach.

Dr Vivek Lal (Global Leprosy Programme) presented the global leprosy strategy, *Towards zero leprosy: global leprosy (Hansen's disease) strategy 2021–2030* (WHO, 2021a) and its alignment with the skin NTD framework. He recalled the four global strategies (2006–2010; 2011–2015; 2016–2020, 2021–2030) for leprosy and the four strategic pillars of the strategy, which are to (i) implement integrated, country-owned zero leprosy road maps in all endemic countries; (ii) scale up prevention alongside integrated active case detection; (iii) manage leprosy and its complications and prevent new disability; and (iv) combat stigma and ensure human rights are respected. COVID-19 has affected detection of new cases of leprosy, with a 37% decrease between 2019 and 2020, which was more pronounced in the South-East Asia and Americas regions than in other WHO regions. He called for improved and prompt case detection through integrated approaches, contact examination and mapping of high endemicity pockets for targeted case-finding. He noted that for effective and sustainable implementation of the skin NTD integrated approach, prerequisites were mapping co-endemicity, integrated country plans, capacity-building of health-care workers, strong referral system and a person-centered approach.

Dr Deborah Friedman (Victorian Department of Health) outlined the changing epidemiology of Buruli ulcer in Victoria (Australia) from 2019 to 2022. She highlighted the fact that Buruli ulcer was first seen in the 1940s and has since evolved substantially in non-contiguous areas in Australia. In recent times, the distribution of Buruli ulcer disease has become significant, with 1143 cases identified over the 4-year period and changes in geographical areas being recorded. She

emphasized the importance of public health management including surveillance to detect new exposure areas, targeted and broad messaging, educating clinicians to consider early diagnosis, collaboration with laboratories and researchers, and translating research into public health management and policy.

Dr Pamela Sabina Mbabazi (WHO/NTD) presented the road map companion document on monitoring and evaluation (WHO, 2021b) emphasizing the importance of information systems, surveillance and reporting of NTDs. She highlighted the future of the World Health Data Hub, mentioning that WHO intends to help build the world's most comprehensive health data platform to ensure that data are better organized and easily accessible, trusted and actionable. She urged participants to take advantage of such emerging platforms being rolled out by WHO. She noted that skin NTD data gaps persisted in 2023, for instance the integrated skin NTD indicator has no data yet, and that it is critical for the NTD community to figure out how this will be reported since NTDs will be a substantive agenda item in the report to the World Health Assembly in 2024. She added that although data collection tools exist for most of the NTDs, they are not yet ready for use for diseases such as mycetoma and scabies, which calls for strengthening of the routine health information system. WHO/NTD is working to complete all NTD modules by the end of 2023; this requires that all key players respond to the call for data and information provision to make the database on skin NTDs accessible by all, anywhere. Dr Mbabazi stated that in order to address data gaps and data quality, the NTD community has pushed for the community-based interventions layer to be included in the information reported through the routine health information system, because most of the NTD activities are community-based. By doing so, the expectation is that when countries submit reports to WHO, NTDs can also be captured and mentioned in high-level ministerial meetings, making them more visible.

Dr Xiaoxian Huang (WHO/NTD) presented an evaluation of integrated NTD activities and lessons learnt from a field observation in Côte d'Ivoire. Following the guidance of the skin NTD framework to adopt a people-centred approach to addressing skin NTDs, Côte d'Ivoire was selected for an evaluation to identify (i) enabling and hampering factors for integration and (ii) the costs and benefits of integrating NTD interventions. Consequently, a yaws screening campaign to update yaws endemicity in Côte d'Ivoire in preparation for a yaws MDA campaign was integrated with diagnosis and treatment of other skin NTDs. This field experience showed that the decision and design of integration should be based on a good understanding of the field work, as not all activities can be integrated; partial integration is an option in cases where not all activities can be integrated. There is a need to give equal attention to all integrated diseases at the beginning so that they are addressed equally and have adequate human resource for the activities. Some initial investment for joint integrated material is also required, as that in use currently was prepared separately. She acknowledged that this was a start and that there were still important gaps to be closed, especially in answering the following questions:

- What will be the impact of integration on the performance of MDA campaigns?
- How can integration optimize, rather than overburden, human resources?
- What other factors will impact the effectiveness of integrated programmes?
- Is integration more cost–effective than conducting MDA campaigns separately?

Dr Esther Freeman (International Alliance for Global Health Dermatology) explained that the Alliance is an international collaboration platform for people interested in skin health including skin NTDs. However, due to inadequate numbers of dermatologists especially in sub-Saharan Africa, there is a need for access to training and care for dermatology and skin NTDs through expansion of training and mentorship, for example through the Regional Dermatology Training Center (Moshi, United Republic of Tanzania) and the University of Global Health Equity (Butaro, Rwanda). The Alliance, which was formed in 2018, has a current membership of over 800. It aims to fill the gap by developing global health dermatology leadership through education, mentorship and community building; leaders will then assist in capacity-building to access dermatology on the front line by detecting, managing and referring cases with skin NTDs as well as other common skin diseases.

Session 2. Integration at country level

The second session was chaired by Dr Rie Yotsu (Tulane School of Public Health and Tropical Medicine).

Mr Iñigo Lasa (Anesvad Foundation) presented the practical experience of the Foundation from 2017 to 2022 in implementing the integrated skin NTD approach in four West African countries: Ghana (15 districts), Côte d'Ivoire (6 districts), Benin and Togo. Integrated activities performed were social mobilization, training, active case-finding, physical rehabilitation, health system strengthening, country ownership and integrated planning for mainstreaming. Other supported cross-cutting activities were diagnosis, water, sanitation and hygiene (WASH), treatment and gender. Integration was measured by three criteria: domain (what elements are integrated), grade (how does integration happen) and level (where does integration take place); integration was categorized as basic, moderate or meaningful, depending on the results (Table 1).

The results yielded the following lessons.

- Improve social mobilization considering the obstacles that populations face in accessing health care.
- Make available clear guidance on integration for mainstreaming.
- Understand how to integrate cross-cutting issues and social determinants.
- Extend analysis of the effect of integration beyond active case detection to include the late phases of diagnosis, treatment and rehabilitation. Further study is needed on other integration aspects, such as confirmation, and within the context of well-being orientation.
- Adopt a dermatological approach as only 3–5% of cases are NTDs, half of which are scabies.

In conclusion, Mr Lasa reported that the main challenge is how to further strengthen health systems so that they can successfully attend to a wider range of community health needs.

Table 1. Measurement of integration in four West African countries

Criteria	Basic integration	Moderate integration	Meaningful integration
DOMAIN: What elements are integrated?	Only the **core activities** of the existing separate NTD programmes are merged.	Existing separate NTD programmes come together to carry out their **policy functions**, such as planning, resource mobilization and coordination of activities.	Separate existing **NTD programmes are merged** into a common structure or form a new organization.

Table 1. (continued)

Criteria	Basic integration	Moderate integration	Meaningful integration
GRADE: How does integration happen?	When **communication and information** are exchanged among the different programmes to simplify the work of each programme separately.	Collaboration is based on improved **coordination** including **sharing of resources and personnel**.	**Consolidation**, in which all or part of a programme is replaced by a **new plan** that implements what the previous ones did.
LEVEL: Where does integration take place?	Only at the **global level**, where international health associations and programmes come together to work collaboratively.	Up to **national and regional levels**, where various divisions of health ministries join together or with other relevant public agencies and external partners, to coordinate activities.	From **district to community levels**, involving public actors coming together with other relevant actors at that level to carry out specific activities.

Professor Andrew Steer (World Scabies Program) reported on their experience in successfully integrating MDAs for scabies and lymphatic filariasis in two regions of Fiji. MDAs were implemented in 2022 and 2023 following the success of three studies referred to as "Shift" (Romani et al., 2015) "FIT" (Hardy et al., 2020, 2021a, 2021b) and "big Shift" (Thean et al., 2022) The aim of the study was to target both skin NTDs for MDA in overlapping areas. The decision to integrate the MDA was because:

- ivermectin is common to both diseases,
- MDA increases cost efficiency and
- reduces burden on staff and communities.

The two programmes worked together on all aspects of planning and implementation (combined launch of the MDA by the Minister of Health, joint implementation plan and cost-sharing budget, health promotion materials co-designed by programme staff, MDA teams trained in integrated messaging (training co-facilitated by lymphatic filariasis and scabies programme staff).) As a result, the prevalence of scabies was reduced by 94% through ivermectin at 12 months.

Main challenges that arose were: aligning budget allocation and plans to ensure that hiring cars and procuring fuel and supplies are all aligned so that the MDA is not delayed; enhancing content of training materials; ensuring staff retain key messages for all diseases and medicines; and increasing data items to collect and coordination between programmes.

He noted that integration of MDA for scabies and lymphatic filariasis is plausible and that the few challenges can be overcome by regular coordination meetings, joint planning and preparation by the teams. In Fiji, community members appreciated that the regimen was treating two diseases at one time.

Dr Alphonse Um Boock (FAIRMED) presented the lessons learnt from the first round of MDA with azithromycin for yaws eradication in three countries of the Congo Basin. The positive results obtained in India and the proven efficacy of a single dose of azithromycin for treatment of yaws encouraged the three border countries (Cameroon, Central African Republic and Democratic

Republic of the Congo) to embark on a yaws eradication programme following the Morges strategy through the Organization for the Coordination of the Fight Against Endemic Diseases in Central Africa (OCEAC) project. The goal was to contribute to the interruption of transmission of yaws in 17 health districts in the three countries. The nine steps for implementation were as follows.

1. Confirm yaws existence.
2. Convene workshop with malaria and onchocerciasis control programmes to share experience on MDA.
3. Convene data collection preparation workshop (development of standardized tools)
4. Conduct strategic planning.
5. Assess availability of azithromycin and rapid tests.
6. Train health workers and community health workers.
7. Launch the activity.
8. Conduct surveillance.
9. Conduct post-MDA follow-up.

As a result, there was 94.9% therapeutic coverage and detection of other diseases during the implementation of MDA and the post-MDA surveillance phase.

The main challenges noted were:

- persistent insecurity in some countries that has led to the displacement of populations to areas that are difficult to access;
- demographic data that were not always up to date;
- scant information on the pygmy camps; and
- negative effects of the COVID-19 pandemic.

In conclusion, Dr Um Boock noted the following.

- A door-to-door strategy with many distributors has been shown to be effective in MDAs in a large population for a short period of 3–4 days.
- Strong political support is of paramount importance in large-scale MDA. It gives great support to the activity and increases the commitment of the whole community to the action.
- Good community mobilization contributes to the success of the programme.
- Accurate demographic data is of paramount importance for planning and analysis of results.
- Involving and taking into account the periods of Pygmy activity in planning an MDA campaign is vital to its success.
- MDA offers a good opportunity for integration with other skin NTDs.

Dr Silmara Pennini (Alfredo da Matta Tropical Dermatology and Venereology Foundation) presented on the Tropical Dermatology in the State of Amazonas, Brazil focusing on work done on leprosy. The objective was to reduce the burden of leprosy in the State through early diagnosis and treatment and to promote the diagnosis and treatment of skin NTDs in active case-finding activities. The method used included training in, and active searches for, skin diseases by a team of dermatologists. The target populations were schoolchildren and indigenous peoples. They were examined by technicians and consulted by dermatologists: 16 955 people were examined

from 2016 to 2018. Several skin diseases were diagnosed, including scabies and leprosy. The main challenges included difficult geographical accessibility, limited and unstable resources, and completeness of treatment especially for leprosy. She emphasized that comprehensive care for patients with dermatological diseases and active search activities are essential for early diagnosis, treatment and transmission control of leprosy and other skin NTDs.

Dr Josefina João (Ministry of Health of Timor-Leste) presented on the integrated transmission assessment survey for lymphatic filariasis, yaws and scabies in Timor-Leste during 2020–2021. According to the national parasite survey in 2012, all municipalities in the country were endemic for lymphatic filariasis. For the study, co-endemicity mapping was carried out for yaws through a student survey and scabies based on a literature review. The objectives were: to assess whether multiple rounds of MDA against lymphatic filariasis had led to a reduction in its prevalence; to identify any sero-reactions to yaws in the 6–7-year age groups; and to collect national data on scabies. Diagnosis of yaws was based on rapid test strips, while that of scabies was clinical. The implementation consisted of sensitization sessions, followed by examination of students in schools. In terms of results, while no cases of yaws were reported, 64 cases of scabies were detected. Main challenges were: higher cost and time required for data collection, disrupted supply chain, delay in implementation of activities, inadequate available resources, lack of joint action, lack of community participation, inadequate monitoring system. She stated that extremely low prevalence of lymphatic filariasis was recorded compared to the baseline study conducted in 2012, indicating that the MDA programmes in Timor-Leste have been successful. No yaws cases were detected, calling for preparation of the verification of absence of yaws transmission by collecting necessary information and evidence for yaws eradication throughout the country. Finally, there is a need to strengthen diagnosis and monitoring of interventions for scabies and other skin NTDs.

Mr Karsor Kollie (Ministry of Health and Social Welfare of Monrovia) presented on a multi-method evaluation of health services integration for NTDs requiring case management in Liberia. The aim was to assess the implementation of the integrated approach and document its impact on NTD service delivery within the context of the wider Liberian health system. A comparative study of implementation in three groups of counties (integration, non-integration, i.e. control group and no research). The reference data used were those for 2016; quarterly data were collected for 3 years. A significant difference was observed between the departments having implemented the integrated approach and those not adopting the approach, with a strong increase in screening and better access to services, except for leprosy. Logistic supplies including medicine should be sufficiently provided to referral clinics and for home-based care. The conclusion and key messages from the sessions were that, besides feasibility, the integration approach has had a positive impact on the health system response through better case detection and notification, better accessibility and availability of services for case management NTDs. However, the quality of care and the sustainability of the integrated approach require further investigation. In addition, the evaluation of the impact of the integration of NTDs is based on the simultaneous consideration of several methods and areas (case detection, access and quality of care). Integrated strategies should be based on evidence, country context and government ownership.

Mr Asrat Mengiste (Addis Ababa University) and Dr Oumer Ali (Armauer Hansen Research Institute) on behalf of the EnDPoINT project presented on integration of a holistic care package for podoconiosis, lymphatic filariasis and leprosy into routine health services in Ethiopia. The objective of the intervention was to integrate and extend a holistic package of community-level care – including physical, mental health and psychosocial care – into routine health services for patients

with lower limb extreme lymphoedema caused by podoconiosis, lymphatic filariasis or leprosy in selected districts of Awi zone in Ethiopia. The project had three phases:

- Phase 1: Develop the care package and strategies for its integration.
- Phase 2: Conduct a pilot feasibility study and evaluate the care package in one sub-district.
- Phase 3: Scale up and evaluate the care package in three districts.

After the intervention, an improvement in the quality of life of the patients was realized. The patients recorded a reduction in oedema of the limbs, an improvement in handicaps, a reduction in depression, a decrease in alcohol consumption and less discrimination. The community also demonstrated improved knowledge on lymphoedema, reduction of stigmatizing attitudes and reduction in social distancing. In conclusion, implementation of the care package resulted in significant improvements in physical and psychosocial outcomes, including limb swelling, disability, quality of life, depression, stigma and discrimination, and it was recommended that the care package be extended to other settings.

Ms Macklyne Katenga (Neglected Tropical Diseases unit) and Mrs Fasihah Taleo (WHO Country Office) elaborated on integrated NTD control in Vanuatu. They reported on their experience in implementing integrated MDA for yaws, scabies and soil-transmitted helminthiases, training in integrated skin disease management, connect and share, NTD surveys and NTD monthly reporting. The main aims were to:

- innovate by tailoring more comprehensive strategies for island-based populations through integration of multiple interventions and services targeting disease elimination;
- systematically document innovations and their validation to provide proof of concept, contribute to refined WHO guidance, and allow broader roll out and scaling to other settings with unique characteristics and hard to reach populations;
- utilize a whole-of-society-approach; and
- introduce innovations in MDA strategies for treatment of scabies, yaws and soil-transmitted helminthiases.

The main lesson learnt was that there was increased acceptability of MDAs in communities where there had been integrated campaigns. The main challenges were the lack of human resources at country level, the long and strict financial process, and the limited supplies and funding to ensure timely implementation. For MDA, high number of tablets to take at the same time, weak pharmacovigilance systems and heavy logistic arrangements were observed.

Dr Benedict Quao (National Leprosy Elimination Programme) reported on the integrated management and control of skin NTDs in Ghana in 2022. Skin NTDs are managed in Ghana by three programmes: the National Buruli Ulcer Control and Yaws Eradication Programme, the National Leprosy Control Programme and the National Focal Point for human African trypananosomiasis/ cutaneous leishmaniasis. The three standalone programmes have increasingly worked together since 2018, with support from the Anesvad Foundation. He shared the outcomes of various case searches and treatment activities undertaken for cases of skin NTDs and their contacts in 2022. The objectives were:

- to carry out integrated active case searches in 450 hard-to-reach areas in 15 selected districts using the integrated skin-NTD approach;
- to carry out total targeted treatment for yaws in the 15 districts;

- to conduct total community treatment in communities recording > 5 confirmed yaws cases during prior integrated skin-NTD case-finding activities; and
- to screen contacts of historical detected for leprosy and other skin-NTD in Upper East region and Upper West region and give single-dose rifampicin as post-exposure prophylaxis.

Some districts that were silent for a while recorded confirmed cases due to awakening of the surveillance system for instance, Wa district reported confirmed cases of yaws and Buruli ulcer, Asikuma Odoben Brakwa district reported a confirmed leprosy case, and in a non-endemic district, such as Biakoye, cutaneous leishmaniasis was confirmed after clusters of suspicious yaws-like ulcers were sampled and tested for cutaneous leishmaniasis.

Main challenges faced were: disruptions from changes in health managers, staff attrition after training disrupting activity implementation, attrition of community-based surveillance volunteers, insufficient knowledge of disease among the public and general health-care workers (Table 2). The integrated skin-NTD approach is feasible, efficient, advantageous to the health system as a whole and advances the concept of community dermatology.

Table 2. Challenges of integration and remedial actions taken in Ghana

Challenges	Remedial actions
Disruptions from changes in health managers	Advocate to improve regional ownership and oversight.
Staff attrition after training affecting activity implementation	Employ a cascade model to facilitate retraining of newly posted staff; increase regional ownership and coverage.
Attrition of community-based surveillance volunteers	Foster non-cash incentives to enhance community engagement through established structures and channels.
Treatment refusals (to azithromycin and single-dose rifampicin)	Use regular community health nurses in single-dose rifampicin post-exposure prophylaxis campaigns to enhance uptake of treatment, and reinforce with counselling.
Insufficient knowledge of disease among public and general health-care workers	Expand public health education on skin NTDs and of health-care workers beyond project districts.

Session 3. Training tools

The third session was chaired by Dr Esther Freeman (International Alliance for Global Health Dermatology).

Dr Kingsley Asiedu (WHO/NTD) provided an overview of the level of health systems where training tools for NTDs are implemented. Training tools are implemented at the subdistrict or community level where early detection is present and leads to early treatment, but not at the national or regional level where some cases are referred. District hospitals are where most referral cases are taken. Infrastructure and human resource are limited to the development of a country, so, for example, what is applicable in Australia may not be so in Papua New Guinea. These factors should be considered when identifying what type of materials, training tools and surveillance systems are required for health workers. He emphasized the need to think about community awareness materials and training materials that are integrated so as to move away from single-disease awareness, single-disease training and single-disease surveillance towards a more integrated approach.

Dr Claire Fuller (International League of Dermatological Societies) presented on capacity-building and tools for district health workers and community agents. Integration for greater impact involves combining activities of two or more diseases at the same time and in the same community with the aim of increasing efficiency. Low-resource settings have a high burden of skin disease worldwide, a scarcity of dermatologists, inadequate resources allocated to dermatology and a reliance on ad hoc dermatologists. This is observed more acutely in sub-Saharan Africa with several countries having no dermatological specialists and others having just 1 per million population (Mosam and Todd., 2021). Training and support for front-line health care workers in basic dermatology are available through skin NTD training materials, Apps and teledermatology. There is large global device penetration and, by 2020, more people had mobile phones than access to running water at home, implying new strategies should be used to leapfrog into the future, jumping over traditional approaches like training more dermatologists. Opportunities for teledermatology will lead to increasing access to service provision, service support, increasing skill transfer through task shifting and increasing data acquisition. She highlighted the need to take lessons from existing training programmes in the field. This includes involving community leaders, incorporating training into existing health systems and structures, and continuing patient education. In addition to the free online training available through the WHO website, there is a need to look at new online methods.

Mr Belete Bizuayehu and Mr Debelo Kitesa (German Leprosy and TB Relief Association) presented preliminary results on optimizing resources for integrated skin NTD screening and care in Ethiopia, by crossing boundaries in formal and informal education. The aim of the study was to gain understanding of how health workers at different levels exchange knowledge in their efforts to optimize integrated skin screening in community events. The study methods involved observations taken in three skin camps in Eastern Ethiopia in January 2023. Interviews were conducted with 10 health workers at various levels involved in the camps. The thematic data analysis is ongoing. Preliminary findings revealed a distinct difference between the type of learning that occurred for participants at different professional levels. The health care workers reported to have learnt a

lot during the formal training and by being coached on location by the dermatologist. All health staff shared that the project spiked their motivation to work with skin NTDs in communities after experiencing and learning about the advantages during their work. In conclusion, Mr Kitesa and Mr Bizuayehu emphasized that investing in both formal and informal learning is important for success in integrated skin screening and task-shifting. Learning should focus not only on clinical topics but also on soft skills, such as communication and logistics, while taking the local context into account.

Ms Mireia Cano Izquierdo (Open University of Catalonia) provided results from a cross-sectional study whose aim was to assess the quality of the WHO Skin NTDs mobile application (WHO, 2020b) as a training tool in Ghana and Kenya. The assessment was done on version 3, which consolidates the Skin NTDs Guide App from WHO, the SkinApp from NLR (Until No Leprosy Remains), and lists of skin NTDs and general skin diseases. The health worker had to show the part of the diseased body and the signs and systems, and the App came up with the most likely disease. The results from the questionnaire (*n*=52) showed that the worst-rated domain was engagement; the best was information. Improvement is needed on the signs and symptoms section, customization aspect, which lacks an expert panel, participants suggested an improvement to the customization aspect through notifications and aesthetics. There was no difference found between variables. The App was found to have good usability. She noted that mHealth is likely to improve management of skin NTDs and that evaluation increases likelihood of success.

Dr Rie Yotsu (Tulane School of Public Health and Tropical Medicine) presented on a mixed methods pilot study in Côte d'Ivoire that employed an mHealth App (eSkinHealth) for early detection and case management of skin NTDs as well as common skin diseases (Yotsu et al., 2022). The eSkinHealth App was developed by a consortium of Japanese companies. The device has two functions: a portable patient support, which allows health workers to be connected to a tele dermatologist and an off-line function for remote use, which allows diagnosis of any types of skin conditions, documentation of patients' clinical course over time, laboratory entry and automatic translation. The study site was Sinfra Health District in Côte d'Ivoire. The participants were eight nurses and 16 community health workers, divided into intervention and control arms. All elements of the study were identical except that in the control arm, training in eSkinHealth App detection and diagnosis was not done. The study reported that the intervention arm had more skin diagnosis (207). In the control arm, diagnosis happened at the dermatology stage, whereas in the intervention arm diagnosis occurred when recording the skin disease. Referrals rate to primary health care nurses in the intervention arm were 59/207 cases (28.5%) while in the control were 8/311 (2.6%) cases. The system usability scores were week 0 (72.3), week 6 (72.3) and week 12 (86.3). The nurses and dermatologists were satisfied with the App and being able to be connected. Community health workers were satisfied at being equipped with a tablet and an App, and there was increase in confidence in doing their work. In conclusion, the integrated skin surveillance approach 'plus' was successful in identifying more skin NTDs (including those with very limited previous reports) and providing diagnosis to various skin conditions. Digital health tools like eSkinHealth facilitates screening, diagnosis and management of skin NTDs and other skin conditions.

Dr José Antonio Ruiz Postigo (WHO/NTD) presented on WHO skin NTD tools for capacity-building on case management and surveillance, specifically online courses, mobile Apps and the District Health Information System version 2 (DHIS2). The Open WHO channel is a key feature on the online course platform, with 7.6 million total course enrolments for 202 total course topics in 65 languages. There are 20 free online courses on NTDs and 22 translations into languages other than English. Currently, there are 11 skin-related courses available with over 30 000 learners enrolled as of mid-March 2023. Lessons learnt include the need to continue publishing in English: the English version (54–75%) is the most popular and most successful course. The course was assessed through an online survey,

with 90% satisfied. In addition, 90% agreed that the appropriate language is used. The mobile App enables translation of *A training guide manual for front- line workers on recognizing neglected tropical diseases through changes on the skin* (WHO, 2018) into a mobile App. Updating of the manual has now been made easier and faster; it has also allowed for addition of the global index, whereby once the country of origin is chosen, the App automatically selects the skin NTDs endemic in that country. In summary, the WHO Skin NTD App is available in four languages, in Android and iOS versions, works offline, is free of charge and the diagnostic algorithm filters by country of origin. The App is merged with the SkinApp from NLR. There is now a Beta version that includes 25 common skin diseases: folliculitis, keloid, noma and urticaria were added on 26 March 2023. There are five diseases in the Beta version of AI in the mobile phones. The bottleneck for the AI is the need for hundreds of images for each skin disease (skin type, lesion type, shape, distribution, etc.) and for Internet connection. This is being resolved by a WHO-led network created to build a global photograph database and conduct field assessments. DHIS2 is an open source, web-based platform that WHO uses to collect data on several diseases; it is also used in many countries for national surveillance. He noted that future work involves:

(a) Online courses

- To publish courses for missing topics
- To discuss with regions/countries about the uptake of non-English courses
- To assess if courses are reaching targeted front-line health workers

(b) Mobile App

- To publish versions with skin NTDs and common skin diseases
- To improve the AI algorithm with photographs on all skin NTDs in regions. Field test.

(c) DHIS2 (countries are free to choose their surveillance tool)

- To include all skin NTDs in the patient-based reporting system at health facility level
- To train clinicians and data managers on all skin NTDs (based on national needs).

Dr Michele Murdoch (International Foundation for Dermatology) presented on training tools for integrated management of wounds and lymphoedema for skin NTDs. The aim was to find out what resources are available for front-line health workers for the management of wounds and lymphoedema in skin-related NTDs. An informal scoping review involved a literature search and a survey on contacts within the skin NTDs community. The inclusion criteria were: any form of training for wounds and/or lymphoedema secondary to a skin NTD; and any study that utilized training for wounds and/or lymphoedema secondary to a skin NTD. The exclusion criteria were: any records not meeting the inclusion criteria. There were many different sources of resources of interest. Few studies documented assessment of training. She noted that a single location for skin NTD training tools was needed. Few studies included assessment of training and there was lack of detail about care of wounds. Further work to be done includes: wound assessment scale(s), wound-specific stigma and well-being scores, field-test wound-Q tool and traditional medicines for wounds.

Professor Wendemagegn Enbiale (VisualDx) presented on a hybrid approach to machine learning and clinical decision support for improved diagnosis of NTDs, highlighting a project done in Botswana. The front-lines of the health-care system in Botswana often consist of clinicians working in areas with unreliable Internet connectivity and with limited training in dermatology. There is a lack of sufficient reference materials that are available offline and easily accessible at the

point of care that can help with diagnosis and management. VisualDx, a mobile clinical decision support tool that has been adapted for use without Internet access, was evaluated in a limited-resource setting in Botswana. The project found that the tool helps health workers in Botswana to expand their abilities to make accurate diagnosis at the initial point of care. Some 94.7% of respondents said it improved their ability to manage dermatological conditions; 89.5% said it improved their ability to make accurate diagnosis and made their work easier. Providers used VisualDx as an educational tool both for themselves and for their patients: 81.8% used it outside work as a study resource and 84.2% used it to educate patients and build patient trust. The use of the tool is being expanded to India and Nigeria. In India, development of a prototype clinical decision support and surveillance tool focused on post-kala-azar dermal leishmaniasis using VisualDx will remove existing barriers by enabling health-care workers to evaluate skin lesions and symptoms, understand diagnostic possibilities, learn about the diseases, and obtain guidance on the next steps for clinical testing and treatment. In Nigeria, a prototype clinical decision support and surveillance tool focused on image collection and machine learning algorithmic analysis optimization for a selection of NTDs in Nigeria will be developed. In conclusion, he emphasized that the project aims to meet the goal of the WHO Skin NTD mobile App by supporting broad differential diagnosis for primary health workers. Ultimately, the App will be designed and extended to fit local disease epidemiology in countries beyond India and Nigeria.

Ms Roos Geutjes (NLR International) presented on capacity strengthening for researchers and other health professionals through an online portal platform (InfoNTD.org) that supports capacity of NTD professionals by making NTD information easily and freely available. It provides easy access to 6000 resources. An online survey was done to learn about the user experience of the audience. Overall, respondents were interested in accessing different types of practical material but indicated special interest in how-to guidelines and special courses. Topics of interest also varied. The outcome of the survey was used to develop extra functionality of the website. An extra menu with tools allows for easy access to practical material.

Dr Bahadir Celiktemur (The Leprosy Mission England and Wales) presented on enhancing leprosy expertise through a new leprosy competencies framework. There is a shortage of skills or expertise in the area of leprosy and other NTDs. As staff retire, it becomes more difficult to recruit people with the right skills and experience. To solve this problem, expertise was mapped and a leprosy tool identifying the training needs of staff was developed. Training needs were categorized as foundation, basic, intermediate and advanced/specialist level. A tool kit is being prepared to avoid bias in assessment and training materials for the skills are being developed. The pilot study is due for completion by 2024. The programme is working closely with the International Federation of Anti-leprosy Associations' operational research study to ensure coordination and the development of joint training with other leprosy programmes.

Session 4. Integrated surveillance and mapping

The fourth session was chaired by Professor Ghislain Sopoh (University of Abomey-Calavi).

Dr Michael Marks (London School of Hygiene & Tropical Medicine) gave an overview of surveillance and mapping, focusing on current knowledge/experience and gaps. He noted that mapping and epidemiological surveillance are powerful tools in the fight against NTDs. Mapping allows for programmatic decisions that may differ among NTDs for instance, decisions to fight yaws and scabies may differ from those for Buruli ulcer. Mapping also has a defined intervention unit, such as a district, and an identified threshold for instance, do we provide MDA above or below this unit for scabies for example. There is clear action associated with the threshold. Surveillance is a rolling activity in areas of known endemicity that relies on active or passive case detection to inform treatment decisions for individuals. It usually does not provide reliable estimates of burden because it is not done systematically with a well-established sampling frame. Unlike mapping, which can be done on an ad hoc basis, epidemiological surveillance is continuous. The decision on whether to do mapping or surveillance depends on the disease. There are very limited data on the burden of skin NTDs, which creates challenges for advocacy and programmatic planning. Currently, in a context where resources allocated to NTDs are limited, integrated control is the recommended strategy and shows promise however, operational research is needed to develop it into a programmatic tool.

Dr Yves Barogui (WHO Regional Office for Africa) presented the yaws situation in 47 countries of the WHO African Region in 2022 compared to that of the 1950s. In 2022, a standardized questionnaire was sent out to all 47 countries, of which 35 responded. Since 1950, 13 countries have reported suspected cases of yaws, nine of which were confirmed to be endemic. Yaws surveillance is integrated in only 12 of the 35 countries that participated in the survey. There is a lack of experts or institutions working on yaws. WHO guidelines are available, but most countries (63%) do not have national yaws technical guidelines. Countries are therefore urged to strengthen surveillance, integrate yaws into the NTD master plan, organize yaws survey at national and subnational levels, and promote and lead the bottom-up process of yaws eradication.

Dr Michael Head (University of Southampton) and Dr Piham Gnossike (National Integrated Programme for Neglected Tropical Diseases of Lomé) presented on prevalence of skin NTDs and superficial fungal infections in two periurban schools and one rural community setting in Togo | Skin examinations were carried out on a total of 1401 people. Across all participants, 105 presented with skin NTDs (7.5%) while 333 had observed mycoses (23.8%). The burden of cutaneous NTDs and fungal infections is high in schools and community settings in Togo, with scabies being the most prevalent skin NTD. He emphasized that an integrated management approach as well as MDA programmes may be effective in controlling these NTDs.

Dr Lynne Elson (Kenya Medical Research Institute–Wellcome Trust Research Programme) presented on the national prevalence and risk factors for tungiasis among school-going children in Kenya, focusing on results from a multi-county cross-sectional survey (Elson et al., 2023). The aim of this study was to determine the national prevalence of tungiasis in Kenya, model the geographical variation of tungiasis at 4*4 km spatial resolution and at sub-county level in Kenya, determine

the number of children living with tungiasis at sub-county level and determine the risk factors for tungiasis in Kenyan schoolchildren. Nine counties were selected covering major climate zones and cultures of Kenya. In total, 21 246 pupils from 194 schools were examined for tungiasis. The results showed that school prevalence varied from 0 to 25 %, 34.5% of schools had at least 1 pupil with tungiasis and 7.1% of schools had prevalence > 4%. The study reported an estimated national prevalence of 1.1%. Factors associated with the disease were found to be age, gender and poverty. She noted that school-based surveys are a reasonable strategy for targeting and monitoring of interventions for tungiasis, which mostly affects school-age children. However, interventions will need to be carefully targeted for cost–effectiveness due to heterogeneity in prevalence. Interventions for tungiasis control could be integrated with other disease control programmes including economic support to affected families, treatment during MDA and WASH programmes, which could add messages for daily use of soap in foot-washing as well as handwashing, with special strategies for boys.

Dr Marlene Thielecke (Charité Center for Global Health) presented on surveillance and treatment of tungiasis, podoconiosis and scabies in north-east Uganda. Skin NTDs share similar risk factors, like poor living conditions, associated with poor body hygiene and lack of resources and infrastructure, leading to poor access to water, health care and education. Poverty, geochemical and certain climatic conditions are predisposing factors for the coexistence of multiple skin NTDs including tungiasis, scabies and podoconiosis. The aim of the study was to assess the prevalence of various skin conditions and implement an integrated control strategy, including effective diagnosis, treatment and prevention for tungiasis, scabies and podoconiosis. Through systemic case detection, treatment of tungiasis with dimeticones (NYDA), treatment of scabies with twice oral ivermectin or benzyl benzoate emulsion and treatment of podoconiosis with daily foot-washing with soap, bathing feet in salty water and distribution of closed shoes. Prevalence of tungiasis decreased from 62.8% to 7.5%, the prevalence of scabies decreased from 40.3% to zero and morbidity from podoconiosis was significantly reduced. In conclusion, tungiasis, scabies and podoconiosis are major individual and public health hazards in Napak district. The skin NTDs can be diagnosed clinically and effectively treated through regular and systemic case detection, treatment and implementation of hygienic measures.

Dr Aboa Paul Koffi (National Buruli ulcer Control Programme) elaborated on yaws assessment in 24 health districts in Côte d'Ivoire. The country decided to undertake an epidemiological evaluation of the disease with the technical and financial support of the Anesvad Foundation. The objectives of the assessment were to understand the basic situation of yaws in the country through the study in 24 health districts, strengthen the surveillance system of yaws in the health districts, develop a plan for the eradication of yaws based on the data collected and strengthen the capacities of the actors in the diagnosis of NTDs. In summary, the assessment revealed the low prevalence of yaws in Côte d'Ivoire and its distribution by household. The approach used reported other cases of cutaneous NTDs, and especially many other common dermatological diseases in the same communities for instance Buruli ulcer, leprosy, scabies, traumatic wounds, ring worms and pityriasis versicolor. The next steps for Côte d'Ivoire are to continue mapping and to treat endemic communities. To succeed it is important to elaborate a yaws eradication plan and to implement an efficient epidemiological surveillance system.

Dr Cristina Galvan Casas (Fight Infections Foundation) presented on her experience with integrated mapping methods for skin NTDs in Malawi. Skin examination offers an opportunity to identify multiple conditions in a single visit since many coexist in the same community. The objectives were to know the actual prevalence of scabies and to implement a more effective treatment method that could reverse the epidemic, to know the causative agent of ulcers, to bring leprosy diagnosis and treatment close to the patient and to treat premalignant or malignant pathology as early as

possible in the albino population. The first point to implement these strategies were the teaching activities that allowed trainers, volunteers, health workers, village agents and translators to successfully carry out the proposed activities. The second point was to raise public awareness, by local information networks, rounded off with loudspeaker announcements and talks. As a result, the prevalence of scabies dropped from an alarming 17% of the population to a much less worrying 2%. In summary:

- Community-based case detection and treatment programmes are successful in reducing the prevalence of scabies and should integrate other skin pathology in the area.
- Current treatments offer dosing and administration difficulties in mass programmes. New medicines, dissemination models and treatment and prevention strategies are needed.
- Despite the reduction in the prevalence of scabies, the infestation continues to be a health problem in the area.
- The priority objective of scabies control included in the road map should be considered in Malawi.

Dr Victoria Cox (Menzies School of Health Research) presented on mapping the burden of skin disease with a focus on scabies prevalence in a remote Aboriginal community in the Northern Territory of Australia. Mapping was conducted alongside an MDA treatment programme. The aim was to determine the prevalence of scabies and common skin conditions by conducting a simplified skin assessment for all community residents. The study found a 25.1% prevalence of scabies, a 7.1% prevalence of impetigo and a 51.1% presence of at least one skin disease. Scabies remains endemic in northern Australia. An ivermectin-MDA treatment programme was conducted as a local health intervention. The main challenges were verifying and accessing contraindications to ivermectin use, updating the population list for repeat prevalence surveys, achieving community penetration for the prevalence survey and following up with second treatment dose.

Dr Earnest Njih Tabah (National Leprosy and Buruli ulcer Control Programme) presented on the development of an integrated community-based surveillance system for skin NTDs in Cameroon. He introduced the national framework on NTDs and mentioned that at least 15 of the 20 NTDs are found in Cameroon, including nine skin NTDs. Although a national skin NTD control programme has existed since 2009, no functional integrated surveillance system for skin NTDs was in place. From 2020 to 2022, OCEAC implemented an NTD control project in the Sub-region, through which an integrated community-based surveillance system for skin-NTDs was developed and implemented in 21 health districts of Cameroon. The goal was to develop a surveillance system that would reinforce integrated early case-detection, management and notification of skin NTDs in targeted health districts. Before activities were integrated, integrated surveillance tools and an integrated training manual for health personnel and community health workers were developed, and the actors involved were trained. These activities enabled screening of multiple skin NTDs including Buruli ulcer, leishmaniases, leprosy, lymphatic filariasis and yaws as well as other skin conditions. In summary, he noted that integration of skin NTD control interventions is feasible on a large scale. A huge burden of other common skin diseases in the remote health districts was revealed (Fig. 1) and yaws endemicity in nine new health districts was confirmed (Fig. 2). Which should be considered for the implementation of the Morges strategy for yaws eradication.

Fig. 1. **Results of active case searches in 21 implementation health districts of Cameroon, 2020–2022**

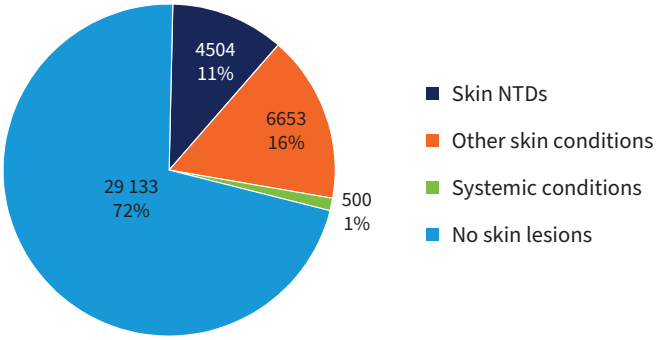
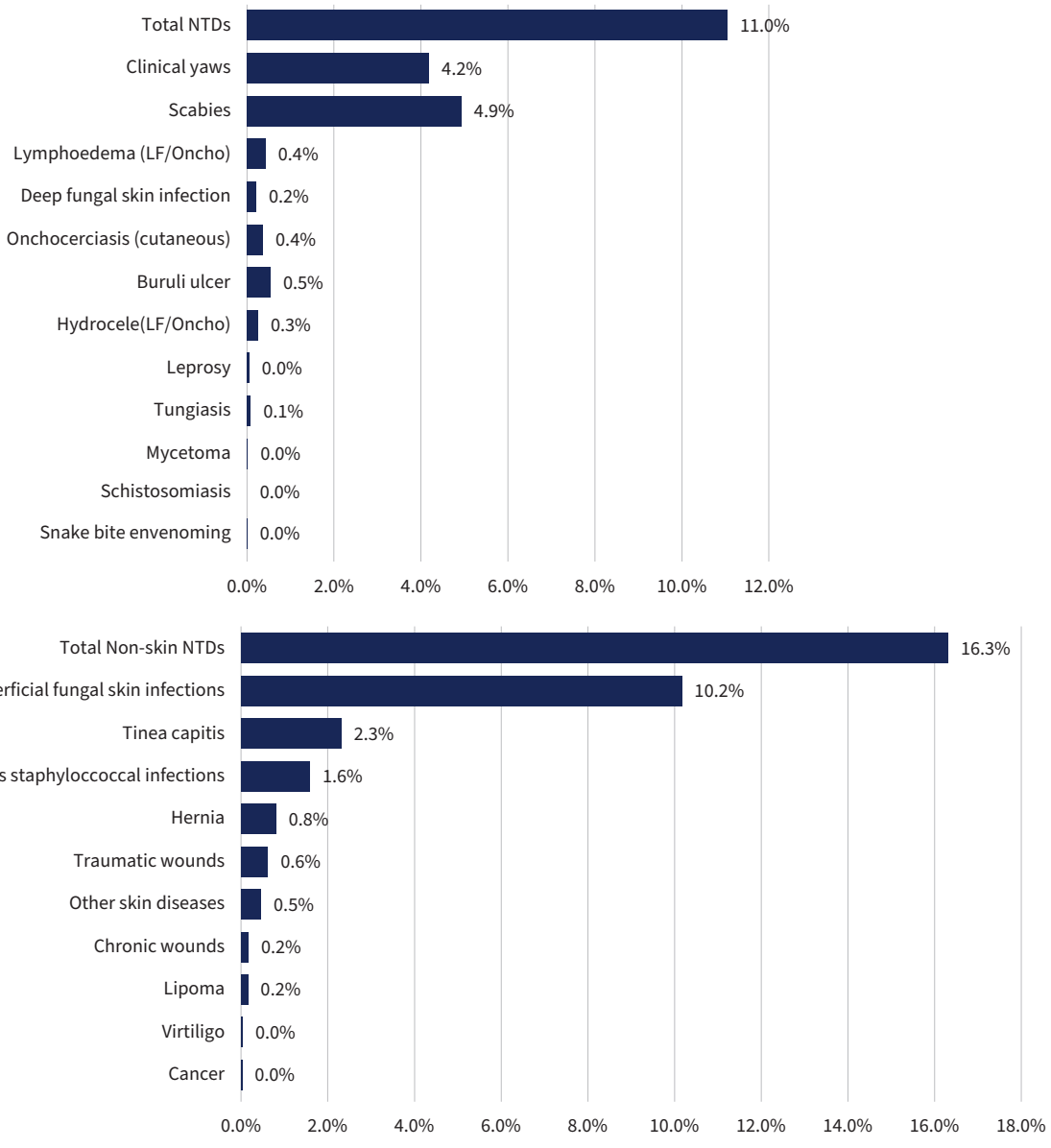


Fig. 2. **Prevalence of skin NTDs and other skin conditions detected among 40 790 persons screened in Cameroon, 2020–2022**



LF: lymphatic filariasis; Oncho: onchocerciasis.

Session 5. Disability, rehabilitation, stigma, mental health and inclusion

The fifth session was chaired by Dr Roch Christian Johnson (Raoul Follereau Foundation).

Dr Wim van Brakel (NLR International) provided an overview of the psychosocial and economic impact of skin NTD-related disability and stigma and highlighted how rehabilitation can help. Complications from skin NTDs may lead to disability, social stigma, restrictions in social participation and other forms of exclusion. These factors together have a profound impact on the mental well-being of persons affected and their families and have a serious economic impact. Regarding the socio-economic effects of skin NTDs, data are hard to find; the Global Burden of Disease provides data on disability-adjusted life-years (DALYs) and years of life lost to disability (YLDs) for only three skin NTDs (leprosy, lymphatic filariasis and onchocerciasis) (IHME, 2019). Skin NTDs are generally not known to cause mortality, so DALYs are equal to YLDs. The true burden of skin NTDs is greatly underestimated; for instance, leprosy disability weights are far underestimated. Taking into consideration only incidence rather than life-long disability (Nanjan et al., 2021) the burden of lymphatic filariasis is twice as high if depression is taken into account (Ton et al., 2015). The burden of dermal leishmaniasis is 10 times higher if chronicity is taken into account (Bailey et al., 2017). He emphasized the importance of understanding problems related to skin NTDs using the ICF framework (WHO, 2001) and its components. The ICF framework focuses on what problem the individual faces regardless of the cause or which disease is causing it. Disease management, disability and inclusion (DMDI), also from the ICF framework, is a holistic approach for providing people-centred services in the NTD field. It includes morbidity management and disability prevention (MMDP) through a holistic approach focused on inclusion and participation and based on human rights. Examples of cross-cutting NTD initiatives to improve access to rehabilitation and inclusion include combined DMDI and WASH for leprosy and lymphatic filariasis in Nigeria, integrated NTD-related disability mapping and strategy development in Ethiopia, Ghana, Liberia and Myanmar, and integrated mental well-being care for people with leprosy, lymphatic filariasis and podoconiosis in Ethiopia. In summary, he noted that persons affected by skin NTDs face physical, social and emotional problems yet they receive very little attention in NTD programmes. The ICF is very useful as a conceptual framework for MMDP and DMDI and, at the field level, community-based rehabilitation or disability-inclusive development addresses problems where people live.

Dr Jennifer Austin (International Alliance of Dermatology Patient Organizations) presented on patient organizations as partners in optimal health care. She introduced the Alliance, also known as GlobalSkin, with its vision to create a world where people with dermatological conditions are healthy and fulfilled. The mission is to amplify the voice of the dermatology patient community globally, ensure a strong and representative global voice for people affected by dermatological conditions and change the way the world perceives dermatological conditions. She highlighted the value of patient organizations including helping to develop policy, providing capacity-building and education, supporting research and providing peer support. The challenges of preventing, controlling and eradicating NTDs cannot fall solely to governments. Patient organizations must be engaged and empowered as key partners in building insights, educating and connecting. This

will result in patient-centered programmes and policies. Close collaboration and co-creation with patient organizations generates programme benefits at the national level. It builds trust and credibility with patients, saves time, money and resources, meaningfully meets patient needs and improves outcomes as well as satisfaction.

Ms Carrie Barrett (Liverpool School of Tropical Medicine) presented on depression and quality of life among people affected by filarial lymphoedema in Malawi. The aims of the study were (i) to determine the prevalence of depression and quality of life of people affected by filarial lymphoedema; (ii) to identify the sociodemographic and clinical risk factors associated with depression and low quality of life; and (iii) to measure the impact of the enhanced self-care intervention on depression and quality of life over time. A statistically significant difference was found for depression and quality of life at baseline compared to 3 months and 6 months ($p < 0.001$) after the enhanced self-care intervention. However, the decline could not be directly attributed to the intervention. In summary, the study highlighted the wider burden of lymphatic filariasis (depression, low quality of life) and the role of self-care interventions in reducing depression.

Ms Hannah Berrian (University of Liberia Pacific Institute for Research and Evaluation) presented on informal health provider roles in addressing stigma and mental health needs among people affected by skin NTDs in Liberia. The aims of the study were (i) to investigate the role of informal providers in the management of people affected by skin NTDs in Liberia; (ii) to understand the experiences and perceptions of informal providers caring for people affected by skin NTDs; and (iii) to co-design an intervention to improve engagement of informal providers through the use of participatory approaches. The key results from the study were that informal health providers (traditional and faith healers) were found to play a key role in providing support and addressing stigma. In addition, they were willing to collaborate with formal health providers. In summary, she emphasized that combatting NTDs requires multisectoral collaboration between formal and informal health systems.

Dr Kibur Engdawork (Organization for Social Science Research in Eastern and Southern Africa) presented on the impact of social intervention on podoconiosis-related stigma in north-western Ethiopia. The objective was to evaluate the effectiveness of the IZUMI-funded intervention “Next steps for podoconiosis patients in Amhara Region” in reducing the impact of podoconiosis in Ethiopia. The study was done in two districts in north-western Ethiopia. The study reached 63% of the sampled affected individuals: female patient involvement in the intervention was lower ($\chi2$ (1) = 3.87 p = 0.04): 88% reported continuing to implement the foot care instruction, 18% of unaffected community members participated in health education activities and 96.2% reported they fully comprehended the message from the training. Shoe-wearing practices were improvedand stigmatizing attitudes reduced. In conclusion, home-based interventions for affected individuals with mobility problems is needed. Psychosocial support and economic empowerment programmes are critical in reducing stigma. Expanding health education campaigns reduces public stigma and reinforces accurate understanding of the disease, dispelling misconceptions. Finally, he emphasized that effectiveness of interventions can be influenced by social and structural factors, for instance the context and community setting. Developing person-centred, high-quality, integrated social interventions requires being aware of the interactive effects of these factors. This will better equip interventions to fight the structures and institutions that create and sustain risks.

Mr Berrick Otieno (KEMRI-Wellcome Trust Research Programme) presented on the impact of tungiasis on neurocognitive functioning, school attendance and achievement. The objective was to investigate the impact of tungiasis on neurocognitive outcomes in schoolchildren in Kenya and Uganda. A community based |cross-sectional study in Kenya and Uganda was conducted in three phases to assess a broad array of neurocognitive outcomes including language, cognitive

flexibility, nonverbal intelligence, working memory, literacy, numeracy, fine motor control and response inhibition. The study on the impact of tungiasis on school absenteeism and academic achievement was nested in a national tungiasis prevalence survey in nine counties in Kenya. The study demonstrated that tungiasis impairs how children learn, interpret and respond to stimuli and this may impact their overall functioning. Integrated approaches should aim at early diagnosis and treatment to prevent the debilitating effects of the disease.

Dr Wim van Brakel (NLR International) presented on stigma and mental well-being and social participation among men and women with disability due to leprosy and lymphatic filariasis in North India. Research questions addressed by the study were:

- To what extent do women and men with lymphatic filariasis or leprosy-related disability perceive and experience stigma, and to what extent are social participation and mental well-being affected?
- Is there a difference in the way and extent to which women and men are affected?

The study found that there was no significant difference between how men and women are affected by leprosy as well as lymphatic filariasis. Interestingly, people living with lymphatic filariasis experienced low levels of stigma in spite of very high levels of community stigma.

Mr Abebayehu Tora (Wolaita Sodo University) and Dr Maya Semrau (Brighton and Sussex Medical School) presented on the role of a community conversation intervention in reducing stigma related to lower limb lymphoedema (caused by podoconiosis, lymphatic filariasis and leprosy) in northern Ethiopia. The objective was to quantitatively investigate whether community conversation contributed significantly to stigma reduction when added into an integrated holistic care package called EnDPoINT. The study found that this care package as a whole resulted in improved stigma outcomes (since all outcomes apart from social support improved over time in both the community conversation and the control sites). Community conversation interventions may not have added much or any value to the already comprehensive holistic care package. Provision of comprehensive, holistic and integrated MMDP services may be adequate and appropriate in tackling stigma related to lower limb lymphoedema in a resource-constrained setting like Ethiopia.

Professor Ahmed Fahal (Mycetoma Research Center) shared his experience on mycetoma disabilities and stigma and elaborated on the solutions invented by the Mycetoma Research Center of Sudan, a WHO collaborating centre. Mycetoma is a chronic disabling disease, characterized by massive deformities and destructions leading to loss of function and in some cases, loss of life. It can be very aggressive and cause extensive deformities. Mycetoma is a disfiguring, mutilating disease. About 30% of affected persons are children. Amputation is associated with stigma, and other economic and social problems. In endemic villages, it can run in families. It affects the poorest of the poor in impoverished communities. Patients are forced to use adapted local prosthesis. The interventions by the Centre included: establishing two peripheral satellite units, implementing field surveys; appointing social ambassadors and mycetoma friends' associations conducting health education, using artists for advocacy, making available surgeries offering ultrasound examinations done free of charge, collaborating with an innovative incubator firm to produce lighter and modern prostheses, conducting mycetoma prosthesis campaigns and deploying mobile vans to villages to conduct surveys, ultrasounds and surgeries, constructing animal cages to reduce contact with animals, undertaking social media activities, establishing SAA'ID, a mycetoma vocational and entrepreneurial centre that provides knowledge in sowing, horticulture, agriculture, carpentry as well as food); and ongoing research including on social impact of mycetoma, economic impact of mycetoma and AI for diagnosis of mycetoma. In conclusion, Mycetoma Research Center interventions have contributed to reducing the number of patients presenting with massive mycetoma and thereby the need for amputation.

Session 6. Transmission

The sixth session was chaired by Dr Lydia Mosi (University of Ghana).

Professor Tim Stinear (University of Melbourne) outlined the progress and challenges to understanding transmission of Buruli ulcer in Australia. The aim of the study was to understand how Buruli ulcer is spread from the environment to people. The progression of the disease in south-eastern Australia has averaged around 300 cases a year, which is similar to that observed in African countries. It is known that transmission peaks in the warmer month in Victoria (Loftus et al., 2018; Trubiano et al., 2013; Yerramilli et al., 2017). The incubation period is long (4–6 months), suggesting that transmission risk is highest when the temperature is warmest. The distribution of ulcers on the body is seen to be non-random (Yerramilli et al., 2017). The disease is transmitted in the warmer months, and the non-random distribution of ulcers on the human body suggest that insects, particularly mosquitoes, play a role in transmission. In Australia, essential elements for progression to disease in people are presence of *M. ulcerans*, which causes BU, a wildlife reservoir (the Australian native possum) which is extremely sensitive to *M. ulcerans* infections, mosquitoes that are in and around the infected possums, and people in the area where the mosquitoes and possums are. When these four factors coalesce, and perhaps with other factors, we see Buruli ulcer in humans. The relationship between possums with that have Buruli ulcer or shed *M. ulcerans* in their faecal pellets and humans with the disease is so strong that statistical models can be built based on collecting possum excreta from around the endemic areas, building maps from where the excreta is positive and predicting a year in advance where humans are likely to get Buruli ulcer. So, there is a powerful health tool based on the convenient analyte that is possum excreta and humans with Buruli ulcer. We have a submission on review at the moment on this. The hypothesis is that mosquitoes transmit *M. ulcerans* to humans. The role of mosquitoes as vectors cannot be over-emphasized. Mosquitoes transmit *M. ulcerans* from possums to humans. This non-random distribution of lesions on the body leads to the assumption that insect activity is involved in transmission. These are interesting observations, however, to implicate a vector, an insect, in disease, one needs to address a formal criterion (Merritt et al., 2010). There are four levels in this hierarchy: the vector has to have close association with infected hosts; the vector must be found infected with the pathogen; the vector must be shown to acquire the pathogen from an identified source; and efficient transmission to competent vertebrate hosts must be demonstrated experimentally. Going down the hierarchy:

1. The vector has a close association with infected hosts: mosquitoes are found in close proximity of possums which are highly adapted to living in urban areas and the humans thus living in these areas.
2. The vector must be found infected with the pathogen; this was confirmed through environmental surveys (Johnson et al., 2007).
3. The vector must be shown to acquire the pathogen from an identified source; they looked into what the insects are feeding on. Forensic methods revealed that some of the trapped mosquitoes had fed on humans and others on possums. This linked possums and humans in the transmission chain with mosquitoes. The pathogen genome (*M. ulcerans*)

wassequenced and the results confirmed that the genomic sequences from humans, possum excreta and mosquitoes are identical.

4. Efficient transmission to competent vertebrate hosts must be demonstrated experimentally; this criterion has been shown in previous studies (Wallace et al., 2017).

He emphasized that it can thus be concluded that Buruli ulcer is a zoonosis, at least in south-eastern Australia, and can be assumed to be the same in other endemic countries. He also noted that there is still work to be done to close the gap on the exact link between mosquitoes, possums and humans and that studies are ongoing.

Dr Dilini Wijesekara (Ministry of Health of Sri Lanka) presented on the transmission status of NTDs with skin manifestations in Sri Lanka. She focused on three NTDs: leprosy, lymphatic filariasis, leprosy and leishmaniasis. The objective of the programme was to interrupt transmission of leprosy and lymphatic filariasis in Sri Lanka by 2030 and to reduce incidence of cutaneous leishmaniasis from 7.2 per 100 000 population (baseline in 2016) to < 1 per 100 000 population in 2030. The methods employed include: control of lymphatic filariasis and leprosy by designated disease control programmes (Anti Filariasis Campaign and Anti Leprosy Campaign, respectively), MDA with two medicines (diethylcarbamazine and albendazole), management of chronic complications and skin manifestations at special morbidity management clinics in endemic areas and effective social marketing campaign. The results revealed a marked impact on reduction of leprosy to reach elimination targets and of microfilaria rates in lymphatic filariasis. Of all three diseases, only the leprosy programme has been integrated into general health services, and patients are treated and followed up in skin clinics in curative health care institutions. Recently, control of leishmaniasis was taken up by the Anti Malaria Campaign. All three diseases maintain disease surveillance systems to assess their burden and monitor trends. For leishmaniasis, an increasing trend is observed in some areas. Six districts in Sri Lanka − mainly in Central and North Central Provinces − reported > 1000 cases, which accounted for 84.5% of all cases reported. Vector indices show abundance of sand fly, which has increased transmission of the disease among vulnerable groups. In conclusion, she noted that low grade transmission of leprosy and lymphatic filariasis continues to occur in Sri Lanka. Intensive interventions together with integration with other health and non-health organizations are required to reach total interruption of transmission. Vector surveillance of leishmaniasis should be integrated into other vector-borne disease programmes. More research should be focused on methods of controlling the sand fly.

Dr Stephen Muhi (University of Melbourne) presented on the establishment of a controlled human infection model for Buruli ulcer. The aim was to introduce the concept of deliberately infecting humans with *M. ulcerans* to study the disease. He explained that a controlled human infection model is the deliberate infection of human volunteers in a controlled careful fashion to reproduce some typical disease phenotype. These models are more relevant for complex but uncommon pathogens such as *M. ulcerans* and generally can be established for non-severe disease syndromes that are self-limiting or have some sort of reliable treatment options and rare rates of complications. Safety is paramount with these studies, with stress on a cautious approach to strain selection and manufacture, and careful selection of consenting adult volunteers according to defined eligibility criteria that have been approved by the human ethics committee. It requires close clinical monitoring in order to support patients throughout the study, with prompt administration of curative antibiotics at the study end point and oversight by an independent safety committee. An *M. ulcerans* controlled human infection model has the potential to revolutionize research on Buruli ulcer. It will be useful to test a number of prophylactic or therapeutic interventions, particularly vaccines, because there is really no clear path to test the efficacy of vaccines. The ideal challenge strain must have the following characteristics: is

not associated with severe disease, reproduces a typical infection phenotype, amenable to a biologically plausible route of entry, susceptible to clinically relevant antibiotics, can be cultured in a non-toxic, animal-free medium without genetic or chemical modification, can be accurately enumerated to ensure consistent challenge dosing, remains viable after cryopreservation and produces the key virulence factor after in vitro culture. In addition, it should maintain a conserved repertoire of genes encoding candidate vaccine antigens and should remain genetically stable during manufacture and challenge. JKD8049, a clinical isolate (ulcer) from Victoria first isolated in 2004, was identified and shown to meet all these characteristics. In conclusion, Dr Muhi emphasized that JKD8049 can be accurately enumerated to ensure consistent challenge dosing, remains viable after cryopreservation, produces the key virulence factor after in vitro culture (confirmed via LC-MS), maintains a conserved repertoire of genes encoding candidate vaccine antigens and remains genetically stable during manufacture.

Professor Paul Johnson (North Eastern Public Health Unit) demonstrated that peak transmission of Ross River virus/Barmah River virus (RRV/BFV) infections and Buruli ulcer in temperate Victoria (Australia) are aligned and strongly influenced by season. The objective of the study was to investigate whether there is a temporal association between incidence of Buruli ulcer and mosquito-vectored alphavirus (RRV/BFV) infections in Victoria. Victorian disease notification data by month was accessed through the Victorian Department of Health. The month of notification was obtained for Buruli ulcer, and the two alphavirus infections combined (RRV/BFV) over the 6-year period 2017–2022. The universal health system in Australia allows easy access to doctors and pathologists; therefore, notifiable diseases are electronically notified. There is very little delay of notice of health and the department of health receiving a notification. In the 6 years of the study, the notification data were divided into month, year and season. The RRV/BFV showed a significant year-to-year variation, with hardly any cases in some years and large outbreaks in other years, making it difficult to describe a pattern; however, it can be agreed visually that all the notifications occur in the summer and autumn seasons. There is almost none in the winter and spring seasons. The Buruli ulcer notifications show that there is much less year-to-year variation. There is a significant annual variation by season, with peak notifications in the winter and spring instead of the summer and autumn. It can be safely concluded that there is absolutely no relationship if no statistical analysis is done. However, there is a need to consider the incubation period of Buruli ulcer, which in Victoria is 4.5–5 months (Loftus et al., 2018; Trubiano et al., 2013). Incubation periods of RRV/BFV infections (alphaviruses) are much shorter, typically 7–14 days (Harley et al., 2002). This allows the inference of transmission by subtracting the incubation from the notification time to get an idea of when peak transmissions are occurring. When a graph is made of the inferred transmissions there is a significant alignment of when the two conditions appear to be transmitted at the same time. Looking at this data qualitatively, transmission is consistently lowest in winter and spring for both alphaviruses and Buruli ulcer. Transmission maxima and minima for Buruli ulcer and alphaviruses correlate.

Professor Jean-François Guégan (National Research Institute for Agriculture, Food and the Environment) presented on the importance of evolutionary ecology literacy in improving the understanding and management of mycobacterial skin diseases. He emphasized that vertebrate–mycobacteria adaptive associations rarely play a role but, through frequent coincidental pathogenicity, there are diverse mycobacteria. The environment is truly important for the genesis of pathogenicity. Therefore, managing the mycobacteria pathogens requires an analysis of opportunistic vertebrates among non-vertebrate organisms that are totally embedded in naturally occurring ecosystems and may provide possible indicators of possible new outbreaks or play a role in the persistence of the pathogens through time and space but also impacting their pathogenicity levels.

Dr Heather Jordan (Mississippi State University) presented on detection of *M. ulcerans* among *Aedes albopictus* (Skuse 1894) that emerged from water contaminated with *M. ulcerans*. Transmission of *M. ulcerans* to humans is unclear, although there are suggestions that it could be through aerosol, contaminated vegetation, skin puncture or insect vector which includes mosquitoes. The aim of the study was to measure presence and abundance of *M. ulcerans* in *Ae. albopictus* hatched and developed in water contaminated with the microorganism, and determine mosquito microbiome changes after addition of *M. ulcerans*. The experimental design included four trials: internal versus external, microbiome analyses, post-sequencing quality trimming and rarefaction, and Alpha/Beta diversity and differential abundance. The results indicated that *M. ulcerans* was detected across life stages and generations. The larvae showed the highest presence and abundance (Generation 1). In general, the presence and abundance decreased through life stages. Environmental samples showed relatively high concentrations of *M. ulcerans*. The data suggest mosquitoes may play a role in dispersal by reintroducing *M. ulcerans* into environmental reservoirs and potentially into susceptible hosts. She noted that the data in this system do not seem to support the assumption that *M. ulcerans* is biologically maintained, although they do rule out mechanical transmission and actually suggest that it may be dispersed by mosquitoes in this type of scenario.

Dr Andrew Buultjens (University of Melbourne) presented on genomics and machine learning to infer the geographical origin of human Buruli ulcer cases with a focus on spread of *M. ulcerans* in south-eastern Australia (Victoria). He highlighted that the key issue for epidemiologists is working out where a patient acquires the infection. *M. ulcerans* has an incubation period averaging 4–5 months, so it is challenging for patients to recall where they could have been infected. A tool that can show the geographical origin of cases with high precision is therefore of value. The aim of the project was to provide more accurate information on the locations where the disease is transmitted by creating a model that can be used to direct public health responses to risk areas. The model is a simple concept, its input is the clinical isolate genome and the output is the likely location of acquisition. A neural network, called Locator, was used. This type of AI is modelled upon how the human brain works (https://github.com/kr-colab/locator). To teach the model about diversity, genomes (n=345) were used to train the model using a process called cross-validation to ensure that it is adequately trained and is generalizable to new data. After training, the model was applied to make predictions upon a set of clinical testing isolates (n=168). The model never encountered the testing isolates until the training was completed. It should be noted that possums are highly territorial, with a homing range of about 100–200 m, meaning that any insights from faecal materials are likely to be geographically trustworthy. Predictive performance of this modelling approach used distance between the known origin's latitude verses the longitude that was predicted by the model. Most of the predictions were low in error; they were within 77% at ≤ 10 km, 86% at ≤ 20 km and 95% at ≤ 30 km. Overall, the approach had good predictive capacity. He noted that genomics have informed the historical movements of *M. ulcerans* in Australia and that genome variation can be used to predict the geographical origins of Buruli ulcer cases.

Dr Bridgette McNamara (Barwon South West Public Health Unit) presented on environmental risk factors associated with the presence of *M. ulcerans* in Victoria, Australia. The main aim of the study was to examine the presence of *M. ulcerans* in residential properties in endemic areas. The specific objectives were: (i) to determine environmental sample types most likely to contain *M. ulcerans* DNA or viable *M. ulcerans* bacteria (RNA) and (ii) to identify environmental features associated with *M. ulcerans* detection and with human cases of Buruli ulcer. Environmental surveys were conducted as a subset of a large case control study that recruited 223 laboratory confirmed cases of Buruli ulcer between June 2018 and June 2020, as well as 520 post-code match controls. These participants were sent a questionnaire, one question of which was would they be willing to have an environmental survey conducted at their property: > 90% of cases and > 88% of the control

were willing to have an environmental survey conducted at their property. From these, 115 case properties and 115 control properties were purposely selected to have a range of properties across the endemic areas. The post-code match control properties consisted of household members who had never had Buruli ulcer. A small number of repeat survey (*n*=27) was also done 3–9 months after the initial survey to look at how the status of the properties had changed over time. *M. ulcerans* was detected by polymerase chain reaction (PCR) in a staged process. First, a screening PCR looked at mycolactone-producing bacteria DNA and then a confirmatory PCR which is more specific for the *M. ulcerans* bacteria was conducted. In addition, a viability assay looking at RNA was done to look for the presence of viable bacteria in the sample. Presence of *M. ulcerans* was found to be common in endemic areas and was more common among case properties; in mammalian faeces it revealed a possible zoonotic transmission. Associated environmental features encouraged the presence of possum (food sources, habitat). *M. ulcerans* was detected in other samples (soil, plants, water, mosquitoes) and mostly, but not always, persisted, especially when faeces was a source. Understanding the location of infected possums and/or reducing infection in possum populations may inform prevention strategies.

Dr Daniel O'Brien (University of Melbourne) presented on an ongoing study that seeks to evaluate BCG vaccination of possums against *M. ulcerans*. The aim of the project is to develop tools for a non-destructive method of managing a zoonotic pathogen in its reservoir host that has benefits for human and animal health without damaging the local ecosystem. The project methodology includes: (i)development of an *M. ulcerans* common ringtail possum infection model with high (~103 colony-forming units [CFU]) and low (~20–30 CFU) doses of *M. ulcerans*; (ii) BCG vaccine efficiency data against *M. ulcerans* in common ringtail possums; (iii) development of a palatable and attractive oral bait for delivery of BCG vaccines to common ringtail possums; and (iv) testing of oral BCG vaccine efficiency against *M. ulcerans* in ringtail possums both in houses and in natural settings. The progress so far is that the team at CSIRO's Australian Centre for Disease Preparedness have established housing and husbandry conditions for ringtail possums. The study is ongoing.

Session 7. Diagnostics and laboratory capacity strengthening

The seventh session was chaired by Professor Tim Stinear (University of Melbourne).

Dr Israel Cruz (Carlos III Health Institute) gave a synopsis of the current diagnostic tests for skin NTDs and laboratory capacity strengthening, emphasizing the opportunities, challenges and priorities. Access to diagnostics is essential to sustainably address the most pressing public health needs including NTDs. At patient level, diagnostics can be used to apply correct treatment, making patients access health; also they can be used at community level to control epidemics and address antimicrobial resistance. At the programme level, diagnostics can provide data for intervention, guide elimination and reduce cost reduction. Additionally, diagnosis can be used also to detect and manage cases, support surveillance activities for NTDs and to map and monitor interruption of transmission and elimination of transmission. In 2021, WHO updated its model list of essential in vitro diagnostics (WHO, 2021c). In vitro diagnostic tests influence approximately 70% of health-care decisions, but only 3–5% of the health-care budget is spent on diagnostic services. In low and lower middle income countries, basic diagnostic capacity is available in only 1% of primary care clinics, leading to incorrect diagnoses in more than two thirds of patients, health workers feeling powerless and patients not receiving appropriate treatment. He also talked about the challenges and solutions that can arise due to integrating diagnostics. These include: need for training packages for different diseases, technical support for new tests, advocacy and funding as well as access (logistics and supply for diagnostic tests) and implementation (barriers to adoption, negative impact of introducing new tests in weak health systems). Developing a multiplex platform will be important to enable mapping of co-endemic diseases and differential diagnosis panels. In conclusion, he highlighted the need to empower laboratory personnel so as to improve diagnosis of NTDs.

Dr Sara Eyangoh (Pasteur Centre of Cameroon) presented on the Buruli ulcer laboratory network for Africa – commonly known as BU-LABNET – and its progress, perspectives and challenges. BU-LABNET was created in October 2019 when the Institute for Tropical Medicine in Antwerp discontinued the external quality assessment (EQA) programme for PCR diagnosis of Buruli ulcer. Since there was still a need, WHO recommended transferring the programme to a volunteer laboratory in Africa with good performance. The Pasteur Centre in Cameroon was duly selected as the Coordinating Centre and BU-LABNET was created; it now includes 13 laboratories from nine countries.[1] The main objective was to establish a new model of an EQA programme, with specific objectives to (i) formalize a network of laboratories; (ii) harmonize and standardize standard operating procedures; (iii) conduct meetings, training, site evaluations and supervision; and (iv) implement EQA. The vision is to expand the network, harmonize standard operating procedures for other skin NTDs and integrate them in the same molecular platform. Progress includes that membership of BU-LABNET has been made official, an advisory board and expert panel have been

[1] Benin, Cameroon, Congo, Côte d'Ivoire, Democratic Republic of the Congo, Gabon, Ghana, Liberia, Nigeria and Togo.

created, four annual general meetings have been held and a Memorandum of Understanding has been signed between WHO and the Coordinating Centre. The main challenges are sustaining supplies of reagents and consumables for diagnosis, coordinating with national Buruli ulcer control programmes for transfer of samples, funding and implementation of collaborative studies, and improving communication among network activities to enhance visibility and equipment maintenance. She emphasized that harmonized procedures are essential to improve diagnostic quality and implementation of EQA, which is applicable to all skin NTDs. The long-term goal for BU-LABNET is to expand and include other skin NTDs such as cutaneous leishmaniasis, leprosy, mycetoma and yaws in the same molecular platform and to conduct collaborative studies in all nine countries.

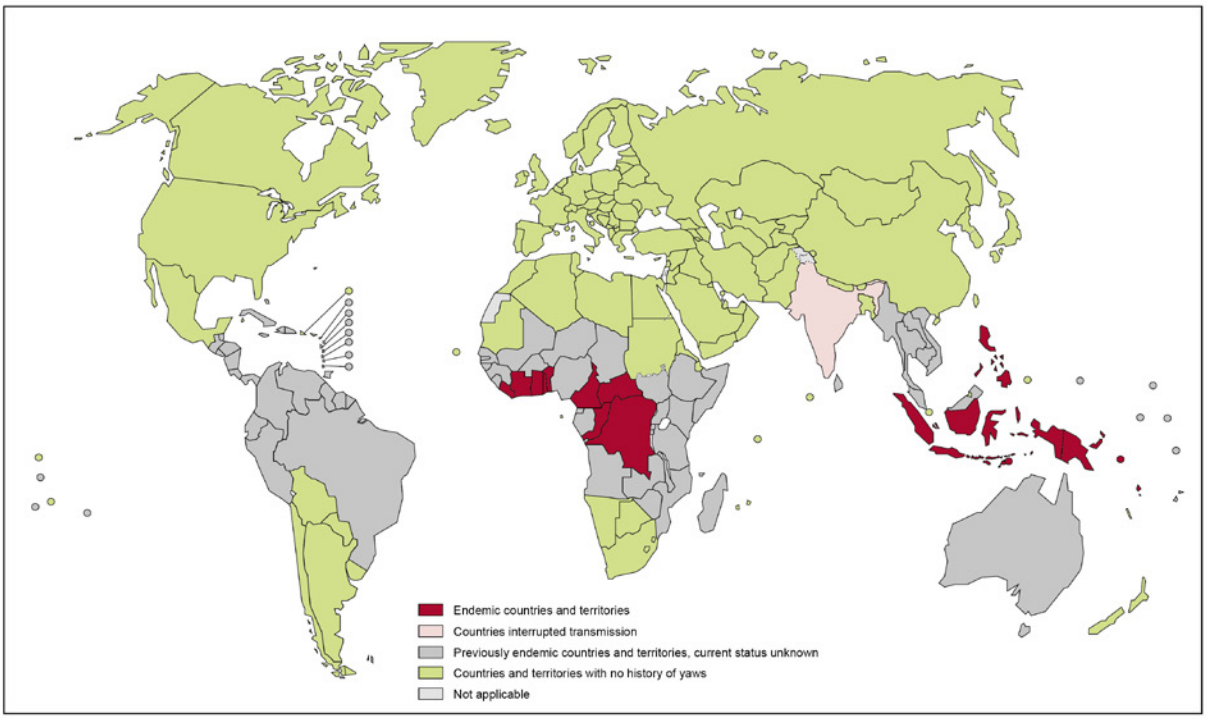
Dr Sundeep Chaitanya Vedithi (American Leprosy Missions) and Dr Michael Frimpong (National Institutes of Health) discussed point-of-care and field-compatible quantitative PCR (qPCR)-based molecular diagnostics for skin NTDs in a study on Buruli ulcer and leprosy. The main aim of the study was to evaluate the use of the Biomeme Franklin™ Mobile qPCR for accurate detection of *M. ulcerans* and *M. leprae* in clinical samples. The specific objectives were: (i) to determine analytical sensitivities and limit of detection of RLEP and IS2404 using Biomeme qPCR in comparison to standard qPCR systems currently in use in three WHO-approved reference laboratories for Buruli ulcer and one research laboratory for leprosy; and (ii) to evaluate the *M. leprae* and *M. ulcerans* qPCR assays for the confirmatory diagnosis of leprosy and Buruli ulcer using clinical samples. The study confirmed that Biomeme qPCR was able to detect *M. leprae* and *M. ulcerans* DNA with equivalent or superior efficiency to standard qPCR in clinical samples. The lyophilized Biomeme qPCR assays for Buruli ulcer remained shelf stable at ambient temperatures and performed consistently at three test sites. The system was also tested at the point of care and in the community.

Professor Dziedzom Komi de Souza (Foundation for Innovative New Diagnostics) presented the challenges and prospects of developing a rapid diagnostic test for Buruli ulcer. He elaborated that the main goal of the Buruli ulcer project was to develop a rapid diagnostic test and generate evidence for its use in endemic countries. The expected impact is to simplify the diagnostic algorithm to enhance testing at primary care and community levels and to reduce the turnaround time for result confirmation, enabling rapid treatment initiation. The challenges include a problem with sensitivity, which could be linked to sample collection, storage and processing. Ulcers come in various forms (dry, wet, bloody) and various remedies are used to treat them, all of which can affect the stability and concentration of mycolactones in the sample. A decrease in numbers of cases may lead to inability to collect enough samples within the required time-period. He noted that there is a need to determine optimal sampling and processing procedures and expand partnership to increase access to fresh clinical samples. Future work will depend on the ability to stabilize mycolactone from degradation and to avoid loss due to aggregation to plastic surfaces and a suitable reference standard. The rapid diagnostic test prototype is available for research and has been tested successfully on mycolactone from culture and patient samples, even though sensitivity remains a major challenge.

Dr Serges Tchatchouang (Pasteur Centre of Cameroon) presented on capacity-building in yaws reference laboratories in Cameroon, Côte d'Ivoire and Ghana. Yaws is endemic in warm, humid and tropical forest areas of Africa, Asia, Latin America and the Pacific (Fig. 3). He elaborated on a project that set out to establish molecular diagnosis of yaws in reference laboratories. The specific objectives were to evaluate the inventory of reference laboratories following good clinical laboratory practice guidelines, optimize and validate amplification tests and to train the reference laboratory personnel. At the beginning, only one laboratory was doing molecular diagnosis on

yaws with a commercial kit. The personnel were not stable since most were part timers, recruited during projects, which caused low sustainability of yaw diagnosis. At the end of the project, 10 people were trained during capacity-building and evidence of the training was comparable among the three reference laboratories, many procedures were tested and validated to be implemented in these laboratories, and a quality system was put in place. The challenges experienced included the long time in shipment of reagents and validation of amplification tests on different platforms to allow the same performance. In conclusion, he noted that three reference laboratories in sub-Saharan Africa for the molecular diagnosis of yaws according to good clinical laboratory practice guidelines are established in Cameroon, Côte d'Ivoire and Ghana. A quality assurance system is in place to ensure that the capacity and expertise developed are maintained. He recommended that the procedures should be integrated into BU-LABNET for harmonization.

Fig. 3. Global endemicity of yaws, 2021



Data Source: World Health Organization
Map Production: Control of Neglected Tropical Diseases (NTD)
World Health Organization

World Health Organization

Professor Sascha Knauf (Friedrich Loeffler Institute) expounded on EQA in the fight against NTDs, focusing on the LAMP4Yaws Project. The main goal of the project was to establish an EQA programme that covers all levels of health care in a low-income setting. He noted that the LAMP4Yaws-specific EQA needs a critical evaluation once all proficiency testing rounds have been run. The current results are stable and promising; however, the performance of loop-mediated isothermal amplification (LAMP) is poorer compared with qPCR. He emphasized that EQA programmes are essential for NTD programmes and that there is a need for more of such programmes at district level in Africa. Cross-sectoral EQA programmes are required to adequately address the One Health approach (bridging human, animal and environmental health) and multiple programmes can be combined to save resources.

Dr Wendy van de Sande (Erasmus Medical Center) presented on molecular diagnostics for mycetoma. Mycetoma is a chronic subcutaneous disease that is characterized by the discharge of grains and purulent material through sinuses. The causative agent includes fungi (mainly *Madurella mycetomatis*) or bacteria (mainly *Nocardia brasiliensis*). The objective of the study was to develop molecular identification methods for the most common causative agent to enable more rapid and accurate identification. The main challenges for implementation were: obtaining grains from mycetoma lesions, which is still an invasive procedure; isolating DNA from grains, which is labour intensive; and developing molecular identification tools, which are currently only developed for *Madurella* species. Etiology differs by endemic region. Species are identified through histopathology and culture, which are prone to misidentification. In conclusion, she highlighted the need to develop a multiplex PCR, qPCR and recombinase polymerase amplification to identify *Madurella mycetomatis*, *Streptomyces sudanensis*, *Falciformispora senegalensis*, *Actinomadura pelletieri*, *Streptomyces somaliensis* and *Actinomadura madurae.*

Ms Abigail Agbanyo (Kumasi Centre for Collaborative Research in Tropical Medicine) presented on laboratory support for the control and elimination of skin NTDs in Ghana, with an emphasis on an integrated case management programme that was implemented for Buruli ulcer, leprosy and yaws. The main aim of the programme was to strengthen laboratory diagnosis for skin NTDs using an integrated approach. The specific objectives were to improve overall quality in sample collection, storage, transport, processing and reporting and to improve the knowledge and skills of health-care practitioners responsible for sample handling. The programme trained 114 health-care practitioners including disease control officers and laboratory technicians, and there was quick turnaround of results (< 1 week). An integrated skin NTD programme is feasible and likely to improve patients' care. For it to be effective, it requires strong laboratory support for accurate surveillance and case management, quality at all levels in the implementation programme to assure accurate laboratory confirmation, training and capacity-building activities, monitoring and supervision, a good communication network and timeliness in reporting.

Dr Andy Wende (Xpedite Diagnostics) presented on Xpedite Diagnostics, a privately owned company that develops and manufactures innovative DNA/RNA extraction kits. He elaborated on two of their products: the Swift DNA, a versatile tool for extraction of DNA from various skin disease agents, and a customizable mobile laboratory called robust pelican case. He noted that the kit complies with the ASSURED criteria: it is affordable, rapid, sensitive, specific, eco-friendly and user-friendly. In addition, the SwiftX™ DNA has no hazardous chemicals, has rapid and easy workflows, has reverse purification and has the ability to address multiple skin NTDs with a single extraction. He also highlighted a customizable mobile laboratory, referred to as robust pelican case. The customizable mobile laboratory is a whole laboratory in plastic housing that fits all instruments and consumables such as solar panels, lithium-ion batteries, vortexes, heat blocks, pipettes and tube racks needed for molecular work.

Session 8. Treatments

The eighth session was chaired by Dr Michele Murdoch (International Foundation for Dermatology).

Professor Richard Phillips (Kumasi Centre for Collaborative Research) gave an overview of current treatments for 10 cutaneous NTDs,[1] opportunities, challenges and priorities. He summarized the current status of treatments for these infections and the gaps therein (Table 3).

He emphasized that appropriate treatment should be considered as it is key to the success of the strategy to eradicate, eliminate or control skin NTDs. In addition, effective treatment facilitates integration. Treatment-related challenges and priorities should be addressed in a timely and appropriate manner.

Table 3. Summary of available drug treatments and gaps for skin NTDs

Disease	Recommended treatment	Gaps
1. Yaws	Azithromycin or benzathine penicillin	Effective treatment; no major challenges
2. Leprosy (Hansen's disease)	Multidrug therapy	Effective treatment; **rifampicin resistance** occurs but is not a major public health issue
3. Onchocerciasis	Ivermectin as preventive chemotherapy	Effective treatment; **a safe, effective microfilaricide to reverse lymphatic dilatation and improve lymphoedema**
4. Lymphatic filariasis (lymphoedema and hydrocele)	Ivermectin, albendazole, diethylcarbamazine citrate, doxycycline (only in certain settings); surgery (for hydrocele)	Effective treatment: **a safe, effective microfilaricide to reverse lymphatic dilatation and improve lymphedema**
5. Buruli ulcer	Rifampicin and clarithromycin	Effective treatment; **shorter treatment**
6. Cutaneous leishmaniasis	Pentavalent antimonials (sodium stibogluconate/meglumine), miltefosine, topical paromomycin, fluconazole, amphotericin B; thermotherapy, cryotherapy	Priority: **more effective, shorter duration medicines**

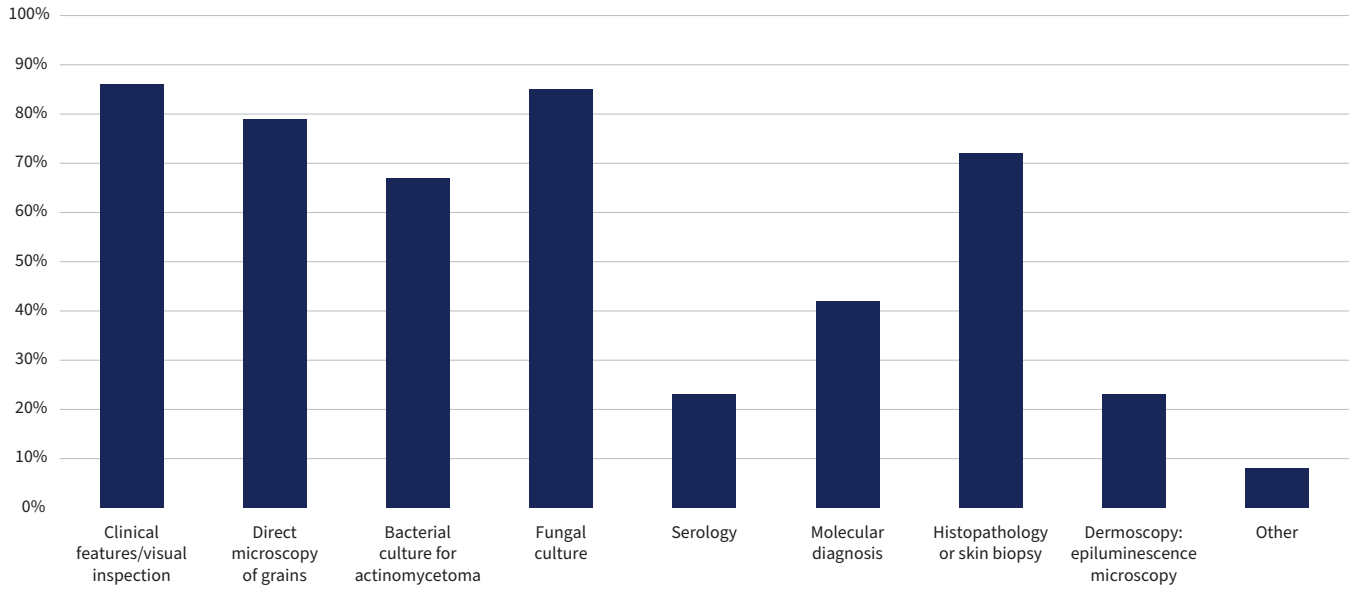
[1] Buruli ulcer, cutaneous leishmaniasis, leprosy, lymphatic filariasis, mycetoma, onchocerciasis, post-kala-azar dermal leishmaniasis, scabies, tungiasis and yaws.

Table 3. (continued)

Disease	Recommended treatment	Gaps
7. Mycetoma, chromoblastomycosis and other deep mycoses (including sporotrichosis)	Combination: antifungals (itraconazole, voriconazole) antibacterial agents (cotrimoxazole, amikacin, co-amoxiclav)	Priority: **more effective medication, shorter duration drugs and less expensive options**
8. Post-kala-azar dermal leishmaniasis	Pentavalent antimonials, miltefosine, amphotericin B	Priority: **more effective, safe, shorter and low-cost medicines**
9. Scabies	Topical benzyl benzoate (25%), permethrin cream (5%), oral ivermectin	Priority: **access to medicines**
10. Tungiasis	Two-component dimeticone, surgical extraction	Priority: **newer medicines**

Ms Barbara Milani (WHO/NTD) presented on the 2022 global WHO online survey on diagnostic capacities and treatment practices for implantation (deep) mycoses (WHO, 2023c). The aim of the survey was to collect data on diagnostic capacities and treatment practices (pharmacological and non-pharmacological treatments) for four implantation mycoses: eumycetoma, actinomycetoma, cutaneous sporotrichosis and chromoblastomycosis. The survey evaluated whether drugs were being repurposed in middle income countries for treatment of selected implantation mycoses, while considering diagnostic challenges, use of non-pharmacological treatments and challenges posed by availability and/or affordability of medicines. The findings were as follows: the main diagnostic methods available are clinical features (visual inspection; 86%), culture fungal (85%), grain direct microscopy (79%) and histopathology on skin biopsy (72%) (Fig. 4).

Fig. 4. Diagnostic methods for implantation mycoses



Of the other techniques not listed, matrix-assisted laser desorption ionization time-of-flight (MALDI-TOF) was indicated by four respondents.

The survey confirmed that drug repurposing is occurring for fungal diseases beyond itraconazole as first choice (85–90%) and terbinafine for refractory cases (44–56%). There was also non-pharmacological treatment for eumycetoma: 82% of respondents indicated that surgery was applied in their setting; 56% of respondents stated that they could not use medicines because they were not available and/or not affordable (WHO, 2023c). In conclusion, the implementation of a global case report registry for implantation mycoses could contribute to addressing the gap in epidemiological information and in collecting valuable observational data on treatment outcomes to inform treatment guidelines and clinical research.

Professor Bouke de Jong (Institute of Tropical Medicine) presented preliminary results on the safety of bedaquiline plus rifampicin for leprosy post-exposure prophylaxis in Comoros. The phase II safety clinical trial confirmed that bedaquiline (800 mg single dose) in combination with rifampicin (600 mg) is equally as safe as rifampicin (600 mg) single dose alone. Efficacy will be compared in a phase III trial from April 2023 to March 2027. Surveillance for the earliest signs of resistance is also in place.

Dr Koert Ritmeijer (Médecins Sans Frontières) presented on the characteristics of patients with cutaneous leishmaniasis and their treatment outcomes in Quetta, Pakistan on a retrospective cohort analysis in 2014−2021.The aim of the study was to investigate patients' characteristics, trends over time, treatment outcomes ("initial response" or "poor response" to the antileishmanial treatment at end-of-treatment, "final cure" or "final failure" at 6 weeks follow up), risk factors for treatment failure and relapse. Diagnosis was by fine needle aspirate microscopy and dermatologists also made clinical diagnosis. Treatment was with meglumine antimoniate (Glucantime) local intralesional injections (7−12 sessions over 3−4 weeks) for < 4 smaller lesions and systemic intramuscular injections (20 mg SbV/kg for 20−28 days) for larger or multiple lesions, or lesions near eye, nose, lips, ear, joints. The study found that a large proportion of patients required extended treatment to achieve initial cure and that young children had higher rates of poor initial response and final failure. In conclusion, he noted that follow up after treatment especially for patients with increased risk of failure is required; these are young children, patients presenting with facial lesions and small lesions with high parasite load. Further research to better understand risk factors for failure (for example are young children being under dosed?), investigate alternative effective, shorter and safer treatment modalities and to develop appropriate preventive control measures is needed.

Dr Bognan Koné (Swiss Centre for Scientific Research, Côte d'Ivoire) presented on basic infrastructure as an essential component of integrated wound management. The aim of the project was to assess, implement and monitor infrastructure requirements for a Wound Management Model at the rural community level. The main components of the project are continuous supply of water, portable water, wound cleansing, toilets, laboratory support and digital support. Wound management in resource-constrained countries requires basic infrastructure resources and well trained and motivated community health workers. The approach to implementing basic infrastructure for wound care is bottom-up and built with the communities and nurses. Community involvement is crucial for identifying affordable and sustainable solutions during the upgrading process and to sustain the wound management infrastructure.

Dr Hubert Vuagnat (Geneva University Hospitals and World Alliance for Wound & Lymphedema Care) presented on the "WAWLC Wound Care Kit". He emphasized that it is a way to bring basic dressing material for adapted modern wound care in low-resource settings with an aim to enhance community-based wound care. The kit contains the following global hygiene products: soap and hydro alcoholic hand rub, general wound care protocol, specific wound care file, trash bag, sharp box, pens, simple dressing material, disinfectant (povidone-iodine), saline, petroleum

jelly gauze, petroleum jelly tube, dry gauze, silver sulfadiazine cream, elastic bandages, tape and transparent plastic film. The kit is used not only to treat but also to teach; users are satisfied with the contentand it can be adapted to the local treatment plans or materials. He noted that chronic wounds have to be recognized as a worldwide major concern. In addition, modern adapted wound care basic teaching should be done at pre-graduate level and basic standard material made and disseminated worldwide.

Professor Hermann Feldmeier (Charité University Medicine) presented on the control of tungiasis by systematic treatment of humans and animals with dimeticone oil and health promotion in a semi-nomadic population in Karamoja, Uganda. This community-based One Health intervention involved regular rounds of door-to-door diagnosis and treatment of tungiasis in humans and animals using dimeticones (NYDA) as well as parallel door-to-door and community-based health promotion. NYDA contains two dimeticone oils of different viscosity (Thielecke et al., 2014) After treatment, prevalence dropped from 62% to 6 or 7% after four rounds of treatment. Very severe cases were also cured after treatment with NYDA (Fig. 5).

In conclusion, regular systematic treatment of tungiasis in humans and animals with NYDA combined with improvement of body hygiene and environmental sanitation reduced the prevalence of tungiasis in the study community from 63% to 6% within a period of 2 years. Ongoing transmission in the soil floor inside the huts explains why prevalence did not fall below 6%.

Fig. 5. Outcome of treatment of a severe case of tungiasis in Uganda with dimecticones

Day 0 Day 4 Day 19 Day 27

Source: McNeilly et al. (2024).

Dr Ruth Nyangacha (Kenya Medical Research Institute) presented on secondary bacterial infections and antibiotic resistance among tungiasis patients in western Kenya. The aim of the study was to identify bacterial pathogens associated with secondary infections in tungiasis patients in western Kenya and to establish the antimicrobial susceptibility profiles of the most common bacteria isolated. The study confirmed the presence of multidrug-resistant bacteria in tungiasis lesions, hence highlighting the significance of secondary infection of the lesions in endemic communities

(Nyangacha et al., 2017). She emphasized that the treatment regimen for tungiasis especially in severe cases should be expanded to include antibiotics and that, where sepsis is observed, a broad-spectrum drug may be considered at the onset to avoid delay in starting treatment as results from cultures are awaited.

Dr Roch Christian Johnson (Raoul Follereau Foundation) presented on the status of a phase II clinical trial in Benin that evaluated a regimen containing beta-lactams in shortening the treatment of Buruli ulcer. The aim of the trial was to assess the possibility of reducing the duration of treatment from 8 to 4 weeks through the co-administration of amoxicillin and clavulanic acid with the current treatment of rifampicin and clarithromycin. The preliminary data show minor adverse events. The expected number of cases was not reached in year one of recruitment due to the decrease in cases observed in recent years. The team will strengthen the active screening strategy to find more patients to recruit in the study. If successful, this study will provide information to improve the management strategy not only for Buruli ulcer but also for leprosy, tuberculosis and other mycobacterial infections for which rifampicin is used.

Session 9. Operational research

The ninth session was chaired by Professor Ymkje Stienstra (University Medical Center Groningen).

Professor Gail Davey (Brighton and Sussex Medical School) gave an overview of operational research for skin NTDs. There are multiple processes through which operational research can be identified:

1. The Coalition for Operational Research on NTDs (COR-NTD) is the most obvious global research community. Historically, they have focused on five priority areas: mapping strategies, diagnostics, programme implementation, stopping MDA and surveillance, and MMDP (DMDI). There have been key challenges in their approach including a lack of equity in meetings. Additionally, there has been a strong focus on the five NTDs amenable to preventive chemotherapy rather than cross-cutting methods, which is ultimately to the detriment of these programmes as well as the non-MDA amenable NTDs.
2. The NGO Network on NTDs (NNN) is a network of over 90 nongovernmental organizations with a particular focus on ensuring programme implementers and affected persons are represented. The power of this network has been in two areas: in cross-cutting groups and in including the voices of affected persons. We need to commit to more meaningful involvement of such people at these meetings.
3. At national level (example provided from Ethiopia), they have technical working groups that typically cover two NTDs who frequently identify operational research gaps. They feed these gaps to the research advisory committee. Approaches such as these make life easy for researchers and make sure that operational research is driven by country priorities.

In conclusion, she highlighted that global structures exist to identify operational research priorities, but these require further development and expansion. Some countries have processes to identify gaps in operational research. In addition, feasibility of identification of operational research needs for a country to develop a skin NTD strategy has been demonstrated. All relevant stakeholders should be able to attend discussions of operational research priorities and there is need to think about a forum in which these needs can be thoroughly discussed.

Professor Delphin Phanzu Mavinga (AIM NTDs Central Kongo) gave a talk on his experience with holistic management of skin NTDs through church networks in Songololo territory. The project focused on the holistic management of skin NTDs through church networks with an aim to reduce morbidity and psychosocial impact of NTDs. Specifically, the objectives were: (i) to empower local networks and faith leaders to provide support and care to those impacted by NTDs; and (ii) to give people the means to identify cases, direct them to health services, share practices of self-care, and provide ongoing spiritual and emotional support. It was a mixed-method study with mapping and identification of churches to train key actors including ministers, pastors and two secular leaders per institution. Some 160 churches were involved in the project and 506 people were trained: 480 from the network churches and 26 health professionals who were trained on self-care.

The project has reached 25 702 people in churches and 28 746 in villages. Of those reached, 441 people had NTDs (87% came to the health centre), of which 243 were suspected cases of Buruli ulcer (10% confirmed), 148 suspected cases of yaws (2% confirmed) and 17 cases of leprosy (35% confirmed). He emphasized that the approach was successful in allowing local church networks to mobilize communities and direct people to the health care system. The intervention improved access to health care and reduced isolation of those affected who were experiencing major stigma. A multidisciplinary approach is efficient and works towards achieving an integrated approach to control and management of skin NTDs.

Dr Juliana Amanyi-Enegela (Christian Blind Mission) presented on barriers associated with accessing lymphatic filariasis MMDP in Jigawa State, Nigeria. This was an exploratory study, including a cross-sectional survey (155 patients), six in-depth interviews, six key informant interviews and eight focus group discussions. Mapping to assess the availability of facilities in the research area, their functionality, capacity and the services available for MMDP was done as well. The main barriers to accessing care were found to be financial constraints, lack of awareness, illiteracy and stigmatization. Social cultural factors may also play a role. The study findings show that there is a need for retraining of facility staff on identifying hydrocele, provision of resources for essential care and clearer criteria on the best way to refer patients to the secondary level including necessary training.

Dr Laura Dean (Liverpool School of Tropical Medicine) presented on a multi-disciplinary participatory action research study, designed to develop a person-centred health systems response to skin NTDs in Liberia. The study had three interlinked intervention pathways which were developed by actors at all levels of the health system in Liberia using participatory research methods. The intervention pathways were as follows: case detection and referral (including laboratory systems strengthening); human resource management; and mental health and stigma reduction. She noted that system approaches are needed to truly address the complex problem of skin NTDs. Cross-departmental and cross-sectoral collaboration are essential to promote innovation and mainstreaming. Participatory health research methodologies and planning approaches support equitable community engagement and ownership of programmes on the road to integration and mainstreaming. Affected persons and other often unheard voices (e.g. traditional healers) have the opportunity for meaningful and equal participation within service design and delivery: they may unlock solutions to ongoing challenges. Accessible and adaptable tools and resources (with clear training guidance) are necessary to support the expansion of skin NTD interventions. These must move beyond clinical confirmation to also include mental health, stigma reduction and supportive human resource management processes.

Dr Anne Schoenmakers (NLR International) presented on an ongoing implementation trial on community-based integrated skin screening and leprosy prevention in Ethiopia, Mozambique and the United Republic of Tanzania. The cluster randomised control trial has two intervention arms: Arm 1, involving skin camps and contact tracing to bring dermatology closer to communities without need to share diagnosis; and Arm 2, involving screening of household contacts at health centres. The trial is looking at the effectiveness and acceptability of such approaches. The study is ongoing and will continue to include new contacts until March 2024. The preliminary data reported that in Ethiopia there were 56 index patients, 26 cutaneous NTDs screened and 3665 traces; and in the United Republic of Tanzania there were 68 index cases, NTD cases 68, contracts 7180, 61 new cases after contacts screened and 3989 other NTDs. During the camps, many other skin diseases were also identified. Importantly, there has been a positive effect on discrimination and stigma because of disease integration. It has also been crucial to ensure that community health workers, volunteers and leaders are involved in these events. In conclusion, she emphasized that skin camps are very important for the community because there is a high burden of dermatological diseases.

Ms Sopna Choudhury (University of Birmingham) presented on sustainability of self-help programmes in the context of leprosy and the work of leprosy missions, highlighting preliminary findings from a study on sustainability of self-help groups from three sites: India, Nepal and Nigeria. Documents and project reports were retrieved and analysed to evaluate if structures were sustained. Groups were found to be sustained if: there local importance was given to the groups and its members continued to acquire new knowledge; a sense of ownership of the group, with strong belief in the value of their meetings, the presence of a champion/facilitator/volunteer/mentor, unifying activity such as a fund, and development of trust through longstanding duration and reputation of organisation in the local community.

Mr Daniel Okyere (Noguchi Memorial Institute for Medical Research) outlined community understandings of the aetiology of Buruli ulcer, leprosy and yaws disease in the Atwima Mponua District in the Ashanti Region of Ghana. A study was designed to gain insight on how affected people understand and experience common skin conditions and how stigma is produced and experienced in Ashanti. This was a qualitative study with affected persons who were identified through health records and in the traditional healer setting. Some 68 in-depth interviews and six focus groups were completed. Ethnography was also conducted in the homes of affected persons. Findings revealed that there were many disease etiologies described by affected persons, including chemicals in the environment, organisms in the environment, chemicals in skin creams and supernatural causation. Socio-cultural beliefs were found to shape health-seeking behaviour. Local understandings of the disease etiology promote stigma. In conclusion, he noted that misconceptions and divergent views on the causes and modes of transmission of skin NTDs among the study population influence their care-seeking behaviour. Awareness is needed on the causes and modes of transmission in preventing skin conditions in the Atwima Mponua.

Professor Eduard Zijlstra (Rotterdam Center for Tropical Medicine) contributed to NTD pharmaco-economics by discussing the costs of mycetoma drug development. A fatal imbalance of new drug development for NTDs still persists yet they represent 12% of the global disease burden. Only about 4% of the new drugs registered are for NTDs (Pedrique et al., 2013). Currently used drugs for eumycetoma are ineffective, with the treatment rate for mycetoma > 90% for actinomycetoma and < 40% for eumycetoma. Ketoconazole was banned due to liver and adrenal toxicity whereas itraconazole, which is the only choice for treatment in low and lower-middle-income countries, has shown cure rate of < 40% in Sudan. The first ever double-blind randomized control trial with fosravuvonazole was done with DND*i* and other partners including Eisai at the Mycetoma Research Center in Sudan. Fosravuconazole, a broad-spectrum antifungal agent, has a long half-life. It was initially used for treatment of Chagas disease and is registered in Japan for onychomycosis. The trial conducted in 2017 validated the efficacy of fosravuconazole as a potential new, safe and affordable treatment for patients with eumycetoma. The next steps include registering the drug in Sudan. The adjusted direct cost was € 38 222 per patient, giving an overall total of € 7 million for the project. The cost drivers included a highly complex study, with low patient prevalence, strict inclusion criteria, patients also in hard-to-reach areas, COVID-19 and political unrest. Access costs were not included. A pharmo-economic study would be welcomed to put costs in perspective and consider the impacts of not having a drug.

Dr Jacob Novignon (Kumasi Centre for Collaborative Research in Tropical Medicine) presented on the economic burden on households of skin NTDs in Ethiopia and Ghana. The study was a multi-disciplinary formative research work to understand the economic burden of skin NTDs on patients and their households in Ghana and Ethiopia. Costs of seeking care, costs of experiencing the disease before even seeking care and strategies to cope with the economic burden were explored. The findings revealed that there are costs of care-seeking to the patient, to other household members and from traditional healers. Transportation and wound dressing costs were found

to be the main costs to the patient. In Ethiopia (but not observed in Ghana), other cost drivers include accommodation, food, laboratory tests and imaging (electrocardiogram). The cost of care seeking to the patient leads to delayed diagnosis, non-adherence to treatment, delayed treatment and poor wound dressing. These may vary based on disease condition and the treatment that is required. The costs of seeking care that are experienced by the household include direct costs (transportation and wound dressing/medicine costs) as well as opportunity costs (missed out on productive activities, e.g. farming and housework). Cost of care-seeking at traditional healers, the main reason why they chose this pathway, is unclear. Some economic reasoning is that traditional healers are closer to the patient and so transportation costs are reduced. The second is that traditional healers have more flexible payment arrangements (e.g. allowing people to wait until harvest). Payment that remains is flexible. Coping strategies were formal, informal and use of household resources. Examples include: (i) formal insurance (i.e. national health insurance in Ghana and community-based health insurance in Ethiopia); (ii) informal contributions and lending of money; and (iii) sale of household assets. Dr Novignon emphasized the need for interventions to reduce the economic burden of health seeking (travel and fiscal barriers to seeking care) as well as addressing non-fiscal barriers.

Session 10. Conclusions and recommendations

The tenth session was chaired by Professor Roderick Hay (King's College London).

The conclusions and recommendations of the meeting from WHO regions and the Global Leprosy Programme, lessons learnt and requests to the Director-General are provided below.

WHO regions

The **WHO African Region** will advocate for endemic countries to strengthen coordination and programme ownership, integrate NTDs at institutional and primary health-care levels and with OneHealth platforms, and ensure domestic funding with dedicated budget lines for NTDs. It also plans to strengthen national health systems to improve the skills of care providers in clinical and biological diagnosis, case management of NTDs, supervision of providers in the implementation of field activities, integrated disease surveillance including post-elimination surveillance, monitoring and evaluation of NTD programmes, and implementation research. Last but not least, the Region will support resource mobilization for all NTDs through expansion of the partnership for NTDs and creation of a special funding mechanism to support implementation of the road map, and contribute to the achievement of Sustainable Development Goal 3 and poverty reduction.

The **WHO Region of the Americas** is committed to adopting, adapting and implementing the skin NTD framework within the context of the *PAHO Disease Elimination Initiative: a policy for an integrated sustainable approach to communicable diseases in the Americas* (WHO, 2019) which aims to eliminate about 30 communicable diseases and related conditions by 2030. Funding will be required for implementation. The regional burden and risk factors for some of the skin NTDs, such as ectoparasitic and fungal diseases, are unknown. Mapping and assessing the disease burden need to be done to know their distribution and identify associated risk factors. A regional strategy for their prevention and control can then be developed. Funding will be needed for both the mapping and the implementation of the strategy at regional and country levels. COVID-19 had important consequences on all public health programmes, including the NTD and national leprosy programmes in the Americas. For example, the leprosy case detection rate dropped by 36% in 2020 as compared with 2019 and only a marginal increase occurred in 2021. It is imperative to design strategies to restore NTD control programmes to their full capacity in order to catch up and close the existing gap of undiagnosed leprosy patients.

In the **WHO South-East Asia Region**, 12 NTDs are present, with at least one NTD endemic in each of the 11 countries of the Region. Dr Poonam Khetrapal Singh explained that the region is keen on eliminating NTDs on the verge of elimination. The flagship priority NTDs for elimination in 2014 were lymphatic filariasis, kala-azar, yaws and leprosy. Since then, the Region has eliminated at least one NTD from six countries (yaws from India; lymphatic filariasis from the Maldives, Sri Lanka and Thailand; and trachoma from Nepal and Myanmar) in 11 Member States. Currently, a dossier to claim achievement of elimination of lymphatic filariasis as a public health problem in Bangladesh is being validated by WHO. Bangladesh is also preparing a dossier for validation of elimination of kala-azar as a public health problem. India is completing the pre-validation survey for validation

of elimination of trachoma as a public health problem. Timor-Leste is planning to conduct a final transmission assessment survey to assess whether the country is eligible for validation of elimination of lymphatic filariasis as a public health problem in 2023.

The **WHO Eastern Mediterranean Region** is working to ensure political commitment for eradication of dracunculiasis (Guinea-worm disease) from Sudan and yaws from Somalia. In addition, it plans to eliminate at least one NTD from each Member State in the Region by 2030. Financial resources are being mobilized to deliver WHO technical guidance at country level by provision of staff, and to support critical interventions to control NTDs amenable to intensified management in high-burden countries. Finally, the Region is advocating to ensure a global supply of diagnostics and medicines for case management (for example for leishmaniasis and mycetoma) and promote the development of point-of-care diagnostics and new medicines.

The meeting heard that for the **WHO Western Pacific Region** to achieve success in fighting NTDs, ending the neglect should start from within WHO; that is, with commitment from the WHO Director-General and the WHO country offices. Secondly, most countries in the Region mention funds as a key requirement for overcoming NTDs, tapping into global and regional funding opportunities is something that can be pursued. There is potential to eliminate NTDs in the Region, as evidenced by the successful elimination of lymphatic filariasis from 11 of the 22 endemic countries.

Global Leprosy Programme

Integrated skin NTD programmes have demonstrated opportunities for augmented case detection, strengthened surveillance, reduced stigma and renewed partnerships. It is therefore an opportune time to call for:

- country commitment and ownership exemplified through renewed focus, policy recommendations and increased domestic funding for diseases targeted for elimination
- strengthened research as gaps exist in knowledge and availability of tools for disease conditions targeted for elimination and
- advocacy with national programmes to strengthen preventive initiatives to accelerate progress towards reaching the road map targets by 2030.

Lessons learnt from the meeting and requests to the WHO Director-General

Professor Hay summarized the lessons learnt from the meeting. Skin NTDs affect the poorest of the poor and have a common feature: visible skin presentations. The skin is a clear strategy for delivering the road map as it is something visible. To succeed, our approaches must be owned and led by countries. At the heart of the effort has to be the patient. The meeting was privileged to hear from patients and their representatives, but we need to continue to recognize the impact of skin NTDs on mental health and stigma. Skin NTDs interface with other WHO initiatives, for example, chronic diseases: many of the skin NTD approaches would also be applicable to diabetic ulcer or lymphoedema as a result of cancer, the burden of health of displaced and marginalized populations:the people in these locations are also impacted by skin NTDs and environmental threats: interface with issues on the skin for example, solar radiation and albinism and life-threatening skin cancer.

NTDs face many challenges, and there is a critical need for support to address operational and research needs identified at this meeting:

- Laboratory diagnostics: 3% of resources allocated to health go into this area, but there is wastage due to misdiagnosis, strengthening laboratory diagnostics will address this.
- Antimicrobial resistance: new drugs are needed. For example for mycetoma, the huge shortages in drugs globally should be addressed and the interface of NTDs with antimicrobial resistance considered like in the case for tungiasis and the pandemic of drug-resistant ringworm coming from the Indian subcontinent and spreading to other continents.
- Health system strengthening: inspiring examples of health systems adjustments and many wonderful opportunities for training front-line health workers would provide support to address workforce shortages.
- Costings and economics: We need ammunition to make our case. There is too little information on the impact of NTDs on the macro-economics of nations, but also on the micro-economics of family budgets, for instance people defaulting from treatment because they cannot afford the drug, as in the case for mycetoma or leishmaniasis.

A number of pertinent issues affecting the Global NTD Programme arose from the 5-day deliberations. Finally, Professor Hay outlined the key asks and actions arising from the meeting to WHO.

Enhance advocacy and visibility. Advocacy should be targeted to intentionally support the positioning of NTDs into the global health architecture by specifically including NTDs when talking, writing and communicating about pertinent issues such as universal health coverage, pandemic preparedness, health emergencies and climate change.

Include NTDs into critical global policy documentation. NTDs should be considered when other critical global policies are being developed and discussed, whether around health emergency planning, universal health coverage, One Health or primary health care. Putting patient needs at the centre and training front-line health workers are absolutely critical to better care.

Support the inclusion of NTDs in global health mechanisms. NTDs should be included into the Global Fund and access supported to other sustainable funding for countries.

Invest resources. Given its cross-cutting nature, the Global NTD Programme should be better supported financially at WHO through flexible funding and inclusion in funding mechanisms such as the Global Health Emergency Appeal.

Issues raised during discussions

Key issues raised during discussions are summarized below.

Mobile health – a challenge for hard-to-reach communities:

- The WHO skin NTDs App (version 3) can be used offline (after downloading online once), making it practical for communities with no Internet access.
- The App is freely available on both Android and iOS devices.

Ethical framework for photo collection in the database:

- Concerns about collecting photographs of patients could be addressed by implementing a rigorous ethics and governance framework.
- Legal agreements should be required for individuals or institutions donating photos to ensure proper consent and mitigate any legal issues.
- Photos will show only the lesion; the patient cannot be identified. The photos will be used for machine learning; they will not be used in public.

Training initiatives for dermatologists:

- The training of more dermatologists is needed to address skin NTDs and other skin diseases.
- Mid-level health workers can be trained on basic dermatology to deal with cases and expand services.
- Training should focus on general practitioners, nurses and front-line health workers in dermatology to enhance capacity.

Mycetoma in Côte d'Ivoire:

- Côte d'Ivoire reported some cases of mycetoma, underscoring the need for heightened surveillance.
- Data are available, highlighting the need for research and interventions.

Massage for patients with lymphatic filariasis:

- Lymphatic massage is not currently recommended by WHO as a method of managing lymphoedema due to lymphatic filariasis.
- A new WHO guideline is under development, which may consider massage as a treatment option based on available evidence review.

Data collection for NTD-related disability:

- The meeting highlighted the inadequacy of global data on NTD-related disability beyond incidence and prevalence rates.
- More data are needed to demonstrate the broader social impact of NTDs to policy-makers and funders.

Catastrophic cost that NTDs impose on patients and families:

- An analysis of catastrophic costs for NTDs is needed to understand the financial burden on patients and families.

Employing digital therapeutics for psychosocial interventions:

- Using of digital means for counselling in dermatology and skin care should be further explored.
- Successful pilot projects implemented during COVID-19 have demonstrated the feasibility of employing digital applications.

Impact of patient organizations in reducing stigma:

- The meeting addressed the potential risk of organizing people affected by skin NTDs into associations and thereby increasing stigma.
- The role of patient organizations is essential in dispelling stigma through education and information.

Challenges in mycetoma control:

- Control of mycetoma faces challenges including gaps in disease mapping and lack of knowledge about the infection process.
- Ongoing research supported by DND*i* aims to improve mycetoma treatment outcomes.

Improving mycetoma diagnosis:

- The meeting highlighted the importance of distinguishing between mycetoma caused by fungi and by actinobacteria to target effective treatment.
- Ongoing research aims to improve diagnosis, including the development of point-of-care diagnostic tests.

Buruli ulcer transmission dynamics and vector species:

- The potential role of vector species in transmitting Buruli ulcer is being explored, including the role of mosquitoes.
- Possums have been identified as primary reservoirs responsible for shedding bacteria into the environment in Australia.
- The challenge model for Buruli ulcer has ethical implications, and ethics specialists should be involved to ensure awareness of participants.
- Possum excreta has been identified as a useful sample for identifying human cases.
- Patients with multiple consecutive lesions have been observed in Australia, requiring further investigation. Lessons from research on Buruli ulcer in Australia are informing ongoing research in Ghana and Côte d'Ivoire.
- The prevalence of Buruli ulcer in Australia differs from that of other countries, hypothesizing that possum infection could be a driving factor.
- The meeting explored the potential impact of climate change on transmission of Buruli ulcer and identified flies as potential vectors.
- It was acknowledged that while Buruli ulcer affects Aboriginal individuals, infection rates are not significantly different from those in other populations.

Funding for NTD diagnostics:

- Funding for NTD diagnostics is low and targeted advocacy is needed to improve funding outcomes.

Inclusion of other laboratories in Africa in EQA and integrating public and private laboratories in BU-LABNET:

- The main aim was to implement a laboratory network in Africa and evaluate implementations of procedures for EQA. The network interest is on national reference laboratories with capacity for molecular methods.
- Members of the network can support other laboratories within their countries if needed.

Genomics in mycetoma research and molecular targets:

- Applied genomics in mycetoma research are showing promising results.
- The whole-genome approach is valuable for identifying novel targets in diagnosing mycetoma. Efforts are ongoing to develop a diagnostic kit to address drug resistance in mycetoma.

Involvement of community health workers in collecting mycetoma samples:

- Currently, community health workers are not involved in collecting mycetoma samples. So far the samples are collected by the Mycetoma Research Center staff (mainly the surgeons and technicians).

Cutaneous leishmaniasis and intravenous treatment:

- The challenges of intravenous treatment for cutaneous leishmaniasis include limited numbers of staff to administer the treatment and high numbers of patients.
- The reasons why small lesions are not responding to treatment are unknown, and further research is therefore needed.
- Use of the wound care kit should be restricted to nurses and community health workers.
- The kit is intended for trained individuals who are familiar with managing complex wounds; community health workers can be trained.

Recurrence of tungiasis in villages after treatment:

- Additional measures are required in response to tungiasis recurring after treatment.
- NYDA is a potential treatment, but availability is limited in endemic areas.
- The effect of antibiotic combinations on the intestinal microbiome has not been tested and more research is needed.

Collaboration with traditional and faith healers:

- Traditional healers are enthusiastic about collaboration; challenges include building trusting relationships and overcoming obstacles in the formal health system.
- Church workers could be trained to explain leprosy to patients and address stigma, with messaging focused on love and understanding and developing relationships to reduce stigma associated with leprosy.

Implementation research and costing:

- Implementation research and costing should be linked in the context of interventions.
- Costs associated with interventions should be documented and reported for advocacy and sustainability purposes.

Sustainable initiatives for community faith integration:

- Alternative approaches should be explored to ensure sustainability of community faith integration initiatives.
- A qualitative study is under way to assess the effectiveness and potential sustainability of religious and classic scenarios in community health integration.

Closing remarks by the Director-General

In his closing remarks, the WHO Director-General Dr Tedros Adhanom Ghebreyesus committed to ensuring that NTDs are better supported by WHO in terms of resources, policy and advocacy.

"*Count me in as one of you: NTDs are where I started. I will follow up on your asks. I don't want the conversations you had this week to be in vain,"* he stated. He fully agreed with all the conclusions, recommendations and requests made by Professor Hay, notably on country ownership, advocacy for financing, inclusion of NTDs into critical global policy documentation, global fund, patient-centred and integrated approaches and WHO flexible funding. "*What I really appreciated is the country leadership and ownership. It is crucial. Unless countries prioritize NTDs, it will be very difficult to get results. Any country can also contribute its share, can put its share on the table, based on what it can afford, however small it doesn't matter: it shows commitment and that is the start of any successful programme*," he stressed. Dr Tedros welcomed the patient-centred approach and that patients are involved. From experience he emphasized that guidelines prepared with the support of patients are very practical and he encouraged the same for NTDs. On advocacy for resources, he acknowledged the fact that most countries affected by NTDs are very low-income countries. Mobilizing resources to support them is crucial as most of the things required from diagnosis, treatment and rehabilitation are costly and cannot be covered fully by the countries. On the Global Fund, he said he would be happy to advocate for the inclusion of NTDs since they affect the poorest countries, adding that this would ensure some sustainability in financing.

Regarding support to NTDs from flexible funding from WHO, he explained that the Global NTD Programme is affected like other WHO programmes. There has been a systemic problem in the financing of WHO. However, there is change, and Member States have agreed to increase funding. It will take time as it is set to happen over 7 years, but WHO/NTD will get its share when this happens. He stressed that the time to act is now. Finally, he acknowledged the work of the late Dr Mwelecele Ntuli Malecela as Director of the NTD programme and the leadership that Dr Ibrahima Socé Fall continues to provide in this capacity going forward.

Way forward and next meeting

Skin NTDs make up half of all NTDs: they must be addressed if the road map targets are to be achieved. Integrating efforts can maximize benefits towards this endeavour. Participants highlighted the need to raise the visibility of skin NTDs within the broader context of NTDs, primary health care and universal health coverage. To meet the road map targets, NTDs must be prioritized and funded locally and globally; they must be integrated across sectors for stronger, more consistent and sustainable programmatic support and funding.

The meeting discussed the importance of digital technologies including online courses, AI to aid diagnosis; surveillance and mapping of co-endemicity to guide integrated interventions; integrated management of disability, rehabilitation, stigma, mental health and inclusion; and knowledge and gaps in understanding the mode of transmission of diseases such as Buruli ulcer. Newer diagnostic tests are needed for most of these NTDs and WHO has published target product profiles to guide their development. On treatment, better and shorter regimens for diseases such as Buruli ulcer, cutaneous leishmaniasis, mycetoma and tungiasis are needed. Other challenges include access to ivermectin for scabies, which is one of the most common skin NTDs.

The second WHO global meeting on skin NTDs is scheduled for March 2025 in Geneva, Switzerland, which gives 2 years to advance work. Participants were encouraged to continue collaboration with each other and with WHO to keep the momentum going towards 2030.

References

Bailey et al. (2017). A new perspective on cutaneous leishmaniasis—Implications for global prevalence and burden of disease estimates. PLoS Negl Trop Dis;11(8):e0005739 (doi:10.1371/JOURNAL.PNTD.0005739).

Elson et al. (2023). National prevalence and risk factors for tungiasis in Kenya. Infect Dis Poverty;12(1):1–12 (doi:10.1186/s40249-023-01131).

Hardy et al. (2020). The safety of combined triple drug therapy with ivermectin, diethylcarbamazine and albendazole in the neglected tropical diseases co-endemic setting of Fiji: a cluster randomised trial. PLoS Negl Trop Dis;14(3):e0008106 (doi:10.1371/JOURNAL.PNTD.0008106).

Hardy et al. (2021a). Community control strategies for scabies: a cluster randomised noninferiority trial. PLoS Med;18(11):e1003849 (doi:10.1371/JOURNAL.PMED.1003849).

Hardy et al. (2021b). Individual efficacy and community impact of ivermectin, diethylcarbamazine, and albendazole mass drug administration for lymphatic filariasis control in Fiji: a cluster randomized trial. Clin Infect Dis;73(6):994–1002 (doi:org/10.1093/CID/CIAB202).

Harley et al. (2002). The effect of time to definitive treatment on the rate of nonunion and infection in open fractures. J Orthop Trauma. 6(7):484–90 (doi:10.1097/00005131-200208000-00006).

IHME (2019). Global Burden of Disease (GBD) study. In: Institute for Health Metrics and Evaluation [website]. University of Washington; 2019 (https://www.healthdata.org/research-analysis/gbd).

Johnson et al. (2007). *Mycobacterium ulcerans* in mosquitoes captured during outbreak of Buruli ulcer, southeastern Australia. Emerg Infect Dis;13(11):1653–1660 (doi:10.3201/EID1311.061369).

Loftus et al. (2018). A severe case of *Mycobacterium ulcerans* (Buruli ulcer) osteomyelitis requiring a below-knee amputation. Med J Aust;208(7):290–291 (doi:10.5694/MJA17.01158).

McNeilly et al. (2024). Management of very severe tungiasis cases through repeated community-based treatment with dimeticone oil formula: a longitudinal study in a hyperendemic region in Uganda. Trop Med Int Health;1–6 (doi:10.1111/tmi.13974).

Merritt et al. (2010). Ecology and transmission of Buruli ulcer disease: a systematic review. PLoS Negl Trop Dis;4(12):e911 (doi:10.1371/JOURNAL.PNTD.0000911).

Mosam and Todd. (2021). Dermatology training in Africa: successes and challenges. Dermatol Clin;39(1):57–71 (doi:10.1016/J.DET.2020.08.006).

Nanjan et al. (2021). Revised estimates of leprosy disability weights for assessing the global burden of disease: a systematic review and individual patient data meta-analysis. PLoS Negl Trop Dis;15(3):e0009209 (doi:10.1371/JOURNAL.PNTD.0009209).

Nyangacha RM et al. (2017). Secondary bacterial infections and antibiotic resistance among tungiasis patients in Western, Kenya. PLoS Negl Trop Dis;11(9):e0005901.

Pedrique B et al. (2013). The drug and vaccine landscape for neglected diseases (2000–11): a systematic assessment. Lancet Glob Health;1(6):371–9 (doi:10.1016/S2214-109X(13)70078-0).

Romani et al. (2015). Mass drug administration for scabies control in a population with endemic disease. N Engl J Med. 373(24):2305-13 (doi:10.1056/NEJMoa1500987).

Thean et al. (2022). Prevention of bacterial complications of scabies using mass drug administration: A population-based, before-after trial in Fiji, 2018–2020. Lancet Reg Health West Pac;22:100433 (doi:10.1016/J.LANWPC.2022.100433).

Thielecke et al. (2014). Treatment of tungiasis with dimeticone: a proof-of-principle study in rural Kenya. PLoS Negl Trop Dis;8(7):e3058.

Ton et al. (2015). The burden of mental health in lymphatic filariasis. Infect Dis Poverty;4(1):1–8 (doi:10.1186/S40249-015-0068-7/TABLES/4).

Trubiano et al. (2013). The incubation period of Buruli ulcer (*Mycobacterium ulcerans* infection). PLoS Negl Trop Dis;7(10):e2463 (doi:10.1371/JOURNAL.PNTD.0002463).

Wallace et al. (2017). *Mycobacterium ulcerans* low infectious dose and mechanical transmission support insect bites and puncturing injuries in the spread of Buruli ulcer. PLoS Negl Trop Dis;11(4):e0005553 (doi:10.1371/JOURNAL.PNTD.0005553).

WHO. (2001). International classification of functioning, disability and health: ICF. Geneva: World Health Organization (https://iris.who.int/handle/10665/42407).

WHO. (2018). Recognizing neglected tropical diseases through changes on the skin: a training guide for front-line health workers. Geneva: World Health Organization (https://iris.who.int/handle/10665/272723).

WHO. (2019). PAHO Disease Elimination Initiative. A policy for an integrated sustainable approach to communicable diseases in the Americas. Washington (DC): Pan American Health Organization/World Health Organization Regional Office for the Americas (2019-cde-dc57-elimin-init-framework-en.pdf (paho.org)).

WHO. (2020a). Ending the neglect to attain the Sustainable Development Goals: a road map for neglected tropical diseases 2021–2030. Geneva: World Health Organization (https://iris.who.int/handle/10665/338565).

WHO. (2020b). Neglected tropical diseases of the skin: WHO launches mobile application to facilitate diagnosis. In: WHO/Control of Neglected Tropical Diseases [website]. Geneva: World Health Organization (https://www.who.int/news/item/16-07-2020-neglected-tropical-diseases-of-the-skin-who-launches-mobile-application-to-facilitate-diagnosis).

WHO. (2021a). Towards zero leprosy: global leprosy (Hansen's disease) strategy 2021–2030. Geneva: World Health Organization (https://iris.who.int/handle/10665/340774).

WHO. (2021b). Ending the neglect to attain the sustainable development goals: a framework for monitoring and evaluating progress of the road map for neglected tropical diseases 2021–2030. Geneva: World Health Organization (https://iris.who.int/handle/10665/341313).

WHO. (2021c). The selection and use of essential in vitro diagnostics: report of the third meeting of the WHO Strategic Advisory Group of Experts on In Vitro Diagnostics, 2020 (including the third WHO model list of essential in vitro diagnostics). Geneva: World Health Organization (https://iris.who.int/handle/10665/339064).

WHO. (2022). Ending the neglect to attain the sustainable development goals: a strategic framework for integrated control and management of skin-related neglected tropical diseases. Geneva: World Health Organization (https://iris.who.int/handle/10665/355448).

WHO. (2023a). Book of abstracts. In: WHO/First global meeting on skin NTDs [website]. Geneva: World Health Organization; 2023 (https://www.who.int/publications/m/item/first-who-global-meeting-on-skin-ntds-page--book-of-abstracts).

WHO. (2023b). Webinar recording. In: Global meeting on skin-related neglected tropical diseases (skin NTDs) [website]. Geneva: World Health Organization (https://www.who.int/news-room/events/detail/2023/03/27/default-calendar/global-meeting-on-skin-related-neglected-tropical-diseases-skin-ntds).

WHO. (2023c). Results of the 2022 global WHO online survey on diagnostic capacities and treatment practices for implantation (deep) mycoses. Geneva: World Health Organization (https://iris.who.int/handle/10665/367342).

Yerramilli et al. (2017). The location of Australian Buruli ulcer lesions—Implications for unravelling disease transmission. PLoS Negl Trop Dis;11(8):e0005800 (doi:10.1371/JOURNAL.PNTD.0005800).

Yotsu et al. (2022). The early detection and case management of skin diseases with an mHealth App (eSkinHealth): protocol for a mixed methods pilot study in Côte d'Ivoire. JMIR Res Protoc;11(9):e39867 (doi:10.2196/39867).

Annex 1. Agenda

Monday, 27 March 2023

Time	Subject	Presenters
Session 1: Introductory presentations Chair: Claire Fuller		
09:00–09:20	Welcome remarks	Daniel Argaw Dagne Unit Head, PTC
	WHO Global NTD Programme	Ibrahima Socé Fall Director, NTD
09:20–09:35	**Keynote presentation:** Skin NTDs and skin diseases: a global view	Roderick Hay
09:35–09:50	Skin NTD Framework: an overview	Rie Yotsu
09:50–10:05	Global Leprosy Strategy 2021–2030 and its alignment with the Skin NTD Framework	Vivek Lal
10:05–10:20	Changing epidemiology of Buruli ulcer in Victoria, Australia 2019–2022	Deborah Friedman
10:20–10:40	**Discussions**	**All**
10:40–10:55	Very severe tungiasis in Amerindians is common and is due to the entanglement in a web of behavioural and environmental factors	Hermann Feldmeier
10:55–11:10	Monitoring of the NTD road map 2021–2030: information system, surveillance and reporting	Pamela Mbabazi
11:10–11:25	Evaluation of integration of NTD activities – lessons learnt from field observation	Xiaoxian Huang
11:25–11:40	International Alliance for Global Health Dermatology (GLODERM): a platform for international collaboration on skin NTDs	Esther Freeman
11:40–12:00	**Discussions**	**All**
12:00–12:15	**Group photograph**	**All**

Time	Subject	Presenters
Session 2: Integration at country level Chair: Rie Yotsu		
14:00–14:20	Keynote presentation: Skin NTDs integrated approach: practical experience, 2017–2022	Iñigo Lasa
14:20–14:35	Integration of lymphatic filariasis and scabies mass drug administration in Fiji	Andrew Steer Sarah Andersson
14:35–14:50	Yaws eradication in three countries of the Congo Basin: lessons learnt from the first rounds of mass drug administration with azithromycin	Alphonse Um Boock
14:50–15:05	Tropical/infectious dermatology in the State of Amazonas, Brazil	Silmara Pennini
15:05–15:20	Integrated transmission assessment survey for lymphatic filariasis, yaws and scabies in Timor-Leste, 2020–2021	Josefina João
15:20–15:40	**Discussions**	**All**
15:40–15:55	A multi-method evaluation of health services integration for NTDs requiring case management in Liberia	Karsor Kollie
15:55–16:10	Integrating a holistic care package for podoconiosis, lymphatic filariasis and leprosy into routine health services in Ethiopia: the EnDPoINT project	Oumer Ali Asrat Mengiste
16:10–16:25	Integrated NTD control in Vanuatu	Macklyne Katenga Fasihah Taleo
16:25–16:40	Integrated management and control of skin-related NTDs in Ghana in 2022	Benedict Quao
16:40–17:00	**Discussions**	**All**
17:00–18:00	**Side meeting: GlobalSkin's vision, mission, programs, network of 200+ patient organizations. Discussion: How to connect to and collaborate with the global dermatology patient community**	**All**

Tuesday, 28 March 2023

Time	Subject	Presenters
Session 3: Training tools Chair: Esther Freeman		
09:00–09:20	**Keynote presentation:** Capacity building and tools for district health workers and community agents	Claire Fuller
09:20–09:35	Learning "on-the-job" for integrated skin NTD screening and care in Ethiopia: optimizing resources by crossing boundaries of formal and informal education: preliminary results	Kitesa Debelo Bizuayehu Belete
09:35–09:50	Assessing the quality of the WHO SkinNTDs App as a training tool in Ghana and Kenya: results from a cross-sectional study	Mireia Cano
09:50–10:05	Use of an mHealth App (eSkinHealth) for early detection and case management of skin diseases: a mixed methods pilot study in Côte d'Ivoire	Rie Yotsu
10:05–10:20	WHO skin NTDs tools for capacity-building on case management and surveillance: online courses, mobile App and DHIS2	José Postigo
10:20–10:40	**Discussions**	**All**
10:40–10:55	Training tools for integrated management of wounds and lymphoedema for skin NTDs	Michele Murdoch
10:55–11:10	A hybrid approach of machine learning and clinical decision support for improved diagnosis of neglected tropical diseases	Wendemagegn Enbiale
11:10–11:25	InfoNTD.org: Capacity strengthening for researchers and other health professionals through an online portal	Roos Geutjes
11:25–11:40	Enhancing leprosy expertise: a new leprosy competencies framework	Bahadir Celiktemur
11:40–12:00	**Discussions**	**All**
Session 4: Integrated surveillance and mapping Chair: Ghislain Sopoh		
14:00–14:20	Keynote presentation: Importance of surveillance and mapping: current knowledge/experience and gaps	Michael Marks
14:20–14:35	A survey of yaws endemicity among the 47 countries in the WHO African Region in 2022: results	Yves Barogui
14:35–14:50	Prevalence of skin NTDs and superficial fungal infections in two peri-urban schools and one rural community setting in Togo	Michael Head

Time	Subject	Presenters
14:50–15:05	National prevalence and risk factors for tungiasis among school-going children in Kenya: results from a multicounty cross-sectional survey	Lynne Elson
15:05–15:20	Surveillance and treatment of tungiasis, podoconiosis and scabies in Northeast Uganda	Marlene Thielecke
15:20–15:40	**Discussions**	**All**
15:40–15:55	Yaws evaluation in 24 health districts in Côte d'Ivoire	Aboa Paul Koffi
15:55–16:10	Integrated mapping methods for skin NTDs: experience in Malawi	Cristina Galvan Casas
16:10–16:25	Mapping the burden of skin disease: scabies prevalence in a remote Aboriginal community in the Northern Territory in Australia conducted alongside a mass-drug administration treatment programme	Victoria Cox
16:25–16:40	The development of an integrated community-based surveillance system for skin NTDs in Cameroon	Earnest Tabah
16:40–17:00	**Discussions**	**All**
17:00–18:00	**Side meetings**	

Wednesday, 29 March 2023

Time	Subject	Presenters
Session 5: Disability, rehabilitation, stigma, mental health and inclusion Chair: Roch Christian Johnson		
09:00–09:20	**Keynote presentation:** The psychosocial and economic impact of skin NTD-related disability and stigma – how can rehabilitation help	Wim van Brakel
09:20–09:35	Patient organizations as partners in optimal health care	Jennifer Austin
09:35–09:50	Depression and quality of life amongst persons affected by filarial lymphoedema: determining socio-demographic and clinical risk factors, and the impact of an enhanced self-care treatment	Carrie Barrett
09:50–10:05	Informal health provider roles in addressing stigma and mental health needs among people affected by skin NTDs in Liberia	Hannah Berrian
10:05–10:20	Impact of a social intervention on podoconiosis-related stigma in Northwestern Ethiopia	Kibur Engdawork
10:20–10:40	**Discussions**	**All**

Time	Subject	Presenters
10:40–10:55	Impact of tungiasis on neurocognitive functioning, school attendance and achievement	Berrick Otieno
10:55–11:10	Stigma and mental well-being and social participation among men and women with disability due to leprosy and lymphatic filariasis in North India	Wim van Brakel
11:10–11:25	The role of a community conversation intervention in reducing stigma related to lower limb lymphoedema in northern Ethiopia	Abebayehu Tora Maya Semrau
11:25–11:40	Mycetoma disabilities and stigma: innovative thinking out-of-the-box solutions	Ahmed Fahal
11:40–12:00	**Discussions**	**All**
Session 6: Transmission Chair: Lydia Mosi		
14:00–14:20	**Keynote presentation:** Understanding transmission of Buruli ulcer in Australia: progress and challenges	Tim Stinear
14:20–14:35	Transmission status of neglected tropical diseases with skin manifestations in Sri Lanka	Dilini Muthukumari Wijesekara
14:35–14:50	Establishing a controlled human infection model of Buruli ulcer	Stephen Muhi
14:50–15:05	Peak transmission of Ross River/Barmah Forest virus infections and Buruli ulcer in temperate Victoria are aligned and strongly influenced by season	Paul Johnson
15:05–15:20	Evolutionary ecology literacy is important for improving the understanding and management of mycobacterial skin diseases	Jean-François Guégan
15:20–15:40	**Discussions**	**All**
15:40–15:55	Detection of *Mycobacterium ulcerans* among *Aedes albopictus* (Skuse 1894) emerged from *M. ulcerans* contaminated water	Heather Jordan
15:55–16:10	Genomic approaches to predict the origins of Buruli ulcer cases	Andrew Buultjens
16:10–16:25	Environmental risk factors associated with the presence of *Mycobacterium ulcerans* in Victoria, Australia	Bridgette McNamara
16:25–16:40	BCG vaccination of possums against *Mycobacterium ulcerans*	Daniel O'Brien
16:40–17:00	**Discussions**	**All**
17:00–18:00	**Side meetings**	

Thursday, 30 March 2023

Time	Subject	Presenters
Session 7: Diagnostics and laboratory capacity strengthening Chair: Tim Stinear		
09:00–09:20	**Keynote presentation:** Diagnostics – Review of current diagnostic tests for skin NTDs and laboratory capacity strengthening: opportunities, challenges, and priorities	Isra Cruz
09:20–09:35	Buruli ulcer laboratories network for Africa (BU-LABNET): progress, challenges, and perspectives	Sara Eyangoh
09:35–09:50	Point-of-care and field compatible qPCR based molecular diagnostics for skin neglected tropical diseases	Sundeep Vedithi Michael Frimpong
09:50–10:05	Developing a rapid diagnostic test for Buruli ulcer: challenges and prospects	Dziedzom de Souza
10:05–10:20	Capacity building in yaws reference laboratories in Cameroon, Côte d'Ivoire and Ghana	Serges Tchatchouang
10:20–10:40	**Discussions**	**All**
10:40–10:55	External quality assurance in the fight against neglected tropical diseases: the LAMP4Yaws project	Sascha Knauf
10:55–11:10	Molecular diagnostics for mycetoma	Wendy van de Sande
11:10–11:25	Laboratory support for the control and elimination of skin neglected tropical diseases in Ghana	Abigail Agbanyo
11:25–11:40	SwiftX™ DNA – a versatile tool for extraction of DNA from various skin disease agents	Andy Wende
11:40–12:00	**Discussions**	**All**
Session 8: Treatments Chair: Michele Murdoch		
14:00–14:20	**Keynote presentation:** Drug treatment: Review of current drug treatments for skin NTDs – opportunities, challenges, and priorities	Richard Phillips
14:20–14:35	Results of the 2022 global WHO online survey on diagnostic capacities and treatment practices for implantation (deep) mycoses	Barbara Milani
14:35–14:50	Safety of bedaquiline plus rifampicin for leprosy postexposure prophylaxis - preliminary results	Bouke de Jong
14:50–15:05	Cutaneous leishmaniasis patient characteristics and treatment outcomes, Quetta, Pakistan, 2014-2021	Koert Ritmeijer

Time	Subject	Presenters
15:05–15:20	Basic infrastructure: an essential component of integrated wound management	Bognan Valentin Koné
15:20–15:40	**Discussions**	**All**
15:40–15:55	The WAWLC kit: a way to bring standardized basic dressing material for adapted modern wound care to low-resource settings	Hubert Vuagnat
15:55–16:10	Control of tungiasis through systematic diagnosis and treatment of humans and animals using dimeticone oil in a resource-poor nomadic setting in Uganda	Hermann Feldmeier
16:10–16:25	Secondary bacterial infections and antibiotic resistance among tungiasis patients in western, Kenya	Ruth Nyangacha
16:25–16:40	Beta-lactam containing regimen for the shortening of Buruli ulcer disease therapy (Phase II in Benin): Clinical trial update	Roch Christian Johnson
16:40–17:00	**Discussions**	**All**
17:00–18:00	**Side meeting:** Current and future landscape on Buruli ulcer treatment	**All**

Friday, 31 March 2023

Time	Subject	Presenters
Session 9: Operational research Chair: Ymkje Stienstra		
09:00–09:20	**Keynote presentation:** Operational research for skin NTDs - what are the critical needs?	Gail Davey
09:20–09:35	Experience with holistic management of skin neglected tropical diseases through church networks in Songololo Territory	Delphin Phanzu
09:35–09:50	Barriers associated with accessing lymphatic filariasis Morbidity Management and Disability Prevention (MMDP) Services in Jigawa State, Nigeria	Juliana Amanyi-Enegela
09:50–10:05	An integrated person-centred approach to the identification, referral, diagnosis, and management of skin NTDs: findings from a multi-disciplinary evaluation	Laura Dean
10:05–10:20	Two and a half years of PEP4LEP skin camps: An implementation trial on community based integrated skin screening and leprosy prevention in Ethiopia, Mozambique and Tanzania	Anne Schoenmakers
10:20–10:40	**Discussions**	**All**

Time	Subject	Presenters
10:40–10:55	Sustainability of self-help programmes in the context of leprosy and the work of leprosy missions	Sopna Choudhury
10:55–11:10	Community understandings of the aetiology of leprosy, Buruli ulcer and yaws diseases in the Atwima Mponua District of the Ashanti Region of Ghana	Daniel Okyere
11:10–11:25	Contribution to NTD pharmacoeconomics: Costs of mycetoma drug development	Eduard Zijlstra
11:25–11:40	Understanding the economic burden on households of neglected tropical diseases of the skin: Qualitative findings from Ghana and Ethiopia	Jacob Novignon
11:40–12:00	**Discussions**	**All**
Session 10: Conclusions and recommendations Chair: Roderick Hay		
14:00–14:40	Report of rapporteurs	
14:40–15:00	Conclusions and recommendations	
14:40–15:00	Closing remarks	Ibrahima Socé Fall

Annex 2. List of participants

Algeria

Dr Nazim Khaled Benmehidi, Secrétaire général, Société Algérienne de dermatologie, Alger

Australia

Professor Eugene Athan, Clinical Director, Public Health & Health Service Partnerships, Barwon Health, Geelong, Victoria

Dr Andrew Buultjens, Postdoctoral Scientist, Department of Microbiology and Immunology, Doherty Institute for Infection and Immunity, University of Melbourne, Melbourne, Victoria

Dr Victoria Cox, Menzies School of Health Research, Global and Tropical Health Division, John Matthews Building, Royal Darwin Hospital, Darwin, Northern Territory

Dr Simon Crouch, Adjunct Associate Professor (Practice), Monash Health, Faculty of Medicine, Nursing and Health Science, Monash University, Clayton

Dr N. Deborah Friedman, Associate Professor, Deputy Chief Health Officer, Communicable Diseases, Victorian Department of health, Melbourne, Victoria

Professor Paul Johnson, Director, North Eastern Public Health Unit, Austin Health, Heidelberg, Victoria

Dr Bridgette McNamara, Epidemiologist, Barwon South West Public Health Unit, Barwon Health, Geelong & Centre for Epidemiology and Biostatsitics, Melbourne School of Population and Global Health, University of Melbourne, Parkville

Dr Stephen Muhi, Infectious Diseases Physician and PhD Candidate, University of Melbourne, Melbourne

Professor Daniel O'Brien, Infectious Diseases Specialist, Department of Infectious Diseases, Barwon Health, Geelong

Professor Andrew Steer, Theme Director, Professor, Infection and Immunity, Murdoch Children's Research Institute, Royal Children's Hospital, Melbourne

Professor Timothy Stinear, Laboratory Head, Department of Microbiology and Immunology, Doherty Institute, University of Melbourne, Melbourne

Mr Sachintha Wijegunasekara, PhD Student, Deakin University, Geelong

Dr Arvind Yerramilli, Infectious Diseases Advanced Trainee (Registar), Department of Infectious Diseases, Barwon Health & Department of Infectious Diseases, Royal Melbourne Hospital, University Hospital Geelong, Parkville

Bangladesh

Dr M M Aktaruzzaman, Programme Manager, Lymphatic Filariasis, STH & LD, Communicable Disease Control, Directorate General of Health Services, Ministry of Health & Family Welfare, Dhaka

Belgium

Professor Catherine Bouke de Jong, Head of Mycobacteriology Unit, Biomedical sciences, Institute of Tropical Medicine, Antwerp

Dr Horace Degnonvi, Ecole de Santé Publique, Université Libre de Bruxelles, Bruxelles

Professor Johan van Griensven, Department of Clinical Sciences, Institute of Tropical Medicine, Antwerp

Dr Saskia van Henten, Department of Clinical Sciences, Institute of Tropical Medicine, Antwerp

Benin

Dr Esaï Anagonou, Géographe Environnementaliste et Santé, Cartographe, Centre Interfacultaire de Formation et de Recherche en Environnement pour le Développement Durable (CIFRED), Université d'Abomey-Calavi, Bénin, Cotonou

Dr Perrin Mario Catraye, Médecin en santé publique, Centre de Dépistage et de Traitement de la Lèpre et de l'ulcère de Buruli de Pobè, Abomey-Calavi

Mr Affolabi Albert Fatolou, Programme national de lutte contre l'ulcère de Buruli et la lèpre, Ministère de la Santé publique, Cotonou

Dr Akimath Olagnide Pélagie Habib, Dermatologue-Vénérologue, Centre de dépistage et de traitement de la lèpre et de l'ulcère de Buruli (CDTLUB/ Raoul Follereau), Pobè

Dr André Marie Lotus Hotegni, West African Health Organisation, Cotonou

Dr Jean Gabin Houezo, Coordinateur, Programme national de lutte contre l'ulcère de Buruli et la lèpre, Ministère de la Santé publique, Cotonou

Dr Flora Sylvie Houndjrebo Balle, Sociologue de Santé, Fundación Anesvad, Abomey Calavi

Dr Kodjo Rodrigue Kohoun, Conseiller Technique en Soins de Santé Primaires, Cabinet du Ministre, Ministère de la Santé, Cotonou

Dr Sena Godwin Gerard Kpoton, Médecin Responsable, Centre de dépistage et de traitement de la lèpre et de l'ulcère de Buruli (CDTUB) de Lalo, Porto-Novo

Professor Ghislain Emmanuel Sopoh, Professeur Titulaire, Santé Publique, Institut Régional de Santé Publique de Ouidah, Université d'Abomey-Calavi, Littoral

Mr Yevedo Borel Tossou, CIFRED Université d'Abomey-Calavi, Abomey-Calavi

Brazil

Dr Danilo De Barros, Serviço de Dermatologia, Hospital Santa Casa Curitiba, Curitiba

Dr Jadel Kratz, Head of Discovery & Partnerships LATAM, DNDi, São Paulo

Professor Ciro Martins Gomes, Ministério da Saúde do Brasil/Universidade de Brasília, Brasília

Dr Valderiza Pedrosa, Chefe Departamento de Epidemiologia e Controle de Doenças, Fundação Hospitalar Alfredo da Matta, Manaus

Dr Silmara Pennini, Dermatologista, Departamento de Controle de Doenças e Epidemiologia, Fundação de Dermatologia Tropical e Venereologia Alfredo da Matta, Manaus

Cameroon

Mr Smith Ndarewah Afanji, Senior Regional Programme Officer, OCEAC/FAIRMED NTD Program, Yaoundé

Ms Brigitte Félicité Bana Owona, Secretariat Direction Scientifique, Centre Pasteur du Cameroun (Centre de Coordination du Réseau des laboratoires PCR pour l'ulcère de Buruli – BU-LABNET), Yaoundé

Dr Sara Irène Eyangoh, Directeur Scientifique, Centre Pasteur du Cameroun, Yaoundé

Mr Yannick Willy Kamdem Simo, Unité de Mycobactériologie, Centre Pasteur du Cameroun (BU-LABNET), Yaoundé

Ms Sabine Nathalie Mbia Owona, Ingénieur d'études N^{0}1 au Service des Etudes et de la Cartographie Section des Systèmes d'Information Environnementale, Ministère de l'environnement, de la protection de la nature et du développement durable, Yaoundé

Mr Ferdinand Mou, African Regional Office, FAIRMED, Yaoundé

Dr Georges Barthelemy Nko Ayissi, Sous directeur, Coordinateur National, Coordinateur du Programme des Maladies Tropicales Négligées, Ministère de la Santé publique, Yaoundé

Mr Hycenth Numfor Neba, Programme Manager, Centre Pasteur du Cameroun (Centre de Coordination du BU-LABNET), Yaoundé

Dr Earnest Njih Tabah, National Programme Manager, National Yaws, Leishmaniasis, Leprosy and Buruli ulcer Control Programme, Ministry of Public Health, Yaoundé

Dr Serges Tchatchouang, Chercheur, Plateforme de Maladies tropicales négligées, Centre Pasteur du Cameroun, Yaoundé

Dr Alphonse Um Boock, Senior Technical Advisor, African Regional Office, FAIRMED, Douala

Dr Franck-Eric Wanda Djofang, Directeur, Centre International de Recherches, d'Enseignements et de Soins, Akonolinga

Canada

Ms Jennifer Austin, Chief Executive Officer, International Alliance of Dermatology Patient Organizations (GlobalSkin), Ottawa

Mr Maneesh Phillip, Director, Department of International Programs, Effect Hope, Markham

Ms Anna Wickenden, Senior Technical Advisor, Health Systems Strengthening and Inclusion, Department of International Programs, Effect Hope, Markham

Ms Visnja Zaborski Breton, Director of Public Affairs, International Alliance of Dermatology Patient Organizations (GlobalSkin), Ottawa

Central African Republic

Dr Bernard Boua, Directeur, Programme National de Lutte contre les Maladies Tropicales Négligées et les Maladies Non Transmissibles, Projet d'Eradication du Pian, Ministère de la Santé et de la Population, Bangui

Democratic Republic of the Congo

Mr Jules Bouku Bokindji, Fondation Uniti Si Può/Pharmacie Venus, Kinshasa

Dr Jude Ilunga Dikita, Médecin superviseur, Fondation Uniti Si Può/Hôpital Saint Joseph, Kinshasa

Professor Alfred Imonda Iloko, Fondation Uniti Si Può, Kinshasa

Dr Hélène Kwamba, En charge de suivi et évaluation, Programme National d'Elimination de la Lèpre, Kinshasa

Dr Fanfan Milau Ibala, Chirurgien, Fondation Uniti Si Può/Hôpital Saint Joseph, Kinshasa

Ms Sophie Monsenepwo Kayumba, Directeur administratif, Fondation Uniti Si Può/Hôpital Saint Joseph, Kinshasa

Dr Thierry Mukendi Kajinga, Interniste, Fondation Uniti Si Può, Kinshasa

Mr Evariste Muse Nziba, Infirmier, Fondation Uniti Si Può/Hôpital Saint Joseph, Kinshasa

Professor Delphin Phanzu Mavinga, Programme Coordinator AIM NTDs Kongo central, Département de la Recherche Scientifique et du Développement en Santé de l'Institut Médical Evangélique de Kimpese, Kinshasa

Dr Mwindila Tshilombo, Dermatologue, Hopital Saint Joseph, Kinshasa

Dr Pierre Umba Mpiana, Directeur médical et Représentant légal, Action Damien, Kinshasa

Congo

Mr Gilius Axel Aloumba, Médecin chef, Programme national de lutte contre la lèpre, le pian et l'ulcère de Buruli, Direction Générale de l'épidémiologie et de la lutte contre les maladies, Ministère de la Santé et de la Population, Brazzaville

Dr Lambert Kitembo, Coordonnateur, Unité de coordination des programmes et projets, Cabinet du Ministère de la Santé et de la Population, Brazzaville

Côte d'Ivoire

Dr Julien Aké Aké, Directeur Associé, COPTIMENT, Abidjan

Mr Amari Jules César Akpa, Consultant en Appui Local, Fundación Anesvad, Abidjan

Professor Bassirou Bonfoh, Director Emeritus & Senior Researcher, Centre Suisse de Recherches Scientifiques en Côte d'Ivoire, Abidjan

Mr Dognimin Ismaël Coulibaly, Doctorant, Université Peleforo Gon Coulibaly/Centre Suisse de Recherches Scientifiques, Korhogo

Dr David Coulibaly N'Golo, Maître de Recherche des universités du CAMES, Co-responsable, Plateforme de Biologie Moléculaire, Département Technique et Technologique, Institut Pasteur de Côte d'Ivoire, Abidjan

Mr Cédric Michaël De Mel, Fondation Raoul Follereau, Abidjan

Dr Ligué Agui Sylvestre Dizoé, Directeur Coordonnateur Adjoint, Programme National d'Elimination de la Lèpre, Ministère de la Santé, de l'Hygiène Publique et de la Couverture Maladie Universelle, Abidjan

Professor Mamadou Kaloga, Directeur Coordonnateur, Programme National de Lutte contre l'ulcère de Buruli, Ministère de la Santé, de l'Hygiène Publique et de la Couverture Maladie Universelle, Djekanou

Dr Yao Didier Koffi, Responsable de la prise en charge et de la qualité des soins, Programme National de Lutte contre l'ulcère de Buruli, Ministère de la Santé, de l'Hygiène Publique et de la Couverture Maladie Universelle, Abidjan

Dr Aboa Paul Koffi, Directeur Coordonnateur Adjoint, Programme national de lutte contre l'ulcère de Buruli, Ministère de la Santé, de l'Hygiène Publique et de la Couverture Maladie Universelle, Abidjan

Dr Bognan Valentin Koné, Assistant à la coordination Afrique One-ASPIRE, Département Recherche et Développement, Centre Suisse de Recherches Scientifiques en Côte d'Ivoire, Abidjan

Dr Aboh Dammo Hugues Kouadio, Coordonnateur de Terrain, Projet LAMP4YAWS, Équipe de Côte d'Ivoire, Abidjan

Dr Mady N'guessan, Médecin, Programme National de lutte contre l'ulcère de Buruli, Ministère de la Santé, de l'Hygiène Publique et de la Couverture Maladie Universelle, Abidjan

Dr N'zarasse Florent Niamke, Programme National de lutte contre l'ulcère de Buruli, Ministère de la Santé, de l'Hygiène Publique et de la Couverture Maladie Universelle, Djekanou

Dr Tanoh Amany Serge Raymond N'Krumah, Enseignant chercheur, Université PGC Korhogo et Centre suisse de recherches scientifiques en côte d'ivoire, Abidjan

Dr Labiya Touré, Médecin d'essai clinique, Programme National de Lutte contre l'Ulcère de Buruli, Ministère de la Santé, de l'Hygiène Publique et de la Couverture Maladie Universelle, Divo

Professor Bamba Vagamon, Directeur Général, Institut Raoul Follereau de Côte d'Ivoire, Abidjan

Mr Koffi Aubin Yao, Directeur National, Hope Commission International, Abidjan

Dr Kouakou Ange Théodore Yao, Programme National de Lutte contre l'ulcère de Buruli, Ministère de la Santé, de l'Hygiène Publique et de la Couverture Maladie Universelle, Abidjan

Ethiopia

Mr Abebaw Yeshambel Alemu, Lecturer and Assistant researcher, Armauer Hansen Research Institute and University of Gondar, Addis Ababa

Dr Oumer Ali**, Researcher, Armauer Hansen Research Institute, Lideta

Mr Mengiste Asrat*, NTD Technical Adviser CDT-Africa, Addis Ababa University, Addis Ababa

Mr Belete Bizuayehu*, Dermatology Professional Specialist, German Leprosy and TB Relief Association & Harar Bisidimo Leprosy Relief Centre, Harar

Dr Kidist Dagnewu, Tresbien Dermatology Clinic, Addis Ababa

Professor Wendemagegn Enbiale, Global Health Information Officer, VisualDx, Bahir Dar

Dr Kibur Engdawork, Department of Sociology, OSSREA, Addis Ababa University & Brighton and Sussex Medical School, Addis Ababa

Ms Mahlet Gebrehiwot, PhD student, Department of Anthropology, Mekelle University, Mekelle

Dr Yohannes Hailemichael, Malaria and Neglected Tropical Diseases, Armauer Hansen Research Institute, Addis Ababa

Mr Debelo Kitesa*, Project Manager, German Leprosy and TB Relief Association, Addis Ababa

Dr Saba Maria Lambert, Clinical Assistant Professor, London School of Hygiene & Tropical Medicine, Addis Ababa

Dr Getachew Taffere, Department of Environmental Health, Mekelle University, Eclipse Project, Mekelle

Mr Abebayehu Tora*, Associate Professor, Wolaita Sodo University, W/Sodo

France

Professor Pierre Buffet, Directeur Médical, Institut Pasteur, Paris

Dr Christine Chevillon, Chercheur, MIVEGEC (UMR CNRS-IRD-Univ.Montpellier), Montpellier

Professor Jean-Pierre Serge Gangneux, Professeur de Médecine, Université de Rennes, Rennes

Mr Antoine Gliksohn, Executive Director, Global Albinism Alliance, Paris

Professor Jean-Francois Guégan, Directeur de Recherche, Institut national de recherche pour l'agriculture, l'alimentation et l'environnement (INRAE) & Institut de Recherche pour le Développement (IRD), Montpellier

Dr Nicolas Homehr, Belle Europe Director, Belle.ai, Toulouse

Dr Roch Christian Johnson, Directeur Médical, Fondation Raoul Follereau, Paris

Dr Estelle Marion, Chercheur, Inserm / Université d'Angers, Angers

Dr Cléa Melenotte, Service de Maladies Infectieuses et Tropicales, Hôpital Necker Enfants Malades, Paris

Mr Oleg Ouss, Directeur des Projets & Président, Fondation Raoul Follereau, Paris

Professor Alain Taieb, Professeur émérite de Dermatologie, INSERM 1312, Université de Bordeaux, Bordeaux

Gabon

Dr Julienne Atsame, Directrice, Programme National de Lutte contre les Maladies Parasitaires, Ministère de la Santé, Libreville

Professor Larson Boundenga, Chef d'Unité de Recherches en Ecologie de la Santé, Centre International de Recherches Médicales de Franceville (CIRMF), Franceville

Germany

Dr Ruth Ansah, Clinical Researcher, Bernhard Nocht Institute for Tropical Medicine, Hamburg

Mr Anil Fastenau, Global Health Advisor, German Leprosy and TB Relief Association (DAWH), Cologne

Professor Hermann Feldmeier*, Professor of Tropical Medicine, Institute of Microbiology, Infectious Diseases and Immunology, Charité University Medicine, Berlin

Dr Mirjam Groger, Deputy Head of Clinical Research Department, Head of Groger Laboratory, Bernhard Nocht Institute for Tropical Medicine, Hamburg

Professor Thomas Junghanss, Senior Clinician, Section Infectiology and Tropical Medicine, University Hospital Heidelberg, Heidelberg

Dr Christa Kasang, Research Coordinator, DAHW /GLRA, Wuerzburg

Professor Sascha Knauf, Acting Director (Institut of International Animal Health/One Health at FLI), Friedrich-Loeffler-Institut, Greifswald - Insel Riems

Dr Marija Stojkovic, Senior Physician, University Hospital Heidelberg, Heidelberg

Dr Marlene Thielecke*, Charité Center for Global Health, Berlin

Dr Andy Wende, General Manager, Xpedite Diagnostics GmbH, Munich

Ghana

Ms Nancy Ackam, PhD Student, Skin NTD Research group, Kumasi Centre for Collaborative Research in Tropical Medicine (KCCR), Kumasi

Mr Jonathan Kofi Adjei, Skin NTD Research group, Kumasi Centre for Collaborative Research in Tropical Medicine (KCCR), Kumasi

Mr Joseph Ken Adu Poku, Physiotherapy Assistant, Department of Physical Therapy, Agogo Presbyterian Hospital, Agogo

Ms Abigail Agbanyo, Research Assistant, Skin NTD Research Group, Kumasi Centre for Collaborative Research in Tropical Medicine (KCCR), Kumasi

Ms Bernadette Agbavor, Research Assistant, Skin NTD Research Group, Kumasi Centre for Collaborative Research in Tropical Medicine (KCCR), Kumasi

Dr Richard Akuffo, Research Fellowguchi Memorial Institute of Medical Research, University of Ghana, Legon, Accra

Dr Yaw Ampem Amoako, Kumasi Centre for Collaborative Research in Tropical Medicine (KCCR), Kwame Nkrumah University of Science and Technology (KNUST), Kumasi

Dr Edwin Ampadu, Public Health Specialist, Accra

Dr Adwoa Asante-Poku, Senior Research Fellowguchi Memorial Institute for Medical Research, University of Ghana, Accra

Mr Thomas Abugbilla Azurago, Focal Point, Human African Trypanosomiasis and Cutaneous Leishmaniasis, Disease Control Unit, Ghana Health Service, Accra

Dr Dziedzom Komi de Souza, Senior Scientific Officer, Foundation for Innovative New Diagnostics, Accra

Professor Fosu Samuel Gyasi, Senior Lecturer and Researcher, Department of Basic and Applied Biology, University of Energy and Natural Resources, Sunyani

Dr Eric Koka, Lecturer/Research Scientist, Department of Sociology and Anthropology, University of Cape Coast, Cape Coast

Dr Nana Kotey, Programme Manager, National Buruli Ulcer Control & National Yaws Eradication Programmes, Disease Control Unit, Ghana Health Service, Accra

Mr Edwin Sakyi Kyei-Baffour, Biochemistry, Cell and Molecular Biology, University of Ghana, Accra

Mr Kabiru Mohammed Abass, Disease Control Officer, Department of Public Health, Agogo Presbyterian Hospital, Agogo

Dr Lydia Nicholine Mosi, Senior Lecturer, Department of Biochemistry, Cell and Molecular Biology, University of Ghana, Accra

Dr Jacob Novignon, Health Economist, Kumasi Centre for Collaborative Research in Tropical Medicine (KCCR), Kumasi

Mr Edmond Kwaku Ocloo, PhD Student, Noguchi Memorial Institute for Medical Research (NMIMR), University of Ghana, Accra

Mr Daniel Okyere, Research Assistantguchi Memorial Institute for Medical Research (NMIMR), University of Ghana, Accra

Dr Kenneth Bentum Otabil, Head, Department of Applied Biology, University of Energy and Natural Resources, Sunyani

Professor Richard Phillips, Scientific Director, Department of Medicine and Kumasi Centre for Collaborative Research (KCCR), Kwame Nkrumah University of Science and Technology (KNUST), Kumasi

Dr Benedict Quao, Programme Manager, National Leprosy Elimination Program, Ghana Health Service, Cape Coast

Professor Dorothy Yeboah-Manu, Directorguchi Memorial Institute for Medical Research, College of Health Sciences, University of Ghana, Accra

Guinea

Dr Ibrahim Traoré, Dermatologue, Université La Source de Guinée, Conakry

India

Dr Bhupendra Tripathi, Country Lead, Elimination Programs – Neglected Tropical Diseases, Bill & Melinda Gates Foundation, India Country Office, New Delhi

Dr Sathish Kumar Paul Manoharan, Head, Department of Research, Schieffelin Institute of Health Research & Leprosy Centre, Vellore

Italy

Dr Antonella Bertolotti, President, Intermed Onlus, Brescia

Dr Lorenzo Cipriani, Intermed Onlus, Brescia

Mr Barnaba Gasparini, Villa d'Almé

Mr Luca Papetti, Intermed Onlus, Brescia

Dr Tatiana Pedrazzi, Intermed Onlus, Brescia

Professor Stefania Varani, Associate Professor of Microbiology, Department of Experimental Diagnostic and Specialty Medicine, University of Bologna, Bologna

Mr Claudio Paparo, Rotary International, Inveruno

Japan

Dr Junichiro En, Associate professor, Niigata University of Health and Welfare, Katsushika-ku, Tokyo

Dr Hanako Fukano, Senior Research Scientist, Department of Mycrobiology, Leprosy Research Centre, National Institute of Infectious Diseases, Tokyo

Dr Ryo Fukaura, Department of Dermatology, Nagoya University Graduate School of Medicine, Aichi-Ken

Dr Yoshihiko Hoshino, Department of Mycobacteriology, National Institute of Infectious Diseases, Tokyo

Dr Mariko Mikami, Department of Dermatology, West Yokohama Sugawara Dermatology Clinic, Yokohama

Dr Yuji Miyamoto, Department of Mycobacteriology, Leprosy Research Center, National Institute of Infectious Diseases (NIID), Higashimurayama

Ms Aya Tobiki, Chief Program Officer, Sasakawa Health Foundation, Tokyo

Dr Mitsunori Yoshida, Research Scientist, Department of Mycobacteriology, Leprosy Research Center, National Institute of Infectious Diseases, Higashi-Murayama

Kenya

Dr Lynne Elson, Research Fellow, Kenya Medical Research Institute (KEMRI)–Wellcome Trust Research Programme/University of Oxford, Kilifi

Dr Esther Kinyeru, Department of Health Services, Nakuru County, Ministry of Health, Nairobi

Dr Ruth Nyangacha, Senior Research Scientist, Kenya Medical Research Institute, Nairobi

Mr Berrick Otieno*, Assistant Research Officer, Kenya Medical Research Institute-Wellcome Trust Research Programme, Kifili

Korea (Republic of)

Dr Hyo jung Whang, International Youth Fellowship, Seoul

Lebanon

Dr Sophie Delaigue, Digital Health Advisor & Dermatologist, Geneva Digital Health Hub, Beirut

Liberia

Ms Hannah Berrian*, University of Liberia Pacific Institute for Research and Evaluation (UL-PIRE), Monrovia

Mr Emerson Rogers, Coordinator, Case Management NTDs, Neglected Tropical and Non Communicable Diseases Program, Ministry of Health and Social Welfare, Monrovia

Ms Nancy Maima Kanney Saydee, National Coordinator, Case Managementn-Communicable Diseases and Injury, Health Services Department, Ministry of Health and Social Welfare, Monrovia

Mr Karsor K. Kollie, Director, Neglected Tropical and Non Communicable Diseases Program, Ministry of Health and Social Welfare, Monrovia

Dr Anthony Tucker, Directorn-Communicable Diseases and Injury, Health Services Department, Ministry of Health and Social Welfare, Monrovia

Mauritania

Professor Mamadou Ball, President, Mauritanian Society of Dermatology, Nouakchott

Nepal

Dr Niraj Parajuli, Assistant Professor and Senior Consultant Dermatologist, Department of Dermatology & Venereology, National Academy of Medical Sciences, Bir Hospital, Kathmandu

Dr Mahesh Shah Shudi, Dermatologist, Acting Medical Director, Department of Dermatology, Anandaban Hospital, The Leprosy Mission Nepal, Kathmandu

Dr Reejana Shrestha, Consultant Dermatologist, Department of Dermatology, Anandaban hospital, The Leprosy Mission Nepal, Bhaktapur

Netherlands (Kingdom of the)

Dr Christine Fenenga, Lead, Technical Capacity Building, NLR International, Amsterdam

Ms Roos Geutjes, InfoNTD Coordinator & Information Officer, Programmes, Research and Partnerships, NLR International, Amsterdam

Dr Liesbeth Mieras, Head, Medical Technical Department, NLR International, Amsterdam

Dr Koert Ritmeijer, Coordinator, Neglected Tropical Diseases, Public Health Department, Médecins Sans Frontières, Amsterdam

Dr Henk Schallig, Principal Investigator and Senior Scientist Parasitology, Department of Medical Microbiology & Infection Prevention, Amsterdam University Medical Centres, Academic Medical Centre, University of Amsterdam, Amsterdam

Dr Anne Schoenmakers, Project manager, Medical advisor & Researcher, NLR International, Amsterdam

Professor Ymkje Stienstra, Internist/infectious diseases specialist and clinical epidemiologist, University Medical Center Groningen, Groningen

Ms Isis Umbelino, Global Health Fellow, Bridges to Development, Almere

Dr Wim van Brakel, Medical Director, Programmes, Research and Partnerships Department, NLR International, Nieuwegein

Dr Wendy van de Sande, Assistant Professor, Department of Medical Microbiology & Infectious Diseases, ErasmusMC, Gilze

Professor Eduard E. Zijlstra, Director, Rotterdam Center for Tropical Medicine, Rotterdam

Nigeria

Mr Peters Adebayo, Leprosy & Buruli ulcer focal person, National Tuberculosis, Leprosy & Buruli Control Programme, Federal Ministry of Health, Abuja

Mr Oluwole Gabriel Afolayan, NTD Program Officer/Research Secretary, Department of Public Health, Federal Ministry of Health, Federal Secretariat Abuja, Abuja

Dr Chukwuma Anyaike, Coordinator, National Tuberculosis, Leprosy and Buruli ulcer Control Programme, Department of Public Health, Federal Ministry of Health, Abuja

Norway

Ms Hanne Brekke, Physician /PhD student, Oslo University Hospital, Oslo

Papua New Guinea

Dr Cynthia Kuanch-Mose, Deputy Chief Dermatologist, National Department of Health, Port Moresby

Paraguay

Dr Olga Aldama, Directora, Programa Nacional de Control de la Lepra, Ministerio de Salud Pública y Bienestar Social, San Lorenzo, Paraguay

Philippines

Dr Belen Dofitas, Associate Professor, Department of Dermatology, College of Medicine, University of the Philippines Manila, Quezon City

Spain

Ms Elssie Ansareo, Content Creator, Fundación Anesvad, Bilbao

Ms Mireia Cano Izquierdo, Research Assistant, eHealth Lab, Universitat Oberta de Barcelona, Cornellà de Llobregat

Dr Carme Carrion Ribas, Scientfic Coordinator for eHealth Centre at UOC, Universitat Oberta de Catalunya, Barcelona

Dr Israel Cruz, Head, International Health Department, Instituto de Salud Carlos III, Madrid

Ms Joanna Furnival-Adams, Barcelona Institute for Global Health, Barcelona

Dr Cristina Galvan Casas, Dermatologist, Fundación Lucha contra las infecciones. DerMalawi, Villanueva de la Cañada, Madrid

Dr José Ramón Gomez Echevarria, Director Leprosy, Sanatorio Fontilles, Valencia

Ms María González Sevilla, International Cooperation and Advocacy, Fundación Anesvad, Bilbao

Ms Miren Hualde, Communication Area, Fundación Anesvad, Getxo

Mr Iñigo Lasa, General Manager, Fundación Anesvad, Bilbao

Dr Santiago Ramon-Garcia, ARAID Investigator, ARAID Foundation & University of Zaragoza, Zaragoza

Mr Guillermo Robert de Arquer, Technical Advisor - Global Health, Department of International Programs, Effect Hope, Barcelona

Dr Emma Sáez López, Project manager/Senior Postdoctoral Researcher, Department of Microbiology, University of Zaragoza, Zaragoza

Ms Clotilde Serien, Coordinator, Civil Society Area, International Cooperation and Advocacy, Fundación Anesvad, Bilbao

Dr Pedro Torres Muñoz, Head of Research laboratory, Sanatorio fontilles, Murla

Ms Larraitz Ventoso, International Cooperation and Advocacy, Fundación Anesvad, Donostia

Dr Jordi Serrano Pons, Founder, Universal Doctor, Sabadell

Sri Lanka

Dr Dilini Wijesekara*, Consultant Community Physician, Anti-Leprosy Campaign, Colombo

Sudan

Professor Ahmed Fahal, Professor of Surgery, Director, The Mycetoma Research Center, University of Khartoum, Khartoum

Switzerland

Dr Byron Arana, Head of Cutaneous Leishmaniasis Program, Drugs for Neglected Diseases Initiative, Geneva

Ms Samantha Bolton, Communications consultant, Incite Insight, Geneva

Dr Eric Comte, Director, Geneva Health Forum, Insitute of Global Health, University of Geneva, Geneva

Ms Maura Concu, Scientific Collaborator, Head of Molecular Diagnostic, Diagnostic Center, Department of Medicine, Swiss Tropical and Public Health Institute, Allschwil

Mr Jean-Francois Gouzer, Co-founder, Global Dermatology, Cologny

Dr Christophe Hsu, Dermatologist, Department of Dermatology, University Hospital of Basel, Geneva

Mr Lorenz Indermühle, Director, FAIRMED, Bern

Dr Laila de Laguiche, President, Alliance Against Leprosy, La Punt Chamues

Dr Elly Kourany Lefoll, Director, ElkoBio, Geneva

Dr Guillaume Linte, SNSF Post-doc researcher, (iEH2) Institute for Ethics, History, and the Humanities, University Medical Center, University of Geneva, Geneva

Dr Julia-Tatjana Maul, Dermatologist (senior), Department of Dermatology, University Hospital of Zürich, Zürich

Dr Nora Monnier, Program Manager, Swiss Tropical and Public Health Institute, Allschwil

Mr Elmuntasir Mukhier, Administrator, The International Federation of Anti-Leprosy Associations, Geneva

Dr Andreas Neumayr, Chief medical officer, Swiss Tropical and Public Health Institute, Basel

Professor Gerd Pluschke, Group Leader, Medicines Development Unit, Swiss Tropical and Public Health Institute, Allschwil

Dr Marie-Therese Ruf, Deputy Head of Unit, Diagnostic Center, Swiss Tropical and Public Health Institute, Basel

Professor Peter Schmid-Grendelmeier, Head Allergy Unit & Responsible for Education, Department of Dermatology, University Hospital of Zurich & International Society of Atopic Dermatitis (ISAD), Zurich

Dr Thomas Spangenberg, Head of Global Health, Open Innovation & Drug Discovery, Merck, Eysins

Mr Bharath Kumar Sundar, Program Officer (Nepal & Sri Lanka), Focal point, Monitoring, Evaluation & Learning, Foundation FAIRMED, Bern

Dr Simone Toppino, Infectious Disease Department, University Hospital Heidelberg, St. Gallen

Dr Laurence Toutous Trellu, Privat-Docent, Dermatology and Venereology Division, Department of Medicine, University Hospital of Geneva, Geneva

Dr Hubert Vuagnat, Head Physician, Wound and Woundcare Program, University Hospital of Geneva & World Alliance for Wound & Lymphedema Care (WAWLC), Geneva

Mr Geoff Warne, CEO, International Federation of Anti-Leprosy Associations, Geneva

Dr Louisa Warryn, Molecular Immunology, Swiss Tropical and Public Health Institute, Allschwil

Timor-Leste

Dr Josefina Clarinha João, National Director for Diseases Control, Diseases Control, Ministry of Health, Dili

Togo

Dr Akila Wimima Bakoubayi, Conseiller médical, Association Allemande de Lutte contre la Lépre et la Tuberculose/Deutsche Lepra- und Tuberkulosehilfe e.V. (DAWH), Lomé

Mr Koffi Fombo, Focal Point, Fundación Anesvad, Lomé

Dr Yawovi Agbenyigan Gadah, Directeur de Programmes, Association Allemande de Lutte contre la Lépre et la Tuberculose/Deutsche Lepra- und Tuberkulosehilfe e.V. (DAHW), Lomé

Dr Piham Gnossike, Directeur Coordonnateur, Programme National Intégré des Maladies Tropicales Négligées, Ministère de la Santé et de la Protection Sociale, Lomé

Ms Massoubayo P'niwè Patchali, Responsable du Suivi et de l'Evaluation, Programme National Intégré des Maladies Tropicales Négligées, Ministère de la Santé et de la Protection Sociale, Lomé

Mr Mawèké Tchalim, Chargé de Planification, Programme National Intégré des Maladies Tropicales Négligées, Ministère de la Santé et de la Protection Sociale, Lomé

Tunisia

Professor Mourad Mokni, Head, Dermatology Department, Hôpital La Rabta Tunis, WHO Collaborating Center, Tunis

United Kingdom of Great Britain and Northern Ireland

Dr Juliet Addo, Director & Head of Africa Open Lab, Global Health Academic Engagement, GSK, London

Dr Gemma Aellah, Research Fellow, Global Health and Infection, Brighton and Sussex Medical School, Brighton

Dr Juliana Amanyi-Enegela, Programme Manager-NTDs, CBM Christoffel Blindenmission Christian Blind Mission e.V, Cambridge

Ms Adeola Bamisaiye, Pharmacist, Centre for Tropical Medicine and Global Health, University of Oxford, London

Ms Carrie Barrett, PhD Student, Liverpool School of Tropical Medicine, Liverpool

Ms Joanna Butler, Student, University of Surrey, Haslemere

Dr Bahadir Celiktemur, Research and Policy Manager, The Leprosy Mission England and Wales, Peterborough

Ms Sopna Choudhury, Research Programme Manager, Institute of Applied Health Research, College of Medical and Dental Sciences, University of Birmingham, Birmingham

Professor Gail Davey, Professor of Global Health Epidemiology, Department of Global Health & Infection, Brighton and Sussex Medical School, Brighton

Dr Laura Dean, Lecturer, Department of International Public Health, Liverpool School of Tropical Medicine, Liverpool

Mrs Kathryn Forbes, Partnerships and Strategy Lead, Oriole Global Health, London

Dr Claire Fuller, Chair, International League of Dermatological Societies, London

Dr Elizabeth González Cueto, Medical doctor, MSc., Nuffield Department of Medicine, University of Oxford, Oxford

Dr Belinda Hall, Senior Research Fellow, Department of Microbial and Cellular Sciences, University of Surrey, Guildford

Professor Roderick Hay, Emeritus Professor of Cutaneous Infection, King's College London, London

Dr Michael Head*, Senior Research Fellow in Global Health, Clinical Informatics Research Unit, Faculty of Medicine, University of Southampton, Southhampton

Ms Liz Hollenberg, Global Health Policy and Programmes Manager, The International League of Dermatological Societies, London

Ms Julie Irving, Research Programme Manager, Department of International Public Health, Liverpool School of Tropical Medicine, Liverpool

Professor Richard Lilford, Professor of Public Health, Institute of Applied Health Research, University of Birmingham, Birmingham

Dr Michael Marks, Associate Professor, Clinical Research Department, London School of Hygiene & Tropical Medicine, London

Ms Iris Mosweu, Research Fellow, Global Health Development, London School of Hygiene & Tropical Medicine, London

Dr Michele Murdoch, Chair, NNN Skin Cross Cutting Group; Consultant Dermatologist, West Herts Teaching Hospitals NHS Trust, International Foundation for Dermatology, West Hertfordshire Teaching Hospitals, Watford

Dr Maya Semrau*, Brighton and Sussex Medical School, Brighton

Mr Sungjin Oh, International Youth Fellowship, London

Dr Kwabena Owusu-Boateng, Post Graduate Researcher, Department of Microbial Sciences, Faculty of Health and Medical Sciences, University of Surrey, Guildford

Professor Helen Price, Professor of Parasitology, School of Life Sciences, Keele University, Keele

Dr Rachel Pullan, Associate Professor, Disease Control Department, London School of Hygiene & Tropical Medicine, York

Dr Sonia Santana-Varela, Department of Microbial Sciences, Faculty of Health and Medical Sciences, University of Surrey, Godalming

Professor Rachel Simmonds, Professor of Immunopathogenesis, Department of Microbial Sciences, School of Biosciences and Medicine, Faculty of Health and Medical Sciences, University of Surrey, Guildford

Dr Joseph Timothy, Assistant Professor, Disease Control Department, London School of Hygiene & Tropical Medicine, London

Dr Sundeep Chaitanya Vedithi, Director of Research and Innovation, American Leprosy Missions & Research Associate, Department of Medicine, University of Cambridge, Cambridge

Dr Steve Walker, Associate Professor and Consultant Dermatologist, London School of Hygiene & Tropical Medicine, London

Dr Mark Wansbrough-Jones, St George's University of London, London

United States of America

Ms Jadesola Akinwuntan, Medical Student, School of Medicine, University of Kansas, Kansas City

Dr Maria Beumont, Chief Medical Officer, TB Alliance, Philadelphia

Dr Chinwe Chukwudi, Research Scientist, University of Nigeria & National Institutes of Health, Bethesda

Ms Magdalene Dogbe, Graduate Student, Department of Biological Sciences, Mississippi State University, Starkville

Dr Paul Converse, Research Analyst, Department of Medicine, Johns Hopkins University, Baltimore

Ms Melissa Edmiston, Senior Program Director, Data and Analytics, American Leprosy Missions, Greenville

Dr Esther Freeman, Director, Department of Dermatology, Global Health Dermatology, Massachusetts General Hospital, Harvard Medical School & The International Alliance for Global Health Dermatology (GLODERM), Boston

Dr Michael Frimpong, National Institute of Allergy and Infectious Diseases, National Institutes of Health, Bethesda

Mr William Gallo, Secretariat Director for the Global Partnership for Zero Leprosy, The Task Force for Global Health, Inc., Decatur

Dr Heather Jordan, Associate Professor, Department of Biological Sciences, Mississippi State University, Starkville

Ms Corrinne Joseph Tendo, Graduate Student, Global School of Public and Environmental Health, New York University, New York

Ms Nina Punyamurthy, Medical College of Wisconsin, Milwaukee

Dr Chandrakant Revankar, Public Health Medical Consultant (skin NTDs), Elimination of NTDs (skin NTDs), Brunswick

Dr Natalya Serbina, Director of Biology, Research and Development, TB Alliance, New York

Dr Dallas Smith, Epidemiologist, Mycotic Diseases Branch, Centers for Disease Control and Prevention, Stone Mountain

Dr Eugene Sun, Senior Vice-President of Research and Development, TB Alliance, New York

Dr Sucheta Waghmare, New York University, Jersey City

Ms Stefanie Weiland, Executive Vice President of Programs, American Leprosy Missions, Greenville

Dr Rie Yotsu, Associate Professor, Tulane School of Public Health and Tropical Medicine, New Orleans

Vanuatu

Ms Macklyne Katenga, National NTD Officer, Neglected Tropical Diseases Unit, Directorate for Public Health, Port Vila

WHO regional and country offices

Dr Dorothy Fosah Achu, Team Lead, Tropical and Vector Borne Diseases, WHO Regional Office for Africa, Brazzaville, Congo

Dr Yves Barogui, Medical Officer, Tropical and Vector borne Diseases, WHO Regional Office for Africa, Libreville, Gabon

Dr Abate Mulugeta Beshah, Medical Officer, Tropical and Vector borne Diseases, WHO Regional Office for Africa, Brazzaville, Congo

Dr Kleydson Bonfim Andrade Alves, Consultant, Tuberculosis and Leprosy Program, Pan-American Health Organization, Brasília, Brazil

Dr Augustin Kadima Ebeja, Medical Officer, Tropical and Vector borne Diseases, WHO Regional Office for Africa, Brazzaville, Congo

Dr Sarosh Jamil, Technical Officer, WHO Country Office, Port Moresby, Papua New Guinea

Dr Vivek Lal, Team Leader, Global Leprosy Programme, WHO Regional Office for South-East Asia, New Delhi, India

Dr Khin Pa Pa Naing, Technical Officer, WHO Country Office, Kathmandu, Nepal

Dr N'goran Raphaël N'Dri, National Professional Officer, WHO Country Office, Abidjan, Côte d'Ivoire

Dr Venkata Ranganadha Pemmaraju, Global Leprosy Programme, WHO Regional Office for South-East Asia, New Delhi, India

Dr Raoul Saizonou, National Professional Officer, WHO Country Office, Cotonou, Benin

Dr Aliyu Suleiman, National Professional Officer, WHO Country Office, Abuja, Nigeria

Dr Santiago Nicholls, Advisor, Neglected Infectious Diseases, WHO Regional Office for the Americas/ Pan American Health Organization, Washington (DC), United States of America

Dr Ronaldo Carvalho Scholte, International Consultant, WHO Regional Office for the Americas/Pan American Health Organization, Washington (DC), United States of America

Dr Zaw Lin, Technical Officer, WHO Regional Office for South-East Asia, New Delhi, India

Mrs Fasihah Taleo, Technical Officer, Communicable Diseases, WHO Country Office, Port Vila, Vanuatu

Mr Etienne Nnomzo'o, Technical Officer, WHO Country Office, Yaoundé, Cameroon

Ms Barbara Milani, Consultant, WHO Global NTD Programme, Geneva, Switzerland

Dr Kazim Sanikullah, Technical Officer, WHO Regional Office for the Western Pacific, Manila, Philippines

WHO headquarters

Dr Kingsley Asiedu, Team Lead, Skin NTDs, Disability and Inclusion, Prevention, Treatment and Care, Global NTD Programme, Geneva, Switzerland

Ms Claire Cotton, Consultant, Prevention, Treatment and Care, Global NTD Programme, Geneva, Switzerland

Dr Daniel Argaw Dagne, Unit Head, Prevention, Treatment and Care, Global NTD Programme, Geneva, Switzerland

Dr Camilla Ducker, Senior Adviser, Global NTD Programme, Geneva, Switzerland

Dr Ibrahima Socé Fall, Director, Global NTD Programme, Geneva, Switzerland

Dr Albis Francesco Gabrielli, Unit Head a.i., Strategic Information and Analytics, Global NTD Programme, Geneva, Switzerland

Dr Xiaoxian Huang, Health Economist, Strategic Information and Analytics, Global NTD Programme, Geneva, Switzerland

Dr Saurabh Jain, Scientist, Prevention, Treatment and Care, Global NTD Programme, Geneva, Switzerland

Dr Pamela Sabina Mbabazi, Medical Epidemiologist, Strategic Information and Analytics, Global NTD Programme, Geneva, Switzerland

Dr Priya Pathak, Technical Officer, Skin NTDs, Disability and Inclusion, Prevention, Treatment and Care, Global NTD Programme, Geneva, Switzerland

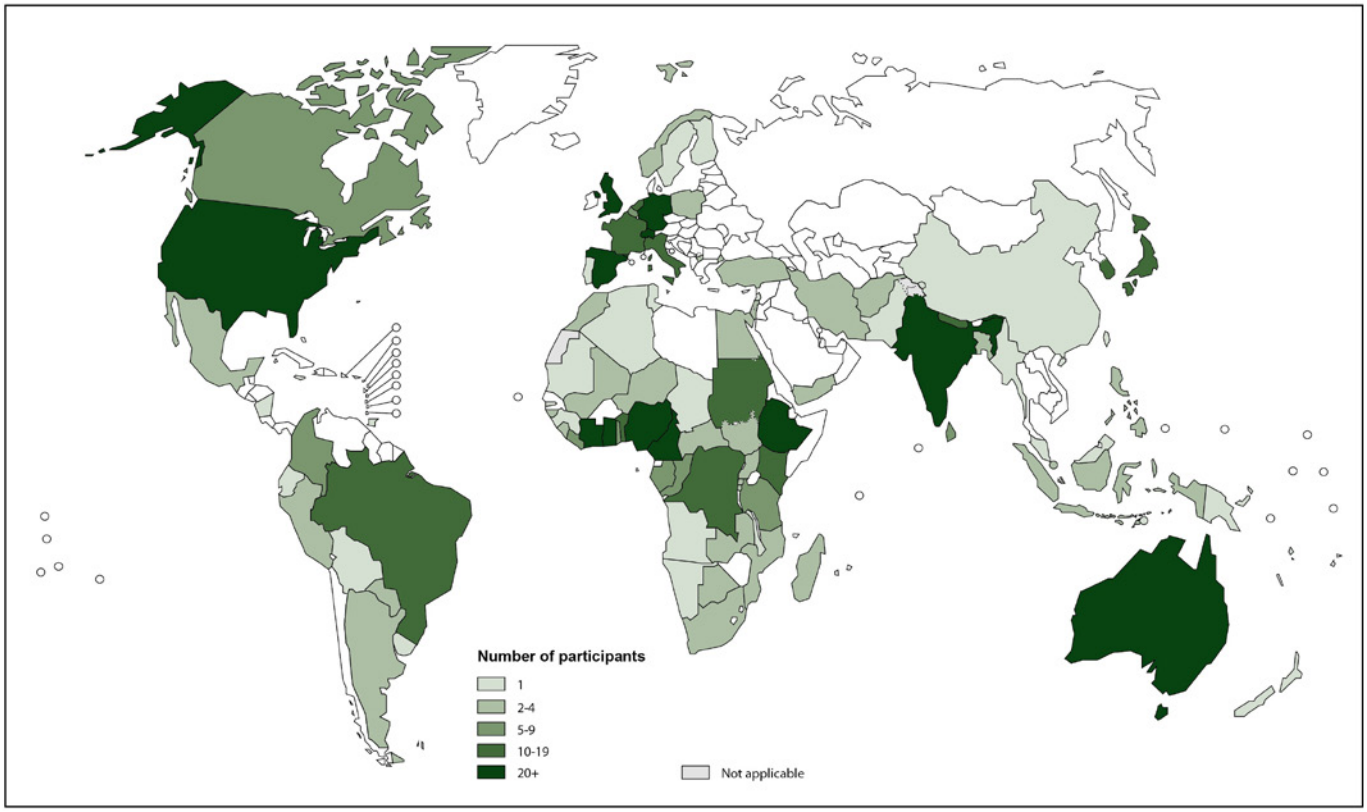
Dr José Antonio Ruiz Postigo, Medical Officer, Skin NTDs, Disability and Inclusion, Prevention, Treatment and Care, Global NTD Programme, Geneva, Switzerland

* Online presenter.

Annex 3. Participant demographics

Demographic information on the registered participants is shown by geographical distribution (Fig. A3.1), by in-person participants (Fig. A3.2), by gender (Fig. A3.3), and by disease-specific (Fig. A3.4) and cross-cutting areas of interest (Fig. A3.5).

Fig. A3.1. Geographical distribution of participants at the first global meeting on skin-related neglected tropical diseases



Data source: World Health Organization
Map production: Control of Neglected Tropical Diseases (NTD)
World Health Organization

World Health Organization

Fig. A3.2. Distribution of in-person participants, by age and gender (*n*=317)

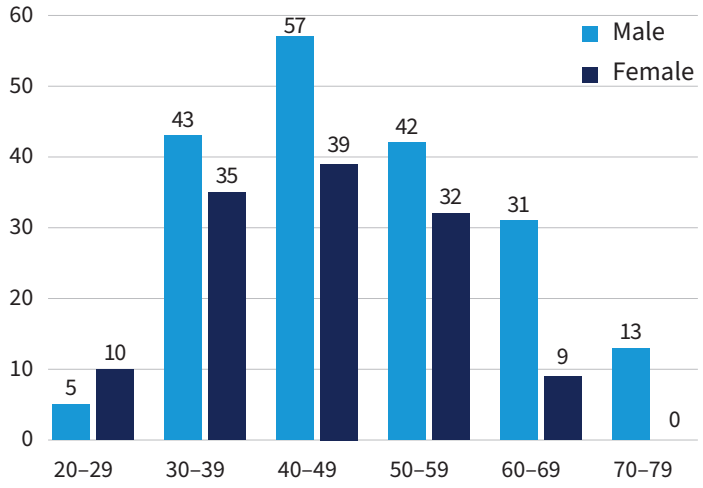


Fig. A3.3. Distribution of participants, by gender (*n*=317)

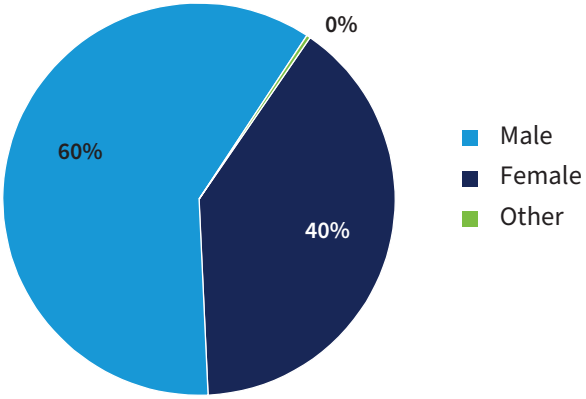


Fig. A3.4. Disease-specific areas of interest among all participants (*n*=804)

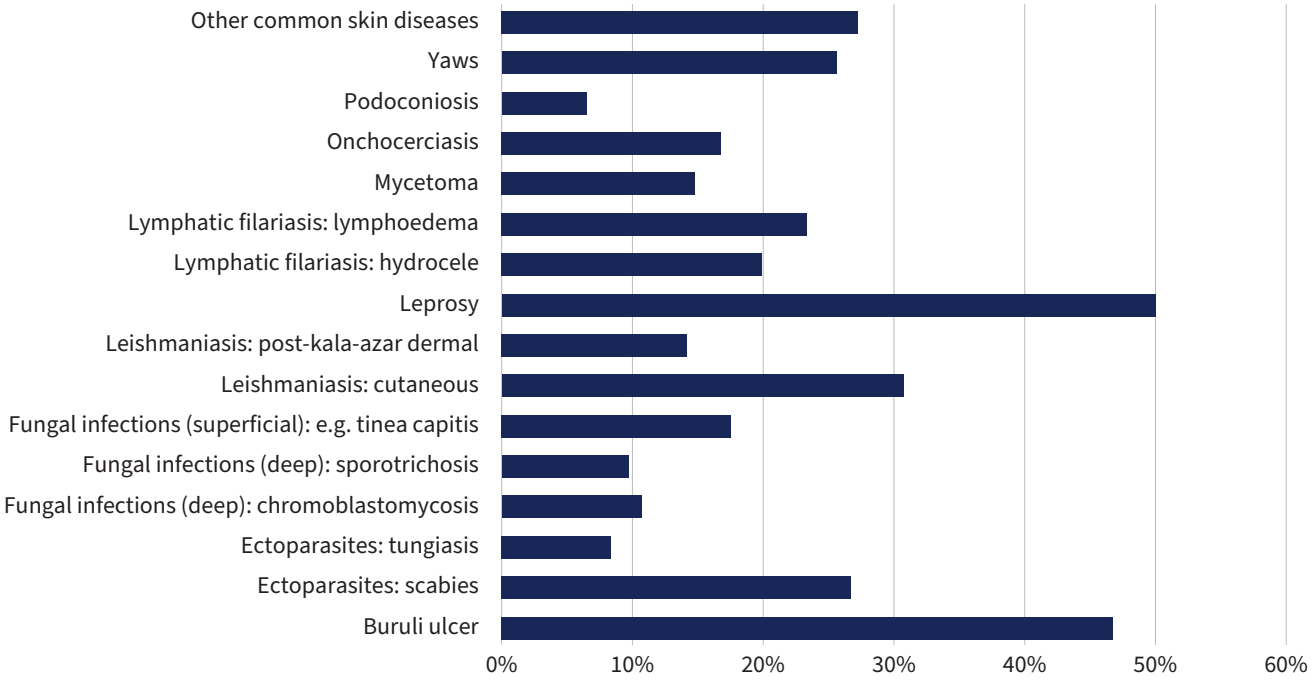
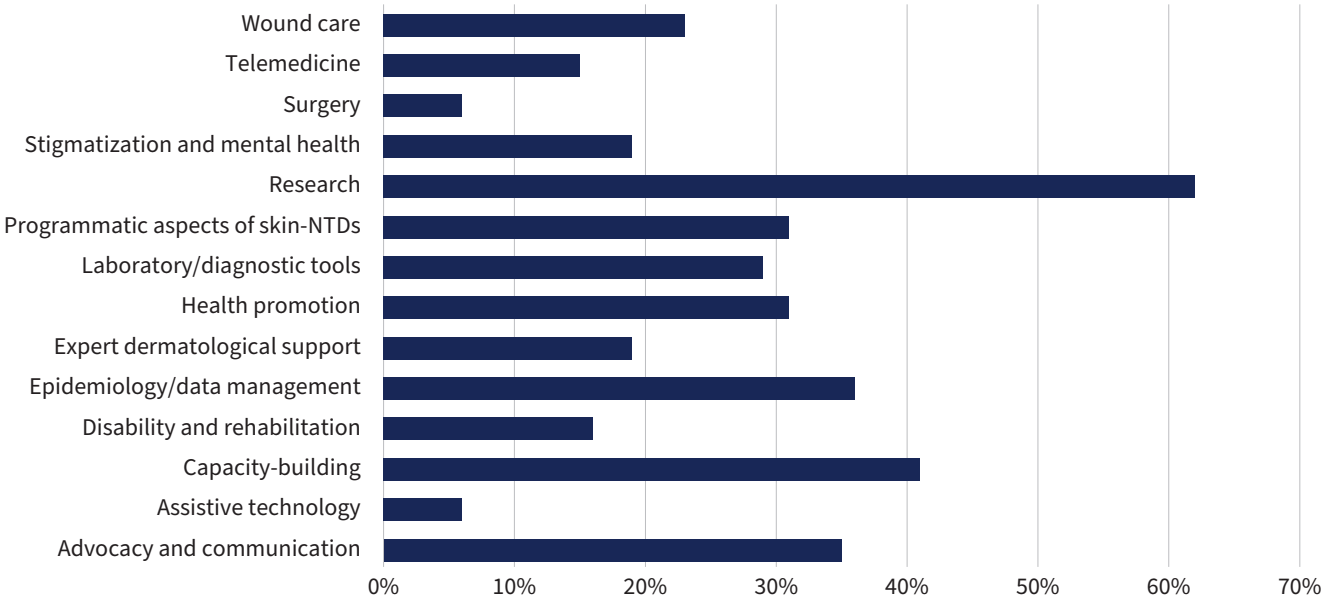


Fig. A3.5. Cross-cutting areas of interest among all participants (*n*=804)



WHO Headquarters, Geneva, Switzerland. Meeting plenary session.
© Fundación Anesvad/Elssie Ansareo

WHO Headquarters, Geneva, Switzerland. Meeting plenary session.
© Fundación Anesvad/Elssie Ansareo

WHO Headquarters, Geneva, Switzerland. Group photo with WHO Director-General (centre right) and Director, Global Neglected Tropical Diseases Programme (centre left).

WHO Headquarters, Geneva, Switzerland. Group photo with WHO Director-General (centre right) and Director, Global Neglected Tropical Diseases Programme (centre left).

For further information, contact:
Global Neglected Tropical Diseases Programme
World Health Organization
20 avenue Appia
1211 Geneva 27
Switzerland
Website: https://www.who.int/teams/control/-of-neglected-tropical-diseases