Report of Soil-Transmitted Helminthiasis Diagnostics Meeting

22-23 August, 2016

Ghent, Belgium

Executive Summary

On 22-23 August 2016, 35 people from 27 organizations met in Ghent, Belgium to review existing and new diagnostics for soil-transmitted helminthiasis (STH) and to discuss and plan for systematic comparative evaluations of the most promising field-ready tests in a variety of programmatic and epidemiologic settings. The focus of the meeting was on the short-term, i.e., deploying the most useful assays for assessing progress toward the World Health Organization (WHO) goal of STH elimination as a public health problem by 2020.

The group reviewed features of several coprological techniques, including the Kato-Katz thick smear, FLOTAC, mini-FLOTAC, McMaster, and FECPAK-G2, as well as the current 'state of the art' on existing quantitative PCR methods. Participants also reviewed several potential study sites or 'platforms' for comparative trials. These include communities with ongoing STH program monitoring or sentinel sites; the DEWORM3 study; transmission assessment surveys (TAS) for LF; the ZEST study; the COUNTDOWN study; drug efficacy trials; and the Starworms project, among others.

General principles were developed for the comparative studies as well as specific recommendations for next steps. The group considered mini-FLOTAC and molecular diagnostic assays (quantitative PCR) to be field-ready and recommended their rapid deployment in comparison studies with the Kato-Katz technique. The group also recommended that the value and validity of pooling samples for PCR should be investigated in low-prevalence settings. Additional recommendations were made regarding quality assurance and specimen preservation.

To facilitate next steps, a 'study site profile' has been circulated to all meeting participants, which, when completed, will facilitate site selection and solicitation of funding from potential donors. Several participants will also attend a subsequent meeting on diagnostic tests for STH, organized by the Bill & Melinda Gates Foundation in Annecy, France, September 12-15, 2016, and will summarize the findings of this Ghent meeting there.

Background

Coverage of preventive chemotherapy (PC) for soil-transmitted helminthiasis (STH) has increased significantly during the past several years, but monitoring of parasite prevalence and intensity to assess progress toward the World Health Organization (WHO) goal of eliminating STH as a public health problem by 2020 remains inadequate. WHO defines a public health problem for STH as >1% prevalence of moderate- and high-intensity infections based on microscopic examination of stool specimens using the Kato-Katz technique. The well-known limitations of the Kato-Katz technique have contributed to low levels of parasitologic monitoring of STH intervention programs. Further, because of its poor sensitivity, the Kato-Katz technique is considered inadequate for assessing low-intensity infections or for investigating interruption of transmission, a topic of increasing interest.

Significant advances have been made during the past few years in the development of new diagnostics for STH, particularly molecular methods. However, consensus is lacking regarding the best candidate assays in terms of sensitivity and other test parameters, feasibility and cost effectiveness. Relatively few comparative studies have been done under field conditions. To be useful in research and in public health programs, these assays need to be standardized, rigorously compared with microscopic methods in a variety of settings, and made widely available. This is a matter of urgency, given the WHO goal to control STH morbidity by 2020.

Building on the multi-site approach used by the NTD Support Center, key stakeholders met in Ghent, Belgium, 22-23 August, 2016, to review existing and new diagnostics and discuss a rapid, systematic evaluation of the most promising field-ready tests in a variety of programmatic and epidemiologic settings. The meeting was hosted by Ghent University and sponsored by Children Without Worms, the NTD Support Center, the STH Advisory Committee, Johnson & Johnson, and GSK.

Annex 1 shows the meeting agenda, with links to background materials and presentations. Annex 2 lists the meeting participants and their affiliations.

Sessions 1-2. Welcome, introduction, and orientation

Professor Jozef Vercruysse, from the University of Ghent, welcomed the participants and offered opening remarks, which highlighted the meeting objectives; the challenges with current STH diagnostics and their interpretation; and the need for capacity-building and proper incentives. He was followed by Bruno Levecke, also from the University of Ghent, who highlighted several key principles for the meeting deliberations. David Addiss, from Children Without Worms, noted that parasitologic monitoring is currently inadequate to measure progress toward the WHO goal of <1% moderate-to-high intensity (MHI) STH infection prevalence by 2020, and that lack of improved diagnostic tools has contributed to this. He also said that the success of the lymphatic filariasis (LF) elimination program and the subsequent dismantling of the community-based drug distribution platform for LF threaten progress toward WHO STH drug coverage targets for 2020. At the same time, these developments provide an opportunity to clarify STH control goals. Patrick Lammie, of the NTD Support Center, described how the NTD Support Center collaborates with WHO in bringing the results of operational research to bear on NTD policy and strategy. He noted that incorporation of new diagnostic tests into official guidelines and policies has become more formalized with the adoption by WHO of a rigorous guidelines review group process.

Session 3. Perspectives of WHO and donors

Antonio Montresor, from WHO, argued that the current standard diagnostic test for STH, the Kato-Katz technique, works quite well given the current approach to STH control. Highlighting its advantages of low cost, simple technology, and use in the field for many years, he argued that there is no major problem with this assay, although improvements are welcome. Minor problems include the need to process specimens quickly, the inability to preserve slides for later quality control, and the unpleasantness of working with feces. Dr. Montresor said that the relatively low sensitivity of the Kato-Katz is not a major issue, since the current focus of STH control is morbidity reduction, and morbidity is associated with high worm burdens.

Steven Silber, from Johnson & Johnson (J&J), emphasized the need to move toward sustainable STH control and to develop more integrated programs. He updated the participants on the J&J's new chewable formulation of Vermox (mebendazole), which is currently being developed. J&J is also interested in innovative diagnostic tests for STH to facilitate accuracy of global mapping and improve surveillance for emergence of drug resistance. He noted the importance of being able to disaggregate STH species, since their epidemiologic features and susceptibility to anthelminthic drugs differ.

Mark Bradley, from GSK, concurred with the need to consider STH species separately, even though they currently all "fall under one label" and their particularities are ignored. He highlighted a sense of urgency to clarify goals and strategies for STH control, in light of the impending scaling-down of LF elimination programs. At the recent meeting of the NTD regional program review group (RPRG) in the Western Pacific convened by the WHO regional office, it became clear that some of the small island nations did not have the technical proficiency to accurately perform the Kato-Katz technique. Thus, development and deployment of new, easy-to-use, cost-effective diagnostic assays is needed to achieve STH goals for 2020 and beyond.

Session 4. STH Diagnostics – State of the Art

Coprological techniques. In his 'state of the art' presentation, Bruno Levecke described four major coprological techniques for STH, including the Kato-Katz thick smear; FLOTAC and mini-FLOTAC; McMaster, and FECPAK-G2. The characteristics of each test are summarized on page 37 of his presentation. Test sensitivity, which is related to infection intensity and the degree to which the specimen is diluted before examination, varies among the tests. For FLOTAC and mini-FLOTAC, which can be preserved, sensitivity decreases with time before examination (page 44). Cost of each test depends on the cost of equipment, consumables, and technician time, among other factors. Cost can be markedly reduced by pooling specimens. Estimated cost of FECPAC-G2 is somewhat higher than for other methods, but it incorporates data entry and reporting. All methods are field-ready, although the protocol for FECPAK-G2 in human STH applications has not yet been optimized.

Discussion. A lively discussion followed Dr. Levecke's presentation. Comments addressed the need for adequate training and quality control, which is often lacking regardless of the method used; the relative lack of data regarding comparability of infection intensity thresholds across tests; the ambiguous meaning of the term 'field-ready'; the absence of a true 'gold standard' and challenges that this creates in comparing methods; and the need for simple laboratory procedures and specimen processing requirements.

Molecular methods. Steve Williams, from Smith College, summarized the 'state of the art' for detecting STH in stool specimens using molecular methods. Comparative studies indicate that polymerase chain reaction (PCR) methods are generally more sensitive than coprological techniques. Two major PCR approaches have been developed. With the multiplex PCR method, used by laboratories at EZT Elizabeth Hospital, Tilburg and Leiden University Medical Center (Verweij and van Lieshout) and the QIMR Berghofer Medical Research Institute (McCarthy), PCR reactions for different STH species occur simultaneously in the same reaction tube. In contrast, with the multiparallel approach, used by laboratories at Smith College (Williams), the US National Institutes of Health (NIH) (Nutman) and Baylor University (Mejia), low-volume PCR reactions occur in separate reaction tubes (see page 5 of Dr. Williams' presentation). All laboratories

use similar methods for stool specimen collection, preservation, and DNA extraction. The multiplex requires a Pentaplex-capable real-time PCR instrument, while multiparallel requires a standard real-time PCR instrument.

Dr. Williams reviewed the STH targets, probes, supplies, and hardware required for the multiplex and multiparallel PCR approaches, as well as details for standard and high-throughput options developed at the NIH lab by Tom Nutman and colleagues. Total estimated cost for the multiplex, assuming US or European labor costs, is about $15.50 per specimen for four parasites. Total estimated cost for the multiparallel method, testing for five parasites, is about $23.00 per specimen if performed in a developed country such as the Australia or the United States, or about $13.00 if run in an STH-endemic country. Costs could be further reduced by testing for fewer than five parasites or, significantly, by pooling specimens.

PCR diagnostics have been used in a variety of epidemiologic situations, including baseline STH mapping; high- and low-transmission areas; in clinical trials; and in areas with zoonotic infections. PCR is particularly more sensitive for hookworm than are microscopic methods. Sensitivity for all species can be as low as the amount of DNA in a single egg or L1 larva. Calibration curves have been developed to interpolate eggs-per-gram from PCR Ct values. Further work is needed to determine the minimum EPG that can be reliably detected with an accurately estimated EPG using this method.

Specificity of the PCR-based tests is very high. In fact, PCR offers a higher level of species-specificity, which may be particularly useful in understanding transmission dynamics and human parasite biology. For example, George and colleagues recently detected *Ancylostoma caninum* (dog hookworm) in a significant proportion of human stool specimens collected in Tamil Nadu, India (George et al, PLoS NTDs 2016; 10:e0004891).

Additional development to further improve the field-applicability of molecular methods would include:

- Pooling specimens, which could reduce cost 10-fold
- Identifying a preservative that is non-toxic, environmentally friendly, inexpensive, and insensitive to interruptions in the cold chain (there are two ongoing studies of preservative by the Verweij/Levecke and Williams/DEWORM3 (Judd Walson) groups).
- Optimizing the process of DNA extraction from stool, which is the rate-limiting step for using molecular methods for PCR.

PATH is working on a recombinase polymerase amplification (RPA)-based assay for STH in stool. It is easy to use, rapid (results in 5-10 minutes), and uses less complex equipment than PCR. A prototype will be available in the first quarter of 2017.

Discussion. Dr. Williams' presentation was followed by a lively discussion. Dr. Montresor questioned the value of increased sensitivity, when the current program goal is morbidity reduction and morbidity is related to worm burden. There is a need to categorize PCR data into classes of STH infection intensity to better correlate with morbidity; work has commenced on this but further investigations will be required. Several comments addressed the need for preservatives that are not biohazards; and the presence of qPCR machines in many laboratories that are being used for detecting other pathogens but are not available to

STH investigators. A question was raised regarding whether PCR detects free DNA in the stool; free DNA does probably not contribute significantly to the PCR signal. An appeal was made not to forget *Strongyloides* in developing and deploying molecular methods for STH.

Session 5. Existing Platforms for Tool Comparisons

Several brief presentations were made on possible study sites or 'platforms' for comparative trials of diagnostic tests for STH. These include communities in which there is ongoing program monitoring in sentinel sites for STH; DEWORM3; transmission assessment surveys (TAS) for LF; the ZEST study; drug efficacy trials; and the Starworms project, among others. Together, they provide a range of epidemiologic settings in which to assess the utility, feasibility, and performance of diagnostic tests.

DEWORM3. Peter Jourdan described the DEWORM3 project, funded by the Bill & Melinda Gates Foundation and based at the Natural History Museum in London. DEWORM3 will rigorously assess the potential for breaking STH transmission in the post-LF MDA setting. Thus, the STH transmission force in some areas is expected to be low. The main study sites will be in Benin, Malawi and India. Sample size for each of the approximately 20 clusters at each site will be approximately 1,000 persons of all ages, with a total of some 20,000 specimens being collected per site. Additional samples will be collected in longitudinal cohorts at each site. Baseline specimen collection should begin early to mid-2017.

TAS-STH. Kim Won, from the US Centers for Disease Control (CDC), described transmission assessment surveys (TAS), which are recommended after five or more years of mass drug administration (MDA) for LF. WHO recently issued guidelines for integrating LF-TAS with stool collection for STH, with the aim of 1) assessing impact of LF MDA on STH; and 2) establishing a new baseline for determining frequency of school-based MDA for STH. TAS use a cluster sampling design, and approximately 330 school-age children are tested for STH in each LF evaluation unit (usually district). As with the DEWORM3 sites, these study areas will have received at least five rounds of community-based MDA for LF, so it is expected that transmission intensity will be low. Hundreds of implementation units in dozens of countries will be eligible for TAS in the next year.

Zanzibar Elimination of Schistosomiasis Transmission (ZEST) study. ZEST is a randomized intervention trial for urinary schistosomiasis in Zanzibar with three study arms: MDA alone; MDA plus snail control; and MDA plus behavior change interventions. Steffi Knopp, from the Swiss Tropical Public Health Institute and Natural History Museum in London, explained that each study arm includes 15 shehias and 15 schools on both Unguja and Pemba, for a total of 90 sites. Each year, 100 school children per school (total, 9000) and 50 adults per shehia (total, 4500) have urine examined for *S. haematobium*. In years 1 (2012) and 6 (2017), blood is being collected from 100 first-year school children per school (9000) and could serve for eventual assessment of serologic assays for STH and other NTDs. However, stool is not currently being collected and examined within ZEST. Conducting a monitoring survey in 24 sentinel sites/schools on each island that had been monitored in 2004-2006 and again in 2011, could serve as a new platform for collecting stool samples and comparing multiple diagnostic assays and at the same time help to assess the impact of 10 rounds of bi-annual MDA (2012-2016) on STH in children and adults, as well as explore the micro-geographical distribution of STH (i.e., persistent hot-spots).

Starworms. Bruno Levecke described the Starworms project, which is designed to develop and validate diagnostic tools (including FECPAK-G2) and molecular markers to strengthen monitoring and surveillance of drug efficacy and anthelminthic resistance in MDA programs for STH. Study sites will include Brasil, Lao PDR, Ethiopia, and Tanzania. In general, prevalence of STH is high in these settings, although species mix varies among the sites. Current plans are to compare Kato-Katz, mini-FLOTAC, FECPAK-G2, and qPCR. The study is funded by the Bill & Melinda Gates Foundation. Comparative studies of diagnostic tests are scheduled for completion by December 2017.

Clinical trials of co-administered STH drugs. Jennifer Keiser, from the Swiss Tropical Public Health Institute, described several studies that are planned to compare the efficacy of various drugs and drug combinations for STH. These studies follow from a recent meeting at the Bill & Melinda Gates Foundation on potential new drugs and drug combinations for STH and schistosomiasis. Addition of molecular diagnostics to these studies would provide critical data on their relative performance and also on drug efficacy.

In response to Dr. Keiser's presentation, participants raised several points related to optimal dosing of currently available drugs for different parasites (noting, for example, that a 3-day regimen of mebendazole is more effective than a single 500 mg dose); the lack of pharmacokinetic studies for many combinations, such as albendazole-ivermectin; and the role of fasting on bioavailability and efficacy of these drugs.

Death to Onchocerciasis and Lymphatic Filariasis (DOLF). Peter Fischer, of Washington University, briefly described the DOLF project, noting that MDA with the triple-drug combination (ivermectin, DEC, and albendazole) is being investigated in Cote d'Ivoire, Indonesia, and Papua New Guinea. Current plans are to examine stool specimens using duplicate Kato-Katz tests and to preserve specimens for qPCR analysis of STH (including *Strongyloides*).

Study of post-partum deworming, Peru. Theresa Gyorkos, from McGill University, described an ongoing study of post-partum deworming, in which 1000 mother-infant pairs are being followed for two years. A school-based deworming program is also being done in the same area. Ongoing stool collection in these sites for analysis by Kato-Katz could be used to compare additional diagnostic assays.

COUNTDOWN. Suzanne Campbell, from the Liverpool School of Tropical Medicine (LSTM), described the schistosomiasis and STH projects within the COUNTDOWN research consortium, funded by the UK Department for International Development (DFID). Studies in Ghana and Cameroon are assessing the feasibility of providing different treatment strategies for STH and schistosomiasis, in particular, biannual treatment of school-age children, and community-based MDA with focus on preschool-aged children, non-attending school children, and adults including pregnant women. Twelve sites in each country will receive biannual school-based treatment. Four sites in Ghana, and eight sites in Cameroon, will receive community-based MDA. Treatment will be co-administered praziquantel and albendazole/mebendazole (depending on country). At each round (baseline and each follow-up) 2,040 stool and urine specimens from Ghana, and 3,060 from Cameroon will be examined by single Kato-Katz, urine filtration and a portion of these by molecular methods. Quantitative PCR machines are available in both countries, and additionally biological material transfer agreements are in place to enable molecular analyses to be conducted at LSTM. These

sites could be used as a platform to conduct additional molecular work, including analysis of *Strongyloides*. Field work is anticipated to commence in late 2016 and finish in 2019.

Pre-TAS surveys. Kim Won noted that, before conducting the LF-TAS, country LF program managers are also assessing their readiness for the TAS by performing "pre-TAS," which present another opportunity for comparing diagnostic tests.

Other drug studies. Alejandro Krolewiecki, from Mundo Sano, described ongoing studies in Argentina using a co-formulation of albendazole-ivermectin, and assessing impact on STH, including *Strongyloides*.

War on Worms. Vicente Belizario, from the University of the Philippines Manila, described an ongoing "War on Worms" project in the Philippines that is following school-age children in sentinel sites and exploring how to improve drug coverage of pre-school age children and women of childbearing age. This project is increasingly integrated with interventions to improve water, sanitation and hygiene (WASH).

Cambodia. Sinoun Muth, from the Ministry of Health in Cambodia, described several opportunities for comparative diagnostic studies in Cambodia, where a national STH control program has been ongoing for several years, with effective monitoring and drug coverage.

Session 6. Practical considerations.

Bruno Levecke challenged the participants to clarify the questions for these comparative studies. What, exactly, do we want to demonstrate? Test sensitivity, cost-effectiveness, practicality, or applicability to policy? Where do we want to do these studies, under what conditions? Who will be sampled, and when? Should we be paying more attention to seasonality? What is the optimal combination of laboratory experiments (e.g., seeding studies – especially in the absence of a 'gold standard') and field trials? Should preservatives be used – and if so, which ones? What additional work needs to be done, particularly with molecular methods, on pooling specimens? What is the ideal technique for homogenization of stool specimens, and how important is this? How do we improve quality control, particularly for methods such as the Kato-Katz, which do not involve stool preservation? How can we improve estimates of cost, and what equipment and materials should be included? To what extent should procedures be standardized across sites, and what are the best training and other methods to do this? How should data be managed and shared? What are our shared agreements regarding interpretation (e.g., the relationship between test sensitivity and infection intensity, or what programmatic decisions might be triggered by the finding of a 40% prevalence by qPCR)?

A robust discussion ensued, which continued on the following morning (Session 7).

- In response to a question regarding vacuum preservation of stools, Laura Rinaldi shared her experience with veterinary specimens, which can be stored for at least one month under refrigeration.
- Jaco Verweij noted that for molecular methods, isolation of DNA is the most important step, but it's actually a combination of steps, which may differ from one laboratory to another. Flexibility is needed to optimize and validate the assay in individual laboratories.

- Several participants commented on the need for different tests at different stages in STH control and elimination. Test requirements for the post-2020 agenda, and for assessing transmission breakpoints, will differ from those required to get programs launched.
- Current WHO guidelines and benchmarks were established based on the Kato-Katz technique; use of more sensitive tests will require changing the benchmarks.
- Pooling may be particularly useful and cost-effective in areas with low STH prevalence.
- Tom Nutman echoed the feelings of many when he said that 'not much more tweaking is needed' before further field-tests of molecular methods.
- Several participants remarked on the lack of evidence to support current WHO guidelines for programmatic decision-making, particularly related to decreasing MDA frequency.
- One advantage of more sensitive assays, even before reaching very low prevalence of infection, is that they could dramatically decrease the sample size (and cost) required to make programmatic decisions regarding treatment frequency. Reliably determining that a 1% prevalence threshold has been reached (either of overall STH or MHI infection) requires a large sample size.

Session 8. Breakout session on diagnostic assays

Session 9. Breakout session on field logistics

Session 10. Summary Points and Recommendations

1. The optimal diagnostic test will vary depending on stage of the STH control program. A range of programmatic and research settings are available for comparative testing of coprological and molecular methods and for investigating their utility to STH control programs. These include:
    a. Evaluating the impact on STH of several years of community-wide MDA for LF. Such settings include LF-TAS and pre-TAS (school-age children); DEWORM3 (all age groups); and DOLF (all age groups).
    b. Evaluating the impact of several years of school-based or other MDA for STH (in areas not endemic for LF or in a post-TAS phase). Such settings include routine school-based sentinel site monitoring and the ZEST study (children and adults).
    c. Evaluating the impact of onchocerciasis elimination efforts (with ivermectin) on STH.
    d. National-level assessments of STH as a baseline for eliminating STH as a public health problem (e.g., Bangladesh and Sri Lanka).
    e. Investigating areas in which STH prevalence or intensity remains unexpectedly high after many years of MDA (e.g., Grand'Anse Department, Haiti or Zanzibar, where *Trichuris trichiura* prevalence remains >70%).

2. In addition, ongoing clinical trials of drug efficacy offer good opportunities to compare the performance of molecular and coprological methods, as well as to further understand drug efficacy.

3. The following principles were recommended as the basis for comparative studies:
    a. The sensitivity and detection threshold of new diagnostic tests should be at least equal to that of the Kato-Katz technique.

   b. There should be published evidence on the field-readiness of a given test (e.g. mini-FLOTAC).
   c. Capacity to perform the test should be available within any country where the study is done.
   d. The setting should be one in which the use of the different tests being compared seems logistically feasible and volume of the stool being collected does not pose a limitation.

4. Based on these principles the following conclusions and recommendations were made:
   a. Diagnostic tests
      i. Kato-Katz is the current programme standard, but it is not a diagnostic gold standard.
      ii. Mini-FLOTAC and molecular diagnostic assays (quantitative PCR) are field-ready and should be employed for diagnostic comparison with Kato-Katz.
      iii. Details on the molecular biology protocol and method depend on the equipment available at the particular center.
      iv. The FecPakG2, LAMP, and RPA assays should be ready for field validation and comparison in the near future.
      v. The value of pooling specimens for PCR should be investigated in low-prevalence settings (in the context of STH programmes).
   b. Quality assurance
      i. Use of PCR provides opportunities for quality assurance and control
      ii. A proficiency panel should be established as a priority for assuring quality.
      iii. Any quality assurance activity for PCR should include DNA extraction methods.
   c. Specimen preservation
      i. Data on the most suitable preservation methods (e.g., using ethanol, potassium dichromate, or other compounds) will become available as of October 2016. These results should be shared with meeting participants.
      ii. Preservation of stool on filter paper is an option to be further evaluated (note: it will be included in the above-mentioned study.
      iii. When using microscopy, fresh stool should be used whenever possible. When preservatives are used, storage should not exceed 14 days.
      iv. Use of potassium dichromate should be avoided because of its toxicity.
      v. Vacuum preservation is an acceptable option.

5. The proposed way forward
   a. A ‘study site profile’ will be circulated to all meeting participants to provide details that will facilitate site selection and presentation of options to potential funders (see accompanying document).
   b. Discussions with potential funders will begin in mid-September, 2016.
   c. A report of this meeting will be shared with the organizers of the diagnostic test meeting being organized by the Bill & Melinda Gates Foundation in Annecy, France, September 12-15.

d. Steve Williams and Bruno Levecke will summarize the deliberations of the Ghent meeting in Annecy and other participants from the Ghent meeting will also attend the Annecy meeting.
e. Results of ongoing studies on stool preservation should be shared with all meeting participants when they become available in October 2016.
f. Core elements of standard operating protocols need to be summarized and shared with investigators to facilitate comparison of results.
g. Participants in this group will find ways to reconvene and further develop plans for comparative studies at the upcoming COR-NTD and ASTMH meetings.

The meeting participants expressed their gratitude to Jozef Vercruysse, Bruno Levecke, and colleagues for their tremendous hospitality and to Piet Cools and Johnny Vlaminck, of Ghent University, for their excellent work as rapporteurs.

Annex 1. Agenda

Soil-Transmitted Helminthiasis Diagnostics Meeting

22-23 August 2016

Ghent University, Ghent, Belgium

Day 1 – 22 August, 2016				
	Time	**Session**	**Presenter(s)**	**Background Materials**
Introduction and Orientation	8:30 – 9:00	***Registration***		
	9:00 – 9:20	**1. Welcome and introduction** a. Welcome (5) b. Introduction (15)	 Vercruysse Levecke	Introduction
	9:20 – 9:50	**2. Meeting orientation and objectives** a. Context and framework for multi-country study b. Linkage to BMGF meeting in Annecy	 Addiss, Lammie	
	9:50 – 10:30	**3. WHO and Donor Perspectives – Need for new diagnostic tests** a. WHO b. J&J c. GSK	 Montresor Silber Bradley	
	10:30 – 11:00	***Coffee Break***		
Diagnostic Tests	11:00 – 1:00	**4. STH Diagnostics – Current State of the Art and Field Readiness** (concise overviews of methods, including strengths, weaknesses, costs and readiness for field deployment) a. Coprological techniques (30) b. Discussion (10) c. Molecular Methods (30) d. Discussion (10) e. General Discussion (40)	 Levecke /Vercruysse Williams All	 Coprological techniques Molecular methods Pooling
	1:00 – 2:00	***Lunch Break***		
Options for Field Comparisons	2:00 – 3:45	**5. Existing Platforms for Tool Comparisons** (Speakers will provide a review of specific programmatic opportunities to compare test performance (10 min. each + 5 min. discussion) a. Routine M&E and sentinel sites (15) b. Deworm3 (15) c. TAS-STH (15) d. ZEST (15) e. Starworms (15) f. Studies of co-administered STH drugs (10) g. Others – to be identified **6. Developing field trials** a. Practical considerations (20)	 Montresor Jourdan Won Knopp Levecke Keiser Levecke/Vercruysse	Existing Platforms DeWorm3 Rationale and Study design WHO TAS STH Things to consider
	3:45 – 4:00	***Coffee Break***		
	4:00 – 5:30	b. General discussion - What tests and platforms should be used? What are barriers? IRB approvals? Funding? Logistics?	Lammie / Addiss	

Day 2 – 23 August, 2016				
	Time	**Session**	**Presenter(s)**	**Background Materials**
	9:00 – 9:30	**7. Recap from Day 1 – Assays to be tested and priority field sites**	Addiss / Lammie	
	9:30-11:00	**8. Breakout 1 - Protocol development - Diagnostic assays to be compared** (individual and pooled samples); specimen collection, preservation, and in-country testing; diagnostic challenges specific for low-income countries **9. Breakout 2 – Protocol development – Field logistics** (e.g. number of samples, period of samplings), study sites, data collection, quality control and management; diagnostic and logistical challenges specific to low-income countries	Keiser, Krolewiecki, and Becker Won and Belizario	
	11:00 – 11:30	***Coffee Break***		
	11:30 – 1:00	**Breakout sessions, continued**		
	1:00 – 2:00	***Lunch Break***		
	2:00 – 4:30	**10. Recommendations from breakout sessions and bringing them together**	Chairs, Session 8 and 9	
	4:30 –5:00	**11. Summary, remaining issues, and next steps**	Lammie / Addiss	

Please find the background reading materials linked via Dropbox here and via Google here.

Annex 2. Participants

Soil-Transmitted Helminthiasis Diagnostics Meeting

22-23 August 2016

Ghent University

Ghent, Belgium

Organization	*Name*	*Email*
Baylor College of Medicine	Rojelio Mejia	rmejia@bcm.edu
Natural History Museum London	Peter Jourdan	P.Jourdan@nhm.ac.uk
Cambodia - National Center for Parasitology, Entomology, and Malaria Control	Sinuon Muth	sinuonm@gmail.com, sinuonm@cnm.gov.kh
CDC	Richard Bradbury	Isl5@cdc.gov
	Kim Won	Kfw7@cdc.gov
CWW	David Addiss	daddiss@taskforce.org
DOLF - Washington University	Peter Fischer	pfischer@ wustl.edu
ETZ Elisabeth Hospital, Tilburg	Jaco Verweij	j.verweij@elisabeth.nl
Ghent University	Bruno Levecke	bruno.levecke@ugent.be
	Jozef Vercruysse	jozef.vercruysse@ugent.be
	Johnny Vlaminck	Johnny.vlaminck@ugent.be
	Piet Cools	Piet.cools@ugent.be
GSK	Mark Bradley	mark.h.bradley@gsk.com
Halteres Associates	Janice Kolberg	jkolberg@halteresassociates.com
Janssen Diagnostics	Lieven Stuyver	lstuyver@its.jnj.com
J&J / Janssen	Steven Silber	ssilber@its.jnj.com
KEMRI	Charles Mwandawiro	mwandawirocharles@gmail.com
Liverpool School of Tropical Medicine	Suzanne Campbell	Suzanne.Campbell@lstmed.ac.uk
London School of Hygiene and Tropical Medicine	Amaya Bustinduy	Amaya.Bustinduy@lshtm.ac.uk
LUMC Leiden University Medical Center	Lisette van Lieshout	lvanlieshout@lumc.nl
McGill University	Theresa Gyorkos	theresa.gyorkos@mcgill.ca
National Institutes of Health	Thomas Nutman	tnutman@niaid.nih.gov
NTD Support Center	Maria Rebollo	mrebollo@taskforce.org
	Patrick Lammie	plammie@taskforce.org
PATH	Tala de los Santos	tdelosantos@path.org
	Helen Storey	hstorey@path.org
Smith College	Steven Williams	swilliam@smith.edu
Swiss Tropical and Public Health Institute	Jennifer Keiser	jennifer.keiser@unibas.ch
	Steffi Knopp	s.knopp@unibas.ch
	Soeren Becker	soeren.becker@becker-malente.de
Univ. Nac. de Salta/Mundo Sano	Alejandro Krolewiecki	alekrol@hotmail.com
University of Naples Federico II	Guiseppe Cringoli	cringoli@unina.it
	Laura Rinaldi	laura.rinaldi@unina.it
University of the Philippines Manila	Vicente Belizario	vbelizar@yahoo.com vybelizario@up.edu.ph
University of Torino, Fondazione Ivo de Carneri	Marco Albonico	albonico@tin.it
WHO	Antonio Montresor	montresora@who.int