

discuss some of the limitations to this method, what efforts can be made to improve its use in the future, and how it might be complemented by epidemiological modeling.

## 1930

### USE OF SALIVA FOR LARGE SCALE *TRYPANOSOMA CRUZI* SCREENING

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Vector control for Chagas disease was aggressively addressed during 1990s, and in 2006, Brazil was certified as free of vector transmission caused by the main vector *Triatoma infestans*. Nevertheless, residual infestation and recolonization can occur, threatening the long-term success of the vector control. Large scale serological surveys using blood collection are complex to perform and have been used only focally to monitor areas where sporadic acute cases were detected. The development of an antibody detection method based on saliva would facilitate large scale and systematic screening of children in endemic regions. The aim of this study was to evaluate if plasma could be replaced by saliva in commercial available T cruzi EIA. We have collected saliva from 100 T.cruzi infected patients and 50 healthy individuals using Sallivete®, Sarsted. Five assays were evaluated (ARCHITECT Chagas – Abbott; Chagas REC – INVITRO; GOLD ELISA Chagas – REM; ELISA recombinant v.4.0 – Wiener and ELISA Chagas III – Grupo Bios S.A – Diasorin). Test parameters such as sample and conjugate dilutions, incubation time and conjugate manufacturer were modified. A better discrimination between Chagas patients and controls were achieved using the ELISA recombinant v.4.0 – Wiener kit under the following conditions: no sample dilution, no conjugate dilution, sample and conjugate incubation period of 60 minutes and a cut-off of two standard deviation above the mean of the controls. Under these conditions the assay sensitivity and specificity were 97% and 100% respectively, showing that saliva could replace plasma for large screening surveys in endemic areas.

## 1931

### POLICY RECOMMENDATIONS FOR REACHING ELIMINATION OF VISCERAL LEISHMANIASIS ON THE INDIAN SUBCONTINENT: A COMPARISON OF MULTIPLE TRANSMISSION MODELS

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Introduction: On the Indian subcontinent (ISC), visceral leishmaniasis (VL) is targeted for elimination as a public health problem by 2020. The elimination target is defined as an annual VL incidence of <1 per 10,000 capita at (sub-)district level. Interventions focus on vector control, surveillance and on diagnosing and treating VL cases. Aim: To explore whether and within which timeframe current interventions may lead to reaching the VL elimination target. Methods: We present multiple mathematical models of VL transmission on the ISC with structural differences regarding the main reservoir of infection, including those with a prominent role of asymptomatic infection. We compare their predictions for achieving the WHO VL elimination targets with ongoing and alternative treatment and vector control strategies. Results: All the transmission models suggest that the WHO elimination target will be met in Bihar, India, before or close to 2020 in sub-districts with a pre-control

incidence of 10 VL cases per 10,000 people per year or less, when current interventions (60% coverage of indoor residual spraying (IRS) of insecticide and an average delay of about 40 days from onset of symptoms to treatment) are maintained. Conclusion: Increasing the IRS coverage and to a lesser extent reducing the time from onset of symptoms to treatment will both decrease the time to elimination. However, in all cases the models suggest there is likely to be ongoing transmission after 2020 and so control measures will have to be kept in place for several years to achieve the longer-term aim of breaking transmission.

## 1932

### A LONGITUDINAL ASSESSMENT OF GAMETOCYTE PRODUCTION AND INFECTIVITY IN CHRONIC AND ACUTE *PLASMODIUM FALCIPARUM* INFECTIONS

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Gametocytes are essential for onward transmission to mosquitoes. In *Plasmodium falciparum*, gametocytes appear 10-12 days after asexual parasites and often circulate at very low densities. It is currently unclear whether individuals are infectious to mosquitoes before symptoms arise or before malaria infections are detectable by microscopy. We assessed gametocyte production and infectivity in two cohorts in Burkina Faso. In the first cohort, children (5-10 years) were cleared of pre-existing infections and were subsequently weekly monitored by molecular methods for incident infections. Upon first detection of infection, sampling was performed daily and monitoring continued for 42 days. Mosquito feeding assays were performed at day 0 (day of detection of infection), d14 and d35. The second cohort was identical in design but malaria infections were not cleared. Intensive follow-up commenced once an asymptomatic infection was detected for 2 consecutive months (a chronic infection). 51 acute and 39 chronic *P. falciparum* infections were monitored for asexual parasite and gametocyte dynamics and infectivity to mosquitoes. Only 13% (7/51) of children with acute infections remained fever free after the first detection of malaria infection by nPCR, whilst 72% (28/39) of all children with chronic malaria infections remained asymptomatic during 42 days of intensive monitoring. Although mature gametocytes were detected at low densities, none of children with acute malaria infections infected mosquitoes compared to 69% (27/39) of children with chronic infections. Of the latter, some were infectious at 2 or 3 occasions during the 35-days of intensive follow-up and infected up to 98% of mosquitoes. Taken together, our results suggest that intensive monitoring allows the detection of symptomatic malaria before infected individuals become infectious to mosquitoes. Asymptomatic malaria-infected children, on the other hand, are often infectious for several weeks; their identification will be key to the success of malaria elimination strategies.

## 1933

### MALARIA BURDEN THROUGH ROUTINE REPORTING: RELATIONSHIPS BETWEEN INCIDENCE ESTIMATES

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Malaria burden remains high in Uganda, ranked 4th by number of cases and 11th by number of deaths worldwide and accounting for 30-50% of outpatient visits. The burden is estimated using routine surveillance for planning, implementation, and evaluation of public health practice. Standard routine measures of burden include total suspected or cases, and test positivity rate (TPR) as incidence proxies. Additional estimates of incidence commonly used are evaluated in this study. We aim to explore relationships between incidence estimates from routine data to improve interpretation of burden reported through routine reporting. Three high-level facilities located at varied malaria endemicities in Uganda (Nagongera, Walukuba & Kihhi) were included. Study participants were children under 11 years suspected to have malaria, and seen between Oct-2011 and Jun-2016. Estimates of incidence (TPR, malaria positive fraction - MPF, mean incidence (reported case) rate - MIR, and standardized incidence ratio - SIR) were derived and pairwise relationships between them explored. Nagongera, Walukuba & Kihhi HCIV saw 46,049 (79%), 31,861 (52%) and 32,675 (78%) study participants of which 33.3%, 34.0% and 60.7% respectively, had home village recorded as located within the facility's sub-county. Strong nonlinear relationships were observed between MPF and MIR over time (monthly). And, positive linear relationships observed between MPF and SIR over time (Coef=0.140,  $p < 0.001$ ; Coef=0.215,  $p = 0.002$ ; Coef=0.198,  $p < 0.001$ ). Similarly, weaker linear relationships were observed across space (Coef=-0.012,  $p = 0.785$ ; Coef=-0.013,  $p = 0.589$ ; Coef=-0.026,  $p = 0.133$ ). Burden over time is not implied across space. Improved interpretation of burden requires an account for both time and space/location. Full results will be presented at the conference.

## 1934

### LONGITUDINAL CLINICAL AND MOLECULAR ANALYSIS OF ASYMPTOMATIC MALARIA INFECTION IN MALAWI

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In Malawi, asymptomatic *Plasmodium falciparum* infections are common and may drive transmission. The frequency, persistence, and clinical outcome of asymptomatic infections is unknown. Although school aged children (SAC) carry the majority of prevalent infections, this may be due to increased exposure to infection or a prolonged duration of asymptomatic infections. Whether and how many asymptomatic infections progress to clinical disease and eventually prompt treatment is unknown. We characterize the age-specific dynamics of asymptomatic infections in a high-transmission setting and examine the association between asymptomatic infection and clinical disease. In total, 120 participants, aged 1-50 years, with uncomplicated malaria (treated with artemether-lumefantrine) were enrolled and followed monthly for up to two years. Samples from all visits were tested for parasites using both microscopy and qPCR. Genotyping with *m*sp1 and *m*sp2 was used to characterize the complexity of each infection. Molecular force of infection was defined as the number of unique infecting genotypes/person/year. Analysis has been completed for 1702 person months of follow up time. Asymptomatic infections were detected in 23% of visits. Asymptomatic infection, the longest of which persisted for 16 months, was associated with increased time to next clinical malaria (HR 0.45,  $p < 0.001$ ) in all ages. The mean duration of persistence of individual infections will be calculated by age.

Overall, 785 incident infections were detected; 35% at a visit when no symptoms were reported. We found SAC are a distinct risk group, and have a significantly higher molecular force of infection (IRR 2.4,  $p < 0.001$ ) than other age groups. In our setting, clinical malaria was more likely to be due to newly acquired infection (OR 4.6, 95%CI 2.5-8.5) than to a persistent infection. Asymptomatic infections constitute a significant reservoir of *P. falciparum* in Malawi and may be protective against clinical malaria.

## 1935

### TRACKING MALARIA: PREGNANT WOMEN AS A SENTINEL POPULATION FOR MALARIA SURVEILLANCE

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With increasing spatial heterogeneity of malaria transmission and an age shift of the disease burden towards older children and adults, pregnant women attending antenatal care (ANC) have been proposed as a pragmatic sentinel population for malaria surveillance. However, the representativeness of routine ANC prevalence data and how it is related to the prevalence in other population subgroups has yet to be investigated. For this study, we obtained monthly ANC malaria prevalence data from all Tanzanian health facilities reporting to the national data warehouse DHIS2 between January 2014 and May 2016. Among 4,354,911 pregnant women attending ANC, 49.6% were tested for malaria. The average malaria infection prevalence in pregnant women was 7.6% (95% CI 7.2-7.9) with little monthly variation. In 2015, malaria prevalence was generally higher in school children and in children aged 6-59 months than in pregnant women, with substantial variability between regions and districts. A high correlation was found between regionally aggregated ANC prevalence and prevalence in children aged 6-59 months (Spearman rho:  $p = 0.90$ ;  $p < 0.0001$ ) as well as school children (regional:  $p = 0.84$ ;  $p < 0.0001$ ; district:  $p = 0.80$ ;  $p < 0.0001$ ). On the other hand, correlation was low with district aggregated prevalence predicted by the Malaria Atlas Project ( $p = 0.56$ ;  $p < 0.0001$ ). In all comparisons, the correlation was substantially better in districts or regions with one rainy season compared to areas with biannual rain. The results of this study provide strong support for using pregnant women attending ANC as a sensible and pragmatic sentinel population to assess malaria trends in Tanzania. However, ANC malaria prevalence cannot be used to directly predict the prevalence in other population subgroups. Further work is required to identify covariates that influence the relationship between ANC and other population subgroup prevalences particularly in areas of more intense seasonality.

## 1936

### COMBINING LONG-LASTING INSECTICIDAL NETS AND INDOOR RESIDUAL SPRAYING FOR MALARIA PREVENTION IN ETHIOPIA: A CLUSTER RANDOMIZED CONTROLLED TRIAL

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Long lasting insecticidal nets (LLINs) and indoor residual spraying (IRS) are effective tools to prevent malaria, but the effectiveness of combining the two are not yet fully understood. This study compared the separate versus combined effect of LLINs and IRS on malaria incidence and anemia. This cluster randomized controlled trial was done in the Adami Tullu