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Evaluation Integrated Mass Drug Administrations (MDA) for Neglected Tropical Diseases, in Koza District, Cameroon

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Evaluation Integrated Mass Drug Administrations (MDA) for Neglected Tropical Diseases, in Koza District, Cameroon

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MS, Soil and Water Science

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Dedication

This thesis is dedicated to those who work every day to end neglected tropical diseases throughout the world. These are the public health heroes that inspire.

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Education

2009-2012 **Georgia State University**

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MPH, Prevention Science/Epidemiology Track

2005-2007 **University of California, Riverside**
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MS Soil and Water Science

2000-2004 **University of the Pacific**
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Research Experience

1/2012-present **Intern, Division of Parasitic Diseases and Malaria**

Centers for Disease Control & Prevention, Atlanta, GA

Analyzed survey data in SAS 9.2. Wrote report for program evaluation on mass drug administration for neglected tropical diseases for country partners.

11/2007-present **Associate Service Fellow, Division of Viral Diseases,**

Pathogen Discovery Team

Centers for Disease Control & Prevention, Atlanta, GA

Specimen processing and employing RT-PCR and sequencing methods to detect novel viruses in human and zoonotic specimens. Participation in Global Disease Detection grant for the surveillance of novel pathogens from bats. Phylogenetic analysis of virus sequences using Mega5 and LaserGene software. Manage laboratory safety and oversee annual safety survey for the Pathogen Discovery team.

9/2005-10/2007 **Graduate Research Assistant, Dept. of Environmental Science**

Dr. Marylynn Yates, UC Riverside

Managed various cell lines and employed real time PCR techniques to monitor the survival of coxsackievirus, echovirus, and polio virus in environmental samples. Researched the survival of viruses in groundwater and compared three different virus quantification methods: integrated cell culture RT-PCR, immunomagnetic separation RT-PCR, and traditional plaque assay. Determined that plaque assay was more consistent over time, although less sensitive than molecular methods, for viral detection. Calculated virus survival curves for each experimental design.

9/2004-8/2005 **Emerging Infectious Disease Training Fellow, CDC & APHL**

Dr. David Boyle, Washington State Public Health Laboratory

Utilized molecular techniques to conduct research on the variance of virulence proteins for circulating strains of *Bordetella pertussis* in Washington State. Developed and optimized SYBR green and Taqman real time PCR assays for high through put screening of pertactin and pertussis toxin alleles. Collaborated with Seattle-King County epidemiologists for optimization of Pulse Field Gel Electrophoresis clustering of *B. pertussis* outbreaks.

6/2004-8/2004 **Summer Intern, Hepatitis C Group**

Roche Bioscience, Palo Alto, CA

Contributed to the evaluation of potential drug candidates against HCV, by assessing their effectiveness against known drug resistant mutant Hepatitis C viruses using the replicon system, real time PCR, and luciferase assays. Generated HCV mutants and determined IC50's for varied drug concentrations.

6/2003-8/2003 **Summer Intern, Molecular Biology Group**

DNAX Research Institute, Palo Alto, CA

Employed routine molecular biology methods in the subcloning of human cytokine gene mutants for the evalution of epitope binding sites. Assisted in the preparation of DNA for sequencing and operation of the ABI3100 for the DNAX sequencing facility.

Lab Techniques

Mammalian cell culture, plasmid transfection and viral infection in mammalian cell lines, virus purification and quantification, RNA isolation from mammalian tissue, RNA/DNA extraction from specimens, plasmid DNA isolation, PCR and real time PCR assay development and validation, restriction digests, gel purification of DNA fragments, PCR, RT-PCR, sub cloning, agarose electrophoresis, pulse field gel electrophoresis (PFGE), real time PCR (ABI 7500 & 7300, BioRad icyler, Cepheid SmartCycler, Stratagene MX3000), site directed mutagenesis, DNA sequencing, immunomagnetic separation, membrane filtration.

Software and applications

SEQUENCHER® Software (Gene Codes), PrimerExpress (ABI), Laser Gene Software (DNA Star), Mega5, SAS, SPSS, TreeView, VectorNTI (Invitrogen), Bionumerics (Applied Maths), ArcGIS (ESRI), Microsoft Office Suite

Relevant coursework

Epidemiology, Intermediate Epidemiology, Prevention Methods, Infectious Disease Epidemiology, Biostatistics, Intro to SAS, Virology, Public Health Microbiology, Molecular Parasitology, Case Studies in Epidemiology

Publications

"Genomic characterization of seven distinct bat coronaviruses in Kenya." Tao Y, Tang K, Shi M, **Conrardy C**, Li KS, Lau SK, Anderson LJ, Tong S. Virus Res. 2012 Jul;167(1):67-73. Epub 2012 Apr 26.
"A distinct lineage of influenza A virus from bats**"** Tong S, Li Y, Rivailler P, Conrardy C, Castillo DA, Chen LM, Recuenco S, Ellison JA, Davis CT, York IA, Turmelle AS, Moran D, Rogers S, Shi M, Tao Y, Weil MR, Tang K, Rowe LA, Sammons S, Xu X, Frace M, Lindblade KA, Cox NJ, Anderson LJ, Rupprecht CE, Donis RO. *Proc Natl Acad Sci U S A. 2012 Mar 13;109(11):4269-74. Epub 2012 Feb 27.*

"Reassortant group A rotavirus from straw-colored fruit bat (*Eidolon helvum*)" Esona MD, Mijatovic-Rustempasic S, **Conrardy C**, Tong S, Kuzmin IV, Agwanda B, et al. *Emerging Infectious Disease Journal. Vol. 16. No. 12. December 2010.*

"Identification of a Novel Astrovirus (Astrovirus VA1) Associated with an Outbreak of Acute Gastroenteritis" Stacy R. Finkbeiner, Yan Li, Susan Ruone, **Christina Conrardy**, Nicole Gregoricus, Denise Toney, Herbert W. Virgin, Larry J. Anderson, **Jan Vinjé, David Wang, and Suxiang Tong.** ***Journal of Virology. Vol. 83. no. 20. October 2009.***

"Detection of novel SARS-like and other coronaviruses in bats from Kenya" S. Tong, **C. Conrardy**, S. Ruone, I. Kuzmin, X. Guo, Y.Tao, M. Niezgoda, L. Haynes, L.J. Anderson, and C.E. Rupprecht. *Emerging Infectious Disease Journal. Vol. 15. No. 3. March 2009.*

Presentations

Coronavirus surveillance in bats 2006-2010. Presented at International Conference for Emerging Infectious Diseases March 2012.

Presented research results at both the Gasteroenteritis and Respiratory Virus Lab Branch Meeting and Division of Viral Diseases meeting during 2009and 2010.

Coronavirus detection from bats in rural areas of Guatemala: implications for emerging infectious diseases. **C.Conrardy**, S. Recuenco, J. Ellison, D. Moran, D. Alvarez, K. Linblade, L.J. Anderson, C.E. Rupprecht, S.Tong. International conference on Emerging Infectious Diseases. July 2010. Atlanta, GA USA

Paramyxovirus, adenovirus, polyomavirus, and rhabdovirus detection from bats in Kenya: potential for emerging zoonotic diseases. S.Tong, **C.Conrardy**, I.V. Kuzmin, B.Agwanda, M. Niezboda, R.F. Breiman, C.E. Rupprecht, L. J. Anderson. . International conference on Emerging Infectious Diseases. July 2010. Atlanta, GA USA

Coronavirus Surveillance in Kenya 2006-2007. **C. Conrardy**, I. Kuzmin, M. Niezgoda, L. Haynes, L.J. Anderson, C.E. Rupprecht, and S. Tong. American Society of Virology Conference July 2009, Vancouver, BC, Canada

Molecular Surveillance of Bordetella pertussis in Washington State from 2000-2004. **C.B. Conrardy**, R. Pallipamu, A. DeRubeis, C. DeBolt, M.Grandjean, J.S. Duchin, M. Goldoft, J. Hu, R. Gautom, D. Boyle. International Union of Microbiological Societies July 2005, San Francisco, California, USA.

Determination of Pertussis Toxin (PTXS1) and Pertactin (PRN) alleles using real time PCR. **C.B. Conrardy**, R. Pallipamu, J. Hu, R. Gautom, D. Boyle. International Meeting on Microbial Epidemiological Markers May 2005, Victorica, BC, Canada.

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I. Disease Burden of neglected tropical diseases or NTD's

The burden of neglected tropical diseases or NTDs is greater than that of malaria, tuberculosis, and other diseases such as HIV/AIDS (Hotez 2011) .One billion of the 2.7 billion poorest people living on less than $2 US dollars a day are infected by one or more neglected tropical diseases, which intensify poverty and stigmatize those that are affected (Liese, Rosenberg et al. 2010). NTDs which often overlap geographically, predominantly affect poor populations living in rural tropical and subtropical regions. According to the WHO 2010 report on NTDs, "100% of low-income countries are affected by at least five neglected tropical diseases simultaneously"(WHO 2010). NTDs contribute not only to a high morbidity and disability, but also contribute to an ongoing cycle of poverty and shame for the people they affect (Hotez 2011).

According to a 2002 report by the World Health Organization (WHO), neglected tropical diseases, which include soil transmitted helminths (STH), trachoma, schistosomiasis, onchoceraisis, and lymphatic filariasis (LF), contribute to 5% of the global burden of infectious diseases (Smits 2009). The world's highest prevalent NTDs which include hookworm, ascaris, trichuris, lymphatic filariasis, schistosomiasis, trachoma and onchocerciasis infect over 1 billion people globally and contribute to 52.1 million disability-adjusted life years (DALYs) (Fenwick 2012). The burden of disease caused by NTDs may be under estimated due to the fact that they may be chronic or that the proper diagnostic tools or epidemiology to estimate the true burden of disease are lacking (Smits 2009). The chronic disease caused by the NTDs can result in disfigurement, impaired child development, poor pregnancy outcomes, and reduced productivity (Hotez, Molyneux et al. 2007).

In 2010, the World Health Organization published its first report on neglected tropical diseases which stated that the highest prevalence NTDs could be eliminated by 2020 (WHO 2010) . Strategies to battle NTDS include increased hygiene, environmental improvement, vector control, sustained socio economic development, and preventive chemotherapy(Smits 2009). Preventive chemotherapy through targeted mass drug administration is one of the most "tool ready" and cost-effective methods for controlling NTDs. The donation of drugs or availability of drugs at very low costs from pharmaceutical companies has made the mass drug administration for control of NTDs possible, even in resource poor countries. According to the WHO 2012 report on the roadmap for reducing the impact of global NTDs, short term solutions such as preventative chemotherapy can significantly reduce morbidity and transmission (WHO 2012). However, long term elimination will not be possible without access to clean water, sanitation, and improved living conditions (WHO 2012). The WHO and United States Agency for International Development or USAID have established elimination and control goals for NTDs targeted by mass drug administration or MDAs. LF is targeted for elimination by 2020. Onchocerciais is targeted for elimination in the Americas by 2016. In addition, the WHO would like to reduce the prevalence of NTDs by 50% in 70% of the population living in areas endemic for these diseases (Hotez 2011).

II. Overview of the major NTDs

A. Trachoma

Trachoma is the leading infectious cause of blindness worldwide (Burton 2007). Trachoma is caused by the bacterium *Chlamydia trachomatis* and can cause visual impairment and blindness (Hu, Harding-Esch et al. 2010). Trachoma infection has been observed for centuries in all areas

of the world including Europe and North America, but today it is found predominantly in poor countries in sub-Saharan Africa and Asia (Hu, Harding-Esch et al. 2010). Trachoma is estimated to cause 2.3-4.0 million DALYs (Smits 2009). Trachoma is transmitted by flies. Repeated infection of the ocular surface initiates chronic inflammatory responses that lead to cornea damage and scarring(Feasey, Wansbrough-Jones et al. 2010). As the scar tissue shortens, the eye lids are distorted and it causes the eyelashes to come into contact with the surface of the eye (trichiasis). When trichiasis occurs the cornea is compromised and blindness occurs(Burton 2007).

MDA for trachoma is a 20mg/kg dose of azithromycin. Other methods of controlling trachoma include improved sanitation, facial hygiene, and health education. One way to undo the effects of the blindness caused by trachoma is through eyelid surgery which reverses the in-turning of the eyelashes and may also improve non-visual symptoms (Mathew, Turner et al. 2009). Through the WHO established Alliance for the Global Elimination of Blinding Trachoma, trachoma control is implemented through the SAFE Strategy (WEST 2003). The components of the SAFE strategy include both short term and long term interventions for control and prevention of trachoma and trichiasis: S, surgery for trichiasis, A, antibiotics to prevent infection, F, facial cleanliness, and E, environmental improvement. The WHO has targeted the elimination of blinding trachoma for the year 2020. Treatment for trachoma is a single oral dose of the antibiotic azithromyxin with treatment every 6-12 months (Mathew, Turner et al. 2009).

B. Soil Transmitted Helminths (STH)

Soil transmitted helminthiasis (STH) is caused primarily by the nematodes *Ascaris lumbricoides* (roundworm), *Ancylostoma duodenale*, *Necator americanus* (hookworm), and *Trichuris*

trichiura (whipworm) which infect the intestine (Bethony, Brooker et al. 2006). Poor personal hygiene and sanitation contribute to the transmission of STH (Bethony, Brooker et al. 2006). Global prevalence of ascariasis, hookworm, and trichriasis is 600 million(Smits 2009). It is estimated that the burden of STH ranges from 4.7-39 million DALYS (Smits 2009). STH are transmitted through contaminated soil or consuming fruits and vegetables that haven't been fully cooked, washed or peeled. After the worms are acquired through ingestion or the soil, they infect the gastro-intestinal tract, reproduce, and release eggs into the environment through the feces(Feasey, Wansbrough-Jones et al. 2010). Children infected from STH can suffer from anemia, vitamin A deficiency, impaired growth, malnutrition, and reduced cognitive development (WHO 2010). The main approach to achieve control or elimination of the highly prevalent STH's includes MDA with albendazole or mebendazole together with ivermectin(Hotez 2011).

C. Schistosomiasis

Schistosomisasis or bilharziasis is caused by the trematodes, *Schistosoma haematobium*, *Schistosoma mansoni, Schistosoma japonica*, and *Schistosoma mekongi(WHO 2010).* Schistosomiasis is common in places with poor sanitation and is acquired by swimming, bathing or coming into contact with contaminated fresh water (Steinmann, Keiser et al. 2006). Fresh water snails carry the larval form (schistosomes) of the trematodes which can penetrate human skin (Feasey, Wansbrough-Jones et al. 2010). The disease burden of schistosomiasis is estimated to be 1.8-4.5 million DALYs (Smits 2009). It is estimated that nearly 600 million people suffer from schistosomiasis with 90% in Africa (Hotez 2011). In Africa, having schistosomasis has been reported to increase the likelihood of contracting HIV/AIDS and nearly 300,000 people die of schistosomiasis each year(Hotez and Fenwick 2009). The symptoms of schistosomiasis are

not caused by the worms themselves, but by the body's reaction to the eggs as they pass through blood vessels, intestine, ureters, bladder or become lodged in the liver or lungs(Feasey, Wansbrough-Jones et al. 2010). The eggs can cause chronic ill health and can damage major organs including the liver, intestine, spleen, lungs, and bladder (Ross, Bartley et al. 2002). School aged children are most at risk for schistosomiasis. Children who are repeatedly infected by shistosomes can develop anemia, malnutrition, and impaired cognitive development which can affect school attendance(WHO 2010). Schistosomiasis treatment and elimination strategies include treatment with Praziquantel based on body weight or height as well as improved access to clean water and sanitation (Smits 2009).

D. Onchoceriasis

Onchoceriasis more commonly known as river blindness, is caused by the nematode worm *Onchocerca volvus* (Duke 1990). The WHO estimates that 37 million people are infected with *O. volvulus* worldwide; of these people 270,000 are blind and 500,000 have some sort of visual impairment. Onchoceriasis causes nearly 1 million DALYs (Boatin and Richards Jr 2006). Transmission of onchoceriasis occurs from multiple bites from the *Simuliaum* black fly which breeds near fast running streams and rivers. People most at risk for onchocerciasis include fishermen, farmers, or those that spend long hours or live near the black fly breeding sites. In fact, in areas near rivers where the disease exists almost every person in a community may be infected and almost half of the population will suffer from blindness (Etya'al 2001). Symptoms of the disease do not manifest until one to three years after the parasite has been injected into its victim (Etya'al 2001). The adult worm lives in the fibrous and subcutaneious nodules. The adult females produce millions microfilariae which migrate under the skin and to the eyes(Crompton and WHO 2006).

Since 1987 onchocerciasis control has relied on the donation of ivermectin (Mectizan®, Merck & Co., Inc.) through the Mectizan Donation Programme (MDP).(Boatin and Richards Jr 2006). Unfortunately ivermectin does not kill the adult but only the larvae, so treatment must be continued for the life of the adult worm which can be as long as 15 years (Amazigo, Leak et al. 2012). International programs including ,the African Program for Onchocerciasis control (APOC) , the Onchocerciasis Control Programme of West Africa, and the Onchocerciasis Elimination Program for the Americas have been successful with implementation of larvicide spraying for black fly control and mass drug administration of ivermectin (Richards, Boatin et al. 2001). Interruption of Transmission of Oncocerciasis has been documented in endemic areas of Guatemala, and several regions in Mali and Senegal (Feasey, Wansbrough-Jones et al. 2010).

E. Lymphatic filariasis (LF)

Lymphatic filariasis also known as elephantiasis is a parasitic infection caused by *Wuchereria bancrofti*, *Brugia malai*, and *Brugia timori*. LF has no animal reservoir and is transmitted by mosquitoes. The main symptoms of LF include swelling of the limbs or lymphodema, elephantiasis, and swelling of genital organs or hydrocele (Richards, Eigege et al. 2011). LF is estimated to have a disease burden 5.6-5.8 DALYS per million people. It is estimated that 1.2 billion people live in areas endemic for LF(Crompton and WHO 2006). Three drugs are recommended for the treatment of LF, ivermectin, diethlcarbamazine (DEC), and albendazole. Adult worms are not totally eliminated by one drug treatment, so a combination of drugs is required. The strategy to eliminate lymphatic filariasis has two components with one component being MDA of DEC+ albendazole or ivermectin+ albendazole. The other component involves home-based care and community based programs to guide individuals suffering from the disease and educate persons on hygiene and treatment of affected limbs (Crompton and WHO 2006). In

order to reduce transmission of LF, it is recommended to have a coverage of 70-80% over a period of 5-6 years (Ottesen, Hooper et al. 2008). In the year 2000, the WHO established the Global Program to Eliminate Lymphatic Filariais (GPELF). Through MDA, 1.9 billion treatments to people in 48 countries have been delivered. Between 2000-2008, the GPELF has prevented more than 6 million cases of hydrocele ,4 million cases of lymphodema, and 6 million DALYs have been averted(Ottesen, Hooper et al. 2008).

III. Preventive chemotherapy as a strategy to control or eliminate NTDs.

According to the WHO, nearly 90% of NTDs can be treated with drugs that only need to be administered once or twice each year in contrast to diseases like AIDS, and TB (WHO 2012). Large scale chemotherapy is a cost-effective intervention that contributes to several Millennium Development goals outlined by the United Nations including, eradicating poverty and hunger, achieving universal primary education, promoting gender equality, reducing childhood mortality, improving maternal health, and fighting HIV/AIDS, TB, and malaria(Crompton and WHO 2006). Preventative chemotherapy (PCT) is "the regular, large-scale elimination of drugs—either alone or in combination—to entire population groups living in areas where helminth infections and trachoma are prevalent, with the aim of reducing their morbidity and transmission"(Montresor, Gabrielli et al. 2012). The WHO recommends preventative chemotherapy as a strategy for the control of highly prevalent NTDs including lymphatic filariasis, onchocerciasis, schistosomiasis, soil-transmitted helminthiasis, and trachoma(Crompton and WHO 2006). Preventative chemotherapy can be targeted based on the epidemiology of a disease in a particular area or can be applied to an entire population in an endemic area using mass drug administration or MDA (Crompton and WHO 2006). Treatment and frequency of the MDA depends on endemicity of a disease in a particular area. Integrated

preventative chemotherapy is a new, key strategy for battling areas where more than one NTD is endemic. Coordinated implementation of preventative chemotherapy for LF, onchocerciasis, schistosomiasis, STH, and trachoma helps to attain higher coverage rates and to efficiently use resources(Montresor, Gabrielli et al. 2012).

Large scale preventative chemotherapy is made possible by the donation or availability of drugs at low cost by pharmaceutical companies. Albendazole is donated by GlaxoSmithKline. Ivermectin (Mectizan®) and praziquantel are donated by Merck. Albendazole and ivermectin are available as long as necessary until the elimination program reaches success. Mebendazole is donated by Johnson and Johnson. Azithromycin (Zithromax ®) used to treat Trachoma, is donated by Pfizer. In order to assess the performance of large scale chemotherapy it is important to determine the coverage of the MDA. Coverage refers to the proportion of the persons in the target population who took the recommended drugs (Crompton and WHO 2006). Determining coverage is critical to assess the effectiveness of the MDA (Smits 2009). Low coverage threatens the success of MDA programs and may present a risk for the development of drug resistance(Smits 2009). Health education and community participation are critical for achieving high coverage rates and the success of the MDA programs (Smits 2009).

IV. Current PCT and MDA programs

Progress has been made in the last 10 years to scale up NTD control and public health partnerships between governments, NGOs, and pharmaceutical companies, (Montresor, Gabrielli et al. 2012). It is estimated that over 700 million individuals are being treated for one or more NTDs each year(Montresor, Gabrielli et al. 2012). A summary of MDA programs, pharmaceutical partners, and number of people treated are listed in table 1. After many

successful rounds of preventative chemotherapy onchoceriasis is on track for elimination in the Americas. For exam ample in Guatemala researchers have observed the disruption of onchocerciasis transmission and children between 6-12 years of age living in endemic areas had no serological evidence of infection(Cruz-Ortiz, Gonzalez et al. 2012). In 2011, Columbia became the first country in the Americas to successfully eliminated onchocerciasis and is on track for elimination in Brazil, Colombia, Ecuador, Guatemala, Mexico and Venezuela (Gustavsen, Hopkins et al. 2011). Globally, progress has been made in the last 10 years to scale up NTD control through public health partnerships between governments, non-governmental organizations (NGOs), and pharmaceutical companies. It is estimated that over 700 million people are being treated for one or more NTDs each year (WHO 2010). For instance an estimated 22 million people have been protected from LF infection and disease saving an estimated $24.2 billion US dollars (Addiss and Filariasis 2010).

Table 1: Summary of programs for NTDs Adapted from Montressor et al. 2012 and Smitts 2009, Fenwick 2012

Disease	Program or Initiative	Treatment	Pharmaceutical partner(s)	Endemic countries (n)	Countries where large scale MDA is being implemented	Number of people receiving treatment in 2009 (coverage %)	Frequency of intervention
Onchocerciasis	Mectizan® (Ivermectin) Donation Program, African programme for onchocerciasis control (APOC) and the Onchocerciasis elimination Program for the Americas (OEPA).	Ivermectin	Merck	33	33	68,730,261 (57%)	annually
Trachoma	International Trachoma Initiative	azithromycin	Pfizer	42	26	45,000,000 (13%)	annually for school aged children
Soil Transmitted Helminthiasis	2001 World Health Assembly resolution, Children without worms	albendazole or mebendazole	Johnson and Johnson, GlaxoSmithKline	112	50	109,749,000 (40%)	once or twice a year depending on prevalence of infection
Schistosomiasis	Schistosomiasis Control Initiative	praziquantel	Medpharm/Merck	78	21	19,570,000(8%)	According to prevalence of infection
Lymphatic filariasis	Global Alliance to Eliminate Lymphatic Filariasis (GAELF), Mectizan® (Ivermectin) Donation Program	Diethylcarbamazide (DEC), or Ivermectin plus Albendazole	Merck, EISAI	81	53	385,270,000(28%)	annually

V. History of Preventative Chemotherapy in Cameroon

The health system in Cameroon is organized into central, regional and into 179 smaller local health districts (Tchuem Tchuenté, Kamwa Ngassam et al. 2012). The population density in Cameroon varies greatly from region to region and can range from 7.4 inhabitants/km^2 to 141.5 inhabitants/km^2(Tchuem Tchuenté, Kamwa Ngassam et al. 2012).

Cameroon has a high prevalence onchocerciasis, lymphatic filariasis, schistosomiasis, trachoma and soil transmitted helminths and affect millions of people throughout the country(Klopp 2009). According to Helen Keller International, a partner working with the Cameroon Ministry of Health , over10 million people are at risk for onchocerciasis, 5 million are at risk for schistosomiasis, and 2 million people may already be infected with schistosomiasis (Klopp 2009). In south west Cameroon, the prevalence of STH infections ranged from 30-40% depending on if person lives in an urban or rural area (Mbuh, Ntonifor et al. 2012).

In Cameroon, the National Strategic Plan for the control of STH and schistosomiasis began in 2004 with a limited budget and under a small scale(Tchuem Tchuenté, Kamwa Ngassam et al. 2012). In 2007, with the help of international and national partners including the Cameroon Ministry of Health, Helen Keller International, United States Agency for International Development, Children Without Worms, Mectizan® Donation program, and African Program for Onocerciasis Control and other partners, the program was implemented all over the country. De-worming campaigns targeting school aged children have occurred annually since 2007(Tchuem Tchuenté, Kamwa Ngassam et al. 2012). In 2009, the Government of Cameroon implemented an integrated approach for controlling NTDs for greater efficiency and cost-effectiveness(Tchuente and N'Goran 2009). With monetary support from the United States

Agency for International Development (USAID), the Cameroon government coordinates co-administration of several drugs for control of NTDs including lymphatic filariasis, onchoceriasis, trachoma, schistosomiasis and soil transmitted helminths(Tchuem Tchuenté, Kamwa Ngassam et al. 2012).

One item to be concerned about while implementing PCT in Cameroon is the occurrence of Lao Lao, a filarial nematode, in areas also endemic for LF, onchoccerciasis, schistosomiasis, and STH. When persons have high levels of loiasis, Ivemectin treatment can result in severe adverse reactions events which could include encephalopathy(Crompton and WHO 2006).

Recent mapping campaigns to determine the prevalence of STH and schistosomiasis have demonstrated that the prevalence of STH and schistosomiasis has declined from 81.1-93% down to 10.5%-46%, proving the impact of annual deworming and NTD control campaigns(Tchuem Tchuenté, Kamwa Ngassam et al. 2012).

VI. Purpose of the Study

In order to accurately measure the achievement of mass drug administration programs and drug delivery it is important to make sure that the drugs reach everyone that needs them and that the coverage is high enough to interrupt transmission. It is believed that through adequate chemotherapy to an at risk population will reduce the prevalence of infection and lead to elimination (Worrell and Mathieu 2012). MDA programs rely mostly on reported drug coverage calculated based on the number of doses given during the drug distribution and the denominator is the targeted population(Worrell and Mathieu 2012). Another way to measure drug coverage is through coverage surveys administered to households in the area where the MDA was administered. Coverage surveys are important for validating the reported coverage and in

addition, provide valuable information including basic demographics of the targeted population and reasons for non-compliance (Worrell and Mathieu 2012). The WHO recommends monitoring MDA programs through coverage surveys, however, coverage surveys require both monetary and human resources that may be scarce in resource poor settings (Worrell and Mathieu 2012). Validating the reported coverage through a coverage survey is an important component of MDA program evaluation and monitoring(Worrell and Mathieu 2012).

References

Albonico, M., D. Engels, et al. (2004). "Monitoring drug efficacy and early detection of drug resistance in human soil-transmitted nematodes: a pressing public health agenda for helminth control." International Journal for Parasitology **34**(11): 1205-1210.

Amazigo, U. V., S. G. A. Leak, et al. (2012). "Community-driven interventions can revolutionise control of neglected tropical diseases." Trends in Parasitology **28**(6): 231-238.

Babu, B. V. and S. K. Kar (2004). "Coverage, compliance and some operational issues of mass drug administration during the programme to eliminate lymphatic filariasis in Orissa, India." Tropical Medicine & International Health **9**(6): 702-709.

Bethony, J., S. Brooker, et al. (2006). "Soil-transmitted helminth infections: ascariasis, trichuriasis, and hookworm." The Lancet **367**(9521): 1521-1532.

Boatin, B. A. and F. Richards Jr (2006). "Control of onchocerciasis." Advances in Parasitology **61**: 349-394.

Burton, M. J. (2007). "Trachoma: an overview." British Medical Bulletin **84**(1): 99-116.

Crompton, D. W. T. and WHO (2006). Preventive chemotherapy in human helminthiasis: Coordinated use of anthelminthic drugs in control interventions : a manual for health professionals and programme managers. Geneva, Swizterland, World Health Organization.

Cruz-Ortiz, N., R. J. Gonzalez, et al. (2012). "Elimination of Onchocerca volvulus Transmission in the Huehuetenango Focus of Guatemala." Journal of Parasitology Research **2012**: 9.

Duke, B. (1990). "Human onchocerciasis-an overview of the disease." Acta Leidensia **59**(1-2): 9-24.

Etya'al, D. (2001). "Vision 2020: Update on Onchocerciasis." Community Eye Health **14**(38): 19-21.

Fenwick, A. (2012). "The global burden of neglected tropical diseases." Public health **126**(3): 233-236.

Hotez, P. (2011). "Enlarging the "Audacious Goal": Elimination of the world's high prevalence neglected tropical diseases." Vaccine **29, Supplement 4**(0): D104-D110.

Hotez, P. J. and A. Fenwick (2009). "Schistosomiasis in Africa: An Emerging Tragedy in Our New Global Health Decade." PLoS Negl Trop Dis **3**(9): e485.

Hotez, P. J., D. H. Molyneux, et al. (2007). "Control of Neglected Tropical Diseases." New England Journal of Medicine **357**(10): 1018-1027.

Hu, V. H., E. M. Harding-Esch, et al. (2010). "Epidemiology and control of trachoma: systematic review." Tropical Medicine & International Health **15**(6): 673-691.

King, J. D., E. Zielinski-Gutierrez, et al. (2011). "Improving community participation to eliminate lymphatic filariasis in American Samoa." Acta Tropica **120, Supplement 1**(0): S48-S54.

Mathew, A. A., A. Turner, et al. (2009). "Strategies to Control Trachoma." Drugs **69**(8): 953-970 910.2165/00003495-200969080-200900002.

Montresor, A., A. F. Gabrielli, et al. (2012). "Preventive chemotherapy and the fight against neglected tropical diseases." Expert Review of Anti-infective Therapy **10**(2): 237-242.

Ottesen, E. A., P. J. Hooper, et al. (2008). "The Global Programme to Eliminate Lymphatic Filariasis: Health Impact after 8 Years." PLoS Negl Trop Dis **2**(10): e317.

Parker, M. and T. Allen (2011). "Does mass drug administration for the integrated treatment of neglected tropical diseases really work? Assessing evidence for the control of schistosomiasis and soil-transmitted helminths in Uganda." Health Research Policy and Systems **9**(1): 3.

Richards, F. O., A. Eigege, et al. (2011). "Epidemiological and Entomological Evaluations after Six Years or More of Mass Drug Administration for Lymphatic Filariasis Elimination in Nigeria." PLoS Negl Trop Dis **5**(10): e1346.

Ross, A. G. P., P. B. Bartley, et al. (2002). "Schistosomiasis." New England Journal of Medicine **346**(16): 1212-1220.

Smits, H. L. (2009). "Prospects for the control of neglected tropical diseases by mass drug administration." Expert Review of Anti-infective Therapy **7**(1): 37-56.

Steinmann, P., J. Keiser, et al. (2006). "Schistosomiasis and water resources development: systematic review, meta-analysis, and estimates of people at risk." The Lancet Infectious Diseases **6**(7): 411-425.

Tchuem Tchuenté, L.-A., R. I. Kamwa Ngassam, et al. (2012). "Mapping of Schistosomiasis and Soil-Transmitted Helminthiasis in the Regions of Centre, East and West Cameroon." PLoS Negl Trop Dis **6**(3): e1553.

Tchuente, L. T. and E. K. N'Goran (2009). "Schistosomiasis and soil-transmitted helminthiasis control in Cameroon and Côte d'Ivoire: implementing control on a limited budget." Parasitology **136**(Special Issue 13): 1739-1745.

WEST, S. K. (2003). "BLINDING TRACHOMA: PREVENTION WITH THE SAFE STRATEGY." The American journal of tropical medicine and hygiene **69**(5 suppl 1): 18-23.

WHO (2010). First WHO report on neglected tropical diseases: working to overcome the global impact of neglected tropical diseases. D. W. T. Crompton and P. Peters. Geneva, World Health Organization.

WHO (2012). Accelerating work to overcome the global impact of neglected tropical diseases – A roadmap for implementation. D. W. T. Crompton, World Health Organization.

Worrell, C. and E. Mathieu (2012). "Drug Coverage Surveys for Neglected Tropical Diseases: 10 Years of Field Experience." The American journal of tropical medicine and hygiene **87**(2): 216-222.

II. Manuscript for Acta Tropica Journal

Evaluation of Integrated Mass Drug Administrations (MDA) for Neglected Tropical Diseases, Koza District, CAMEROON

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Abstract:

Health education and preventive chemotherapy are main strategies to control or eliminate neglected tropical diseases (NTDs) such as lymphatic filariasis (LF), trachoma, onchocerciasis, schistosomiasis (SCH), and soil-transmitted helminthiasis (STH). Integrated MDA for LF, onchocerciasis, SCH, STH, and trachoma were organized in the Koza district of Cameroon from July to August 2011. Ivermectin (IVM) and albendazole (ALB) were distributed for LF to the entire population except pregnant or lactating women, children <90 cm in height, and the severely ill. Azithromycin was distributed at least one week after the LF MDA to all persons older than 6 months of age. Praziquantel (PZQ), targeting school age children (SAC), was only distributed in schools. In order to validate reported coverage and assess the knowledge and attitude of the population towards NTDs and MDAs, an independent coverage and Knowledge, Attitudes, and Practice (KAP) survey was administered. The WHO recommended population based 30-cluster coverage survey was implemented. Clusters were selected by Probability Proportional to Estimated Size and in each cluster, 10 houses were selected using the improved

expanded program on immunization random walk. Coverage questions were administered by trained interviewers to each person living in selected houses and KAP questions were asked to a randomly selected adult in the house.

A total of 1303 persons participated in the coverage survey and 149 adults answered the KAP questions. The survey coverage estimates for IVM /ALB and azithromycin are 76.9% (95% CI 72.0-81.9), 86.8% (95% CI 80.9-92.7), respectively, while the reported coverage is 80.3% and 93%, respectively. The survey coverage estimated for PZQ among SAC is 39.9% (95% CI 30.7-49.1), reported coverage is unknown. There was no significant association between participation in the MDA and age, gender, or knowing the disease. SAC who attended school were 269 times as likely to have taken PZQ and 3 times as likely to have taken LF drugs as SAC not attending school. Less than 50% of respondents had heard of LF and only 31.8% could mention at least one LF symptom. More than 70% of respondents had heard of STH, SCH, and trachoma, but only 52.3%, 40%, 30%, respectively, knew at least one way to prevent or treat STH, SCH, and trachoma. Despite low or incorrect knowledge of LF, SCH, STH, and trachoma, overall, MDA coverage was good except for the PZQ which was only distributed in school.

Keywords: Mass Drug Administration, Neglected Tropical Diseases, Cameroon, Coverage, Survey

Introduction:

The burden of neglected tropical diseases or NTDs is greater than that of malaria, tuberculosis, and other diseases such as HIV/AIDS(Hotez 2011) . The world's highest prevalent NTDs which include hookworm, ascaris, trichuris, Lymphatic filariasis, schistosomiasis, trachoma and onchocerciasis infect over 1 billion people globally and contribute to 52.1 million disability-

adjusted life years (DALYs) annually (Fenwick 2012). The chronic disease caused by the NTDs can result in disfigurement, impaired child development, poor pregnancy outcomes, and reduced productivity (Hotez, Molyneux et al. 2007). Preventive chemotherapy through targeted mass drug administration is one of the most "tool ready" and cost-effective methods for controlling NTDs. The donation of drugs or availability of drugs at very low costs from pharmaceutical companies has made the mass drug administration for control of NTDs possible, even in resource poor countries.

In Cameroon, the plan for control of STH and schistosomiasis began in 2004 with a limited budget and under a small scale. In 2007, with the help of international and national partners, the program was implemented all over the country. De-worming campaigns targeting school aged children have occurred annually since 2007 (Tchuem Tchuenté, Kamwa Ngassam et al. 2012). An integrated approach for controlling the most prevalent NTDs including not only STH and schistosomiasis but LF, trachoma, and onchoceraisis was established in 2009 for greater efficiency and cost-effectiveness (Tchuente and N'Goran 2009). In July-August 2011, a mass drug administration (MDA) campaign was implemented in the Koza District of Cameroon, in the extreme nord region. In order to validate reported coverage and assess the knowledge and attitude of the population towards NTDs and MDAs, an independent coverage and Knowledge, Attitudes, and Practice (KAP) survey was administered.

Methods

Mass drug administration for LF, onchocerciasis, schistosomiasis, STH and trachoma were organized in the Koza district in July-August 2011. The Centers for Disease Control and Prevention (CDC) and the Cameroon Ministry of Health implemented the standard WHO

cluster-survey protocol in 8 of the 14 sub-districts of Koza District: Koza 1 and 2, Gaboua, Ouval, Gouzda Wayam, Djingliya, M'tsikar, Ndougui Kilda .

MDA program consisted of a sub-district based distribution of single dose of 400 mg Ivermectin, single dose 400 mg Albendazole, 20mg/kg azithromyxin. Praziquantel doses of 40mg/kg were delivered in an annual primary school-based distribution.

Ivermectin and albendazole were distributed to the entire population except pregnant women, lactating women in the first week after birth, children <90 cm in height, and the severely ill. Azithromycin was distributed at least one week after the distribution of ivermectin and albendazole to all persons above the age of 6 months. Praziquantal was only distributed in schools to school aged children (SAC).

After the MDA, the districts were required to report coverage of each ivermectin/albendazole , Azithromycin, and praziquantel to the Ministry of Health. Reported coverage for the Koza district for ivermectin/ albendazole and azithromycin was 80.3% and 93% respectively. Reported coverage for praziquantel was not available.2.2 Survey sampling methodology

The sampling methodology was a population based 30- cluster survey as recommended by the WHO LF manual and described in detail by Worrell and Mathieu (Worrell and Mathieu 2012). Clusters were selected by Probability Proportional to Estimated Size (PPES) and in each cluster, 10 houses were selected using the improved EPI walk(Worrell and Mathieu 2012). The first step was a census of all members living in the selected household including age, gender, and whether or not they participated in the MDA. If the one or more of the persons in the household were not present, the parents or other family member served as a proxy. One random member of the each

household over the age of 14 was chosen to take the KAP survey. No alternates were selected if the person was not present at the time of the survey

2.3 Questionnaires

A MDA coverage and knowledge attitudes, and practices (KAP) survey were administered in each household selected via the sampling procedure discussed above. Survey questions were open ended, but included answers that the authors anticipated would be most mentioned. For most questions, multiple answers were possible. The questionnaires were administered in French. Informed consent forms were included with each questionnaire. The coverage questionnaire questions included demographics including age and gender, and if they were answering for themselves or for a family member. The coverage questionnaire also included questions on participation in the MDA and which type of medication the person received. For children ages 5-14, they were also asked if they attended school and whether or not they received the medication at school. The KAP survey gathered information on the participant's knowledge of the NTD treatment, and prevention, participation in the MDA, and reasons for non-compliance. For the KAP survey, questions were included to assess knowledge, attitudes and practices regarding control of LF, STH, schistosomiasis, and trachoma infections. Further questions included knowledge of someone in the household of village with signs or symptoms of LF, trachoma, or schistosomiasis. Additionally adults answered questions regarding access to sanitation and improved drinking water sources.

2.6 Interview training

The interviewers were district-level health personnel selected by the Ministry of Health. The interviewers were not involved in the MDA distribution. The Ministry of Health (MoH) and

CDC organized a two -day training which included sampling methodology, informed consent and administering the questionnaire. The training included in class lectures, a role-play exercise and a one-day practical session.

2.7 Data management and analysis

Data was entered into Epi Info database by a staff member from the MoH in the district personnel. Data were analyzed using SAS, version 9.2. Treatment coverage was calculated as x/n where x is the number of persons treated and n is the total amount of persons surveyed. Various age strata were created based on age (0-13, 14-24, 25-39, 40-59, and greater than 59 years), gender, and school attendance. Categorical data were compared using the Mantel Haenszel Chi square test. KAP MDA coverage was calculated as x/n where x is the number of persons treated and n is the total amount of persons who participated in the KAP survey.

Demographics were calculated using frequencies. For the KAP survey, participation in the MDA and relationship to gender and age were calculated and tested using Mantel Haenszel Chi square tests.

2.8 Ethical considerations

The protocol was evaluated by a CDC human subjects review board and was determined to be exempt from IRB approval because it consisted of a program evaluation. Verbal informed consent was obtained from participants over 18 years of age. If the person was less than 18 years old, verbal informed consent was asked from the head of the household or responsible adult. If the individual was 6-18 years old, a verbal assent was asked of the child in addition to consent by the representing adult.

Results

3.2 Household survey

3.2.1 Demographics

There were 1303 respondents for the coverage survey in the Koza district (Table 1). The median age was 15 years (range 0-110 years) and 52% were female (Table 1). Almost one fifth were under 5 years old (N=221, 17%). One third of the persons were school age (N=428, 32.9%, 5-14 years).

3.2.2 Treatment coverage

Coverage was defined as having received ivermectin/albendazole , Azithromycin, or praziquantel during the MDA. Survey coverage for ivermectin/albendazole was 76.9% (CI 72-81.9), Azithromycin 86.8% (CI 80.9-92.7). Praziquantel coverage for children 5-14 years was 39.9% (CI 30.7-49.1). There was no significant difference between male and female coverage for any of the drugs. There was a statistically significant difference for coverage between self-reporting and reporting for others for ivermectin/albendazole OR 2.2 (95% CI 1.6-3.0) and praziquantel OR 4.2 (95% CI 2.6-6.7) but not for azithromycin OR 0.977 (95% CI 0.69-1.38) (Figure 1). For those self-reporting, the coverage was 85.6% for Ivermectin/Albendazole, 52% for Praziquantel, and 86% for Azithromycin(Figure 1). The coverage when someone else was reporting was 73% for Ivermectin/Albendazole, 20% for Praziquantel, and 84% for Azithromycin (Figure 1).

3.2.3 Treatment coverage and school attendance

Praziquantel was only distributed in schools. Children ages 5-14 years old were 269 times more likely to have taken Praziquantel than children not attending school ($p < 0.05$) Table 2. Of those that attended school, 21% of parents reporting for their children did not know if they had taken praziquantel. There was a statistically significant association between drug coverage and attending school for ivermectin/albendazole and Praqiquantel administered during the June 2011 MDA (Table 2). Coverage for Azithromycin was not statistically associated with school attendance Cochran mantel haenszel test statistic ($p = 0.06$)

3.3 Knowledge, Attitudes, and Practices (KAP) survey

3.3.1 Demographics

For the KAP survey, 149 individuals were surveyed and 35.8% (N=53) were male (Table 1). The median age of the respondents was 41 years (range 14-100) (Table1). 3.3.2 Treatment coverage according to the KAP survey.

Of the adults participating in the KAP survey, 87.2% (95% CI 78.8%-95.5%) reported taking the each medication during the MDA. Of those who participated in the MDA, 64% (95% CI: 55%-73%) were female

3.3.3 Lymphatic filariasis (LF) knowledge

Of those participating in the KAP survey, 44.3% (66/149) of the participants had heard about LF. Among people who had heard about LF, 32% (21/66) knew at least one symptom (lymphedema or swelling) (Table 3). A common incorrect symptom mentioned was itching not related to LF (9%, 6/66) and 21% (14 /66) said they did not know any symptoms of LF. Among people who had heard about LF, only 4.5% (3/66) knew that it is transmitted by mosquitoes and 34.5% did

not know how it was transmitted and gave an incorrect responses . For example, 9% of those that heard of LF incorrectly believed that LF is transmitted through food and/or water . One fourth of the respondents knew that taking medicine could prevent LF while nearly one third believed traditional treatment could prevent LF (Table 3).

3.3.4 Soil transmitted helminths (STH) knowledge

Eighty five percent of individuals surveyed had heard of STH but only 52.3% (78/126) reported that STH can be prevented with medication and fewer than 5.4% knew that good hygiene and clean food preparation could prevent STH (Table 3).

3.3.5 Schistosomiasis knowledge

Nearly 75% of those surveyed had knowledge of schistosomiasis (Table 3). There was a significant relationship between gender and having heard of schistosomiasis. Males had 2.7 higher odds of hearing about schistosomiasis compared to females 95%CI (1.06-6.6). Of individuals who had heard of schistosomiasis 38% (42/109) knew how to treat or prevent schistosomiasis and 27% (30/109) gave the wrong answer. For example 5% (6/109) thought that avoiding the sun was a way to prevent or treat schistosomiasis.

3.3.6 Trachoma knowledge

Nearly 70% of individuals surveyed heard of trachoma (Table 3). Of individuals who had heard of trachoma less than 35% (33/98) knew how to treat or prevent trachoma and 30% (29/98) replied that traditional treatment was the way to prevent or treat trachoma (Table 3).

For all the neglected tropical diseases targeted by the MDA there was not a significant relationship between knowledge of the disease and participation in the MDA.

3.3.7 Knowledge of persons with symptoms

A summary of respondent's answers about knowing someone in their household or village with symptoms of trachoma or lympatic filariais is presented in Table 4. Of the 149 respondents, 11-12% reported knowing someone with bloody urine and blindness in their households. Trachoma was the most common disease observed in the village followed by lymphatic filariasis. Individuals who reported that someone in their household or village had symptoms were not statistically more likely to have taken the participated in the MDA than individuals who did not have someone in their household or village with symptoms.

3.3.8 Participation in the mass drug administration according to the KAP questionnaire

Eighty seven percent (129/149) of adult selected for the KAP survey respondents reported that they had taken all the medication during the MDA campaign. The most common reason cited for not taking the medication was being out of town at the time of distribution. The second most common answer was being pregnant or breastfeeding. Of those taking the medicine, 17.2% (22/149) reported that they experienced side effects. Stomach ache and nausea were the most common side effects reported (36.5%), followed by dizziness (18.2%), itching (18.2%), and diarrhea (9%).

3.3.9 Water and sanitation

The source of drinking water for the majority of respondents was 36% river (N=54) and rain water collection 34%(N=50). Over 25% of respondents used water from a spring (N=40), 9% tap water (N=14), and 4% bought water (N=6). The majority of the survey population used latrines as their main form of sanitation 89.2% (N=133). A minority of respondents practiced open

defecation in the field, river, or a hole in the ground, 7%, 2%, and 1% respectively. There was no relationship between source of water or sanitation and participation in the MDA.

4. Discussion

MDA guidelines require participant countries to collect and report data concerning the number of persons treated during MDAs. However, census figures are often inaccurate, making it difficult to calculate correct coverage rates. In addition reported coverage figures may also be an overestimation or underestimation of actual coverage. In the Koza district the reported coverage rates were comparable to coverage survey rates. According to the KAP survey, the coverage for the MDA was 87%, well above the target 80% threshold established by WHO. Achieving consistent high levels of coverage greater than 75% is essential for interrupting transmission of lymphatic filariasis, STH, schistosomiasis, and trachoma. Obtaining accurate data on treatment coverage is very important for program evaluation. Although the coverage for the Koza district MDA may be incomplete or inaccurate to evaluate the health impact, evidence from other studies have demonstrated that MDA is beneficial and reduces parasite morbidity in the targeted populations (Amazigo, Leak et al. 2012).

Ivermectin/Albendazole and Azithromycin were both above the targeted coverage of 75%. However, the survey coverage for Praziquantel was lower than expected. The coverage for Praziquantel, which was only distributed in schools, was much higher for self-reporting than when one someone else answered. This seems to indicate that the parents were not aware that Praziquantel was distributed in schools. Although the school based approach has been reported to be successful for the distribution of drugs in other similar settings it ultimately depends on how

many children attend school. Children who do not attend school will be left out of the MDA if this is the only way school age children are targeted.

The coverage survey had several limitations. First, these survey results are based on self-reported data and may be subject to recall bias. However, studies in Togo reported that 80% of respondents were able to accurately recall participation in MDA up to one year after the campaign ended (Worrell and Mathieu 2012). Second, given that parents often served as proxies for their children and were not present during the actual treatment, the information provided by the parents may be less reliable than if the information was provided by the children themselves.

In order to maintain successful high treatment coverage it is important to examine the predictors of non-compliance with treatment. According to the coverage survey, there was no difference in coverage between males and females or between age groups. For Praziquantel, one significant predictor of compliance was school attendance. Although the coverage survey did not determine any predictors of compliance for Ivermectin/Albendazole and Azithromycin (azithromycin), the coverage was still over 70% for the population living in the Koza district.

The KAP survey did not reveal any significant predictors of compliance with the MDA. In the Koza district, the knowledge of the diseases targeted for the MDA was very poor. In the Koza district most participants in the KAP survey did not have knowledge about the diseases or the purpose of the MDA including etiology, prevention, treatment, transmission, and personal risk. Even those that had knowledge of the disease were not more likely to have participated in the MDA than those who did not know about the disease. There was also no relationship between those who knew someone in their household or village disease symptoms and MDA compliance. Studies in both Haiti and Indonesia have suggested that knowledge of LF and symptoms,

especially if seen in the community through photographs were predictors of compliance with the MDA (Mathieu, Lammie et al. 2004; Krentel, Fischer et al. 2006)It is important to achieve high levels of coverage in order to interrupt transmission and elimination of diseases targeted by the MDA. People who do not participate in the MDA could provide a reservoir for the parasites and maintain transmission after the MDA programs are no longer in place. Although coverage was high despite low knowledge, for long term sustainability of reduced morbidity and mortality from NTDS, people in endemic areas need to be aware of ways to prevent re-infection with the diseases that have been reduced through the MDA. For instance, in Haiti those who knew that lymphatic filariasis was transmitted by mosquitoes were more likely to participate in the MDA(Mathieu, Lammie et al. 2004). Educational programs as part of MDA have demonstrated to increase knowledge of persons and make them aware that avoiding mosquito bites is a way to prevent LF (Krentel, Fischer et al. 2006).

5. Conclusion

This study stresses the importance of completing a KAP survey in addition to a coverage survey. Through evaluation of the MDA program we can identify opportunities for improvement of drug delivery and communication strategies to increase awareness of the diseases and the purpose of the MDA. Populations living in endemic areas need to be targeted with appropriate health education messages and appropriate drug delivery strategies. In the American Samoa, a KAP survey identified barriers in MDA participation for LF including not knowing about the MDA, and unperceived risk from LF (King, Zielinski-Gutierrez et al. 2011). After educational messages were targeted to fill in the knowledge gaps, MDA compliance increased from 71% in 2003 to 92.7% in 2004 (King, Zielinski-Gutierrez et al. 2011).

In the Koza district, those who had knowledge of the disease or knew someone with the disease were not more likely to participate in the MDA. One possible way to increase coverage could be to increase health education. In Uganda it has been reported that when health education was poor, the information about appropriate health behaviors to prevent NTD transmission was confusing (Parker and Allen 2011). In India, more targeted health messages significantly increased MDA awareness and coverage(Babu and Kar 2004). Another way to increase coverage would be to increase the number of MDA campaigns per year since the largest barrier to non-compliance was not being home at the time of the MDA.

Despite the limitations of the coverage and KAP surveys, they are important tools for assessing treatment coverage and barriers to compliance. Community driven interventions have been demonstrated to be very successful and have the potential to significantly reduce the morbidity of LF, schistosomiasis, STH, and ochocerciasis. Evaluating the program can provide opportunities to modify the MDA program and increase MDA coverage in the Koza district and other districts in Cameroon.

III. Conclusion

Coverage surveys are an integral part of program evaluation for preventative chemotherapy. Coverage surveys evaluate the reported coverage determined by drug distributors during the MDA. Without the coverage surveys the program managers would not know how effective their efforts are. By completing this coverage survey in the Koza district, program managers know that they can rely on the reported coverage. Although there were slight differences between the reported coverage and survey coverage, the results were similar. By knowing that the reported coverage is reliable, it can save time and effort needed to complete a coverage survey.

Drug coverage is reported for each individual district for program managers, but is also reported to the WHO for the entire country. Evaluating coverage for each district on a smaller scale is a better way for overall program evaluation. The coverage for Ivermectin/Albendazole was close to the target established by WHO, over 70% for the Koza district. However , when compared to the coverage for the entire country, Ivermectin/Albendazole coverage is reported to be less than 50%. According to the World Health Organization preventative chemotherapy index, the national coverage in 2011 in Cameroon for Ivermectin/Albendazole for treatment of STH was 46.07%, praziquantel coverage for schistosomiasis 17.19%, and Ivermectin/Albendazole coverage for LF to be 47.6%(WHO 2012). The coverage for Ivermectin/Albendazole for STH, and LF was higher in the Koza district, with 70% coverage and praziquantel coverage was also reported higher in the Koza district at 65% for school age children. By looking at the MDA program coverage for the entire country, it would appear that the program is not working equally across the country. By administering the KAP survey, program evaluators can identify ways to improve the MDA program in a particular area. If the MDA coverage is high in one district, but low in another program evaluators can look at the results from the survey to find out what is working and what is not working.

There is a clear association between the burden of NTDs on health and poverty (Montresor, Gabrielli et al. 2012). Receiving deworming drugs can make a huge difference in the life of a child as it can impact anemia, improve cognitive and physical development and school attendance for school age children (Crompton and WHO 2006; Hotez, Molyneux et al. 2006). Mass drug administration of azithromycin has also been associated with reduced risk of childhood diarrhea and respiratory infections in children (Coles, Seidman et al. 2011; Coles, Levens et al. 2012).

The control of NTDs not only positively impacts the health of the targeted populations but also has other implications. Control of NTDs provides an opportunity to strengthen health systems at the same time(WHO 2010). Implementation of preventative chemotherapy helps to train a health care workforce for drug distribution and increases health education(WHO 2010). These effects on the health care system and capacity building have long term impacts for the future in often resource poor countries that are endemic for NTDs.

IV. Tables and Figures for Manuscript

Table 1: Demographics for coverage and KAP surveys.

Survey Demographics				
	Total N	**% Female (N)**	**Median Age**	**Age Range**
Coverage Survey	N=1303	52% (N=673)	15 years	0-110 years
KAP survey	N=149	62% (N=96)	41 years	14-100 years

Table 2: Relationship between coverage and school attendance for children ages 5-14 years

	Coverage for Children who attended school (ages 5-14)		
	Ivermectin/Albendazole	**Zithromax**	**Praziquantel**
Attended school	92.4 %	89.8%	65.3 %
Did not attend school	79.9 %	83.3 %	0.69 %
Odds Ratio	3.1	1.8	269.3
95% CI	1.7-5.6	1.0-3.1	37.0-1962.4

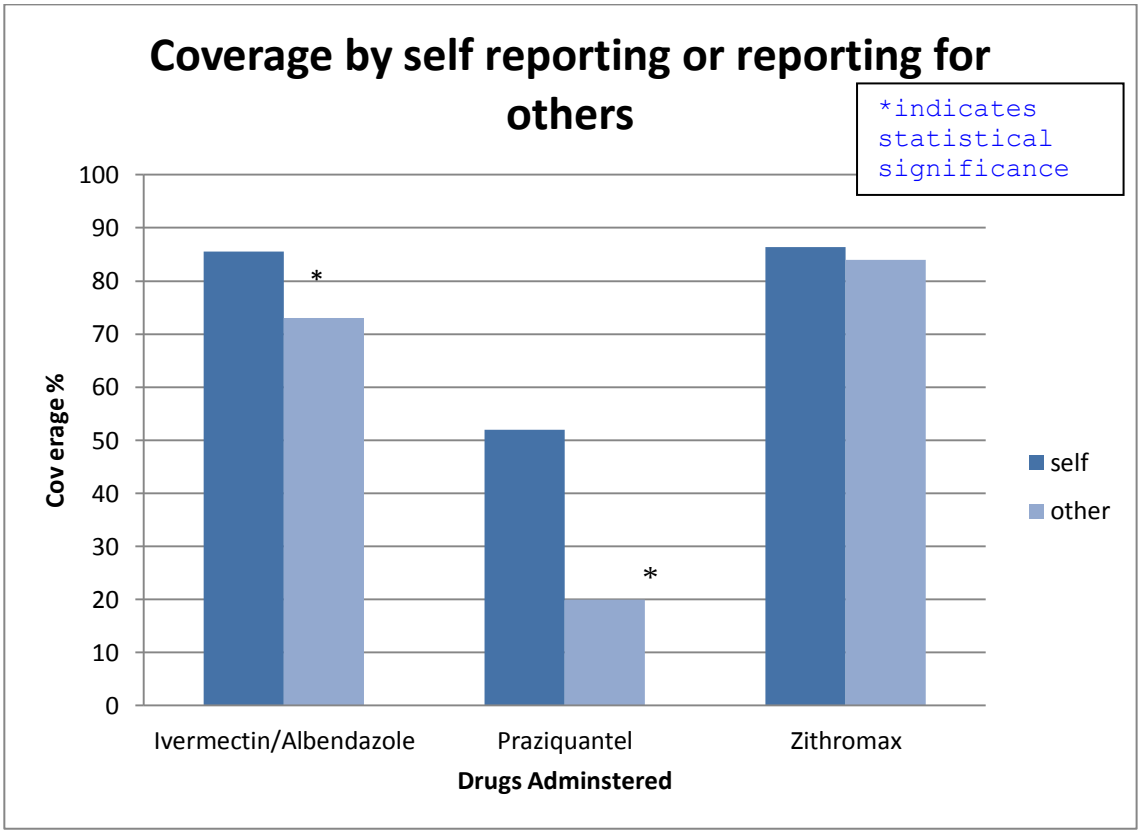
Table 3: Knowledge about NTDs from KAP survey questionnaire

Table KAP Results	% of Respondents	N (number of respondents)
Knowledge of LF:		
Heard of LF	44.30%	N=66
Symptoms of LF(knew at least 1 symptom)	31.80%	N=21
Transmission of LF	4.50%	N=3
Treatment of LF	23%	N=15
Knowledge of STH:		
heard of STH	84.50%	N=126
Transmission of STH	38%	N=48
Treatment of STH	52.30%	N=78
Knowledge of Schistosomiasis:		
Heard of Schisto	73%	N=109
Treatment of Schisto	40%	N=44
Knowledge of Trachoma:		
Heard of Trachoma	68.50%	N=98
Treatment of Trachoma	30%	N=29

Table 4: Knowledge of persons with symptoms of NTDs

	% of Respondents	
Knew someone with symptom	**Household**	**Village**
Elephantiasis	6.7 %	13.4%
Hydrocele	7.4 %	27.5%
Bloody Urine	11.4%	8%
Blindness	12%	54.4%
Flies near eyes of children	24.8%	30.9%

Figure 1: Coverage for self- reporting and reporting for others



References

Addiss, D. and T. G. A. t. E. L. Filariasis (2010). "The 6th Meeting of the Global Alliance to Eliminate Lymphatic Filariasis: A half-time review of lymphatic filariasis elimination and its integration with the control of other neglected tropical diseases." Parasites & Vectors **3**(1): 100.

Amazigo, U. V., S. G. A. Leak, et al. (2012). "Community-driven interventions can revolutionise control of neglected tropical diseases." Trends in Parasitology **28**(6): 231-238.

Babu, B. V. and S. K. Kar (2004). "Coverage, compliance and some operational issues of mass drug administration during the programme to eliminate lymphatic filariasis in Orissa, India." Tropical Medicine & International Health **9**(6): 702-709.

Bethony, J., S. Brooker, et al. (2006). "Soil-transmitted helminth infections: ascariasis, trichuriasis, and hookworm." The Lancet **367**(9521): 1521-1532.

Boatin, B. A. and F. Richards Jr (2006). "Control of onchocerciasis." Advances in Parasitology **61**: 349-394.

Burton, M. J. (2007). "Trachoma: an overview." British Medical Bulletin **84**(1): 99-116.

Coles, C. L., J. Levens, et al. (2012). "Mass distribution of azithromyxin for trachoma control is associated with short-term reduction in risk of acute lower respiratory infection in young children." Pediatr Infect Dis J **31**(4): 341-346.

Coles, C. L., J. C. Seidman, et al. (2011). "Association of Mass Treatment with Azithromycin in Trachoma-Endemic Communities with Short-Term Reduced Risk of Diarrhea in Young Children." The American journal of tropical medicine and hygiene **85**(4): 691-696.

Crompton, D. W. T. and WHO (2006). Preventive chemotherapy in human helminthiasis: Coordinated use of anthelminthic drugs in control interventions : a manual for health professionals and programme managers. Geneva, Swizterland, World Health Organization.

Cruz-Ortiz, N., R. J. Gonzalez, et al. (2012). "Elimination of Onchocerca volvulus Transmission in the Huehuetenango Focus of Guatemala." Journal of Parasitology Research **2012**: 9.

Duke, B. (1990). "Human onchocerciasis-an overview of the disease." Acta Leidensia **59**(1-2): 9-24.

Etya'al, D. (2001). "Vision 2020: Update on Onchocerciasis." Community Eye Health **14**(38): 19-21.

Feasey, N., M. Wansbrough-Jones, et al. (2010). "Neglected tropical diseases." British Medical Bulletin **93**(1): 179-200.

Fenwick, A. (2012). "The global burden of neglected tropical diseases." Public health **126**(3): 233-236.

Gustavsen, K., A. Hopkins, et al. (2011). "Onchocerciasis in the Americas: from arrival to (near) elimination." Parasites & Vectors **4**(1): 205.

Hotez, P. (2011). "Enlarging the "Audacious Goal": Elimination of the world's high prevalence neglected tropical diseases." Vaccine **29, Supplement 4**(0): D104-D110.

Hotez, P. J. and A. Fenwick (2009). "Schistosomiasis in Africa: An Emerging Tragedy in Our New Global Health Decade." PLoS Negl Trop Dis **3**(9): e485.

Hotez, P. J., D. H. Molyneux, et al. (2007). "Control of Neglected Tropical Diseases." New England Journal of Medicine **357**(10): 1018-1027.

Hotez, P. J., D. H. Molyneux, et al. (2006). "Incorporating a Rapid-Impact Package for Neglected Tropical Diseases with Programs for HIV/AIDS, Tuberculosis, and Malaria." PLOS Med **3**(5): e102.

Hu, V. H., E. M. Harding-Esch, et al. (2010). "Epidemiology and control of trachoma: systematic review." Tropical Medicine & International Health **15**(6): 673-691.

King, J. D., E. Zielinski-Gutierrez, et al. (2011). "Improving community participation to eliminate lymphatic filariasis in American Samoa." Acta Tropica **120, Supplement 1**(0): S48-S54.

Klopp, J. (2009). "Worms Not Welcome: HKI Aims to Eliminate NTDs in Cameroon." Retrieved November 8, 2012, 2012, from http://www.hki.org/file/upload/HKIrelease_NTD_Cameroon_10.20.09.pdf.

Krentel, A., P. Fischer, et al. (2006). "Using knowledge, attitudes and practice (KAP) surveys on lymphatic filariasis to prepare a health promotion campaign for mass drug administration in Alor District, Indonesia

Utilisation des connaissances, attitudes et pratiques des surveillances sur la filariose lymphatique pour la préparation d'une campagne de promotion de l'administration en masse de médicament dans le district de Alor en Indonésie

Utilización de encuestas de conocimiento, actitudes y prácticas sobre filariasis linfática, en la preparación de una campaña de promoción de la salud para la administración masiva de medicamentos en el Distrito de Alor, Indonesia." Tropical Medicine & International Health **11**(11): 1731-1740.

Liese, B., M. Rosenberg, et al. (2010). "Programmes, partnerships, and governance for elimination and control of neglected tropical diseases." The Lancet **375**(9708): 67-76.

Mathew, A. A., A. Turner, et al. (2009). "Strategies to Control Trachoma." Drugs **69**(8): 953-970 910.2165/00003495-200969080-200900002.

Mathieu, E., P. J. Lammie, et al. (2004). "Factors associated with participation in a campaign of mass treatment against lymphatic filariasis, in Leogane, Haiti." Annals of Tropical Medicine and Parasitology **98**(7): 703-714.

Mbuh, J. V., N. H. Ntonifor, et al. (2012). "The epidemiology of soil-transmitted helminth and protozoan infections in south-west Cameroon." Journal of Helminthology **86**(01): 30-37.

Montresor, A., A. F. Gabrielli, et al. (2012). "Preventive chemotherapy and the fight against neglected tropical diseases." Expert Review of Anti-infective Therapy **10**(2): 237-242.

Ottesen, E. A., P. J. Hooper, et al. (2008). "The Global Programme to Eliminate Lymphatic Filariasis: Health Impact after 8 Years." PLoS Negl Trop Dis **2**(10): e317.

Parker, M. and T. Allen (2011). "Does mass drug administration for the integrated treatment of neglected tropical diseases really work? Assessing evidence for the control of schistosomiasis and soil-transmitted helminths in Uganda." Health Research Policy and Systems **9**(1): 3.

Richards, F. O., B. Boatin, et al. (2001). "Control of onchocerciasis today: status and challenges." Trends in Parasitology **17**(12): 558-563.

Richards, F. O., A. Eigege, et al. (2011). "Epidemiological and Entomological Evaluations after Six Years or More of Mass Drug Administration for Lymphatic Filariasis Elimination in Nigeria." PLoS Negl Trop Dis **5**(10): e1346.

Ross, A. G. P., P. B. Bartley, et al. (2002). "Schistosomiasis." New England Journal of Medicine **346**(16): 1212-1220.

Smits, H. L. (2009). "Prospects for the control of neglected tropical diseases by mass drug administration." Expert Review of Anti-infective Therapy **7**(1): 37-56.

Steinmann, P., J. Keiser, et al. (2006). "Schistosomiasis and water resources development: systematic review, meta-analysis, and estimates of people at risk." The Lancet Infectious Diseases **6**(7): 411-425.

Tchuem Tchuenté, L.-A., R. I. Kamwa Ngassam, et al. (2012). "Mapping of Schistosomiasis and Soil-Transmitted Helminthiasis in the Regions of Centre, East and West Cameroon." PLoS Negl Trop Dis **6**(3): e1553.

Tchuente, L. T. and E. K. N'Goran (2009). "Schistosomiasis and soil-transmitted helminthiasis control in Cameroon and Côte d'Ivoire: implementing control on a limited budget." Parasitology **136**(Special Issue 13): 1739-1745.

WEST, S. K. (2003). "BLINDING TRACHOMA: PREVENTION WITH THE SAFE STRATEGY." The American journal of tropical medicine and hygiene **69**(5 suppl 1): 18-23.

WHO (2010). First WHO report on neglected tropical diseases: working to overcome the global impact of neglected tropical diseases. D. W. T. Crompton and P. Peters. Geneva, World Health Organization.
WHO (2012). Accelerating work to overcome the global impact of neglected tropical diseases – A roadmap for implementation. D. W. T. Crompton, World Health Organization.
WHO. (2012). "Preventative chemotherapy databank." Retrieved October 31, 2012, from http://www.who.int/neglected_diseases/preventive_chemotherapy/sth/en/index.html.
Worrell, C. and E. Mathieu (2012). "Drug Coverage Surveys for Neglected Tropical Diseases: 10 Years of Field Experience." The American journal of tropical medicine and hygiene **87**(2): 216-222.

V. Appendix

Appendix 1: Coverage Questionnaire

Enquête de Couverture Thérapeutique 2011 – Cameroun Grappe |__|__| Maison |__|__|

Enquêteurs |__|__| Village _____ Numéro du ménage |__|__|

Nombre de personnes vivant dans la maison au moment de la distribution |__|__| Consentement éclair ☐

ADULTS (> 15 ans)

	Nom	Sexe	Age	Répondre pour lui-même ?		Avez-vous pris <le médicament> pendant la dernière compagne?					
						Ivermectin/Albendazole			Zithromax		
		M/F	(Ans)	Oui	Non	Oui	Non	Ne Sais Pas / Refuse de répondre	Oui	Non	Ne Sais Pas / Refuse de répondre
1				1	2	1	2	8	1	2	8
2				1	2	1	2	8	1	2	8
3				1	2	1	2	8	1	2	8
4				1	2	1	2	8	1	2	8
5				1	2	1	2	8	1	2	8
6				1	2	1	2	8	1	2	8

ENFANTS (0 ans – 14 ans)

	Nom	Sexe	Age	Répondre pour lui-même ?		As-tu pris <le médicament> pendant la dernière compagne?						As-tu pris le médicament à l'école cette année ?			Est-ce que tu vas à l'école ?	
						Ivermectin/Albendazole			Zithromax			Praziquantel				
		M/F	(Ans)	Oui	Non	Oui	Non	Ne Sais Pas / Refuse de répondre	Oui	Non	Ne Sais Pas / Refuse de répondre	Oui	Non	Ne Sais Pas / Refuse de répondre	Oui	Non
1				1	2	1	2	8	1	2	8	1	2	8	1	2
2				1	2	1	2	8	1	2	8	1	2	8	1	2
3				1	2	1	2	8	1	2	8	1	2	8	1	2
4				1	2	1	2	8	1	2	8	1	2	8	1	2
5				1	2	1	2	8	1	2	8	1	2	8	1	2

Appendix 2: KAP questionnaire

Questionnaire

Enquêteurs |__|__| Village_____ Numéro du ménage |__|__|

Age |__|__| **Sexe** M F

Section 1

1. Est-ce que vous avez entendu parler de éléphantiasis?

1 Oui
2 ~~Non~~
8 Ne sais pas
9 ~~Refuse de répondre~~

→ *Allez à **Section 2***

2. Comment se manifeste éléphantiasis? *Encerclez TOUTE(s) réponse(s)*

1. Eléphantiasis
2. Hydrocèle
3. Autre
7. (précisez)
8. Ne sais pas
9. Refuse de répondre

3. Comment est-ce qu'on peut attraper éléphantiasis? *Encerclez TOUTE(s) réponse(s*

1. Moustiques
2. Hériter de mes parents / ma famille
3. Mal esprits / le sorcier
7. Autre _____ (précisez)
8. Ne sais pas
9. Refuse de répondre

4. Comment est-ce qu'on peut prévenir ou traiter l'éléphantiasis? *Encerclez TOUTE(s) réponse(s)*

1. Prendre des médicaments
2. Dormir sous une moustiquaire
3. Aller a l'hôpital
4. Nettoyer les alentours de la maison
5. Chirurgie
6. Traitement indigène

7. Autre _____ (précisez)
8. Ne sais pas
9. Refuse de répondre

Section 2

5…Est-ce que vous avez entendu parler des infections par les vers intestinaux?

1. Oui
2. Non
8. Ne sais pas → *Allez à **Section 3***
9. Refuse de répondre

6…Comment est-ce qu'on peut attraper des infections de vers intestinaux?*Encerclez TOUTE(s) réponse(s)*

0. Manque d'hygiène
1. Nourriture (pas bien lavée/préparé)
2. Mouches ou bestioles
3. Vers à travers la peau de pied
4. L'eau sale
5. Ne pas laver les mains
6. Ne pas utiliser les latrines
7. Autre _____ (précisez)
8. Ne sais pas
9. Refuse de répondre

7…Comment est-ce qu'on peut prévenir ou traiter les infections de vers intestinaux? *Encerclez TOUTE(s) réponse(s)*

1. Prendre médicaments
2. Laver les mains
3. Utiliser les latrines
4. Bien préparer/laver la nourriture
5. Porter les chaussures

6. Traitement indigène
7. Autre _____(précisez)
8. Ne sais pas
9. Refuse de répondre

Section 3

8…Est-ce que vous avez entendu parlez de {mot local} schistosomiase?

1. Oui → **8.a. Comment on peut prévenir/traiter schistosomiase?** ***Encerclez TOUTE(s) réponse(s)***

- **1.** Prendre médicaments
- **2.** Eviter nager l'eau
- **3.** Utiliser les latrines
- **7.** Autre _____ (précisez)
- **8.** Ne sais pas
- **9.** Refuse de répondre

2. Non
8. Ne sais pas
9. Refuse de répondre

9…Est-ce que vous avez entendu parlez de trachome?

1. Oui → 9.a.**Comment on peut prévenir/traiter le trachome?** ***Encerclez TOUTE(s) réponse(s)***

- **1.** Laver le visage

2. Prendre les médicaments
3. Utiliser les latrines
4. Traitement indigène
7. Autre _____
8. Ne sais pas
9. Refuse de répondre

2. Non
8. Ne sais pas
9. Refuse de répondre

10. La morbidité

	Est-ce qu'il y a quelqu'un dans votre ménage qui souffre de :	**Vous connaissez quelqu'un dans le village qui souffre de :**
Eléphantiasis	Oui Non ?	Oui Non ?
Hydrocèle	Oui Non ?	Oui Non ?
Urine sanglante	Oui Non ?	Oui Non ?
Aveugle	Oui Non ?	Oui Non ?
Mouche au tour des yeux des enfants	Oui Non ?	Oui Non ?

11. Est-ce que vous avez pris les médicaments <u>chaque fois</u> ils étaient offerts pendant la dernière campagne?

1. Oui
2.
3. Non ➡ 11.a **Pour quoi vous n'avez pas pris les médicaments ? *<u>Encerclez TOUTE(s) réponse(s)</u>***

1. Distributeur/infirmier me disait que je ne pouvais pas les prendre

2. J'étais enceinte
3. Je n'étais pas à la maison
4. J'étais malade
5. Je ne voulais pas
6. J'ai peur des symptômes secondaires
7. Autre __(précisez)
8. Ne sais pas
9. Refuse de répondre

Si non, allez à ***Section 4***

8. Ne sais pas
9. Refuse de répondre

Allez à ***Section 4***

12. Vous avez eu des problèmes/effets secondaire après avoir pris les médicaments?

1. Oui ➡ 12.**Après quel médicament** ***cerclez toute(s) réponse(s)***
- **1.** Mectizan/albendazole (oncho/filariose lymphatique)
- **2.** Zithromax (pour le trachome)

Quel était le problème? ***cerclez toute(s) réponse(s)***

- **0.** Mal à la tête
- **1.** Fièvre
- **2.** Vertiges
- **3.** Nausee
- **4.** Douleur testiculaire
- **5.** Démangeaison
- **6.** Douleur générale
- **10.** Diarria
- **11.** Vomissement
- **12.** fatiguee
- **7.** Autres _____ (précisez)
- **8.** Ne sais pas
- **9.** Refuse de répondre

2. Non
8. Ne sais pas
9. Refuse de répondre

13. Est-ce que vous avez du payer pour avoir les médicaments ?

1. Oui → 13.a.Combien ? _____
2. Non
8. Ne sais pas
9. Refuse de répondre

Section 4

14. Quel est la source de l'eau pour votre ménage?

1. Puits
2. Forage

2. Source
3. Rivière (mayo)
4. Eau vendue dans les bidons
5. Robinet
6. L'eau de pluie
7. Autre _____ (précisez)

8. Ne sais pas

9. Refuse de répondre

15 Combien de temps devez-vous marcher pour aller chercher de l'eau pendant la saison seche

: |__|__|__| (minutes)

16. Où est ce que les membres de vote famille vont faire les selles de l'habitude?

1. Champ
2. Latrine
3. Rivière
7. Autre _____ (précisez)

8. Ne sais pas

9. Refuse de répondre