The Information School

Analyzing Drug Administration in Africa

Aditya Ramani Bradley Balansay Shane Martin Daniel Lee

adir84@uw.edu, balansay@uw.edu, stm7631@uw.edu, donloby@uw.edu

Project Manager: Zach Charat

zach.charat@gatesfoundation.org

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Abstract

The Gates Foundation partnered with ESPEN to create an open access data portal for the purpose of empowering Ministries of Health and other partners with the information necessary to drive efficient investments for neglected tropical disease treatment. This project aims to address low utilization of the ESPEN portal through the development of new metrics and dashboards that health officials can derive actionable insights from. By leveraging publicly available data from ESPEN and consolidating many relevant data points, we have provided tools for health officials to more effectively identify and act upon points of concern in drug procurement and administration.

Contents

Chapter 1

Introduction

Neglected tropical diseases are a diverse group of communicable diseases that prevail in tropical and subtropical conditions in 149 countries. They affect more than one billion people and cost developing economies billions of dollars every year. Populations living in poverty, without adequate sanitation and in close contact with infectious vectors and domestic animals and livestock are those worst affected. In response, mass drug administration programs (MDA) have been developed to effectively combat these diseases. The Expanded Special Project for Elimination of Neglected Tropical Diseases (ESPEN) data portal was developed to support the workflow of health ministries in executing MDA programs.

1.1 Aims and Objectives

The primary aim of this project is to address usability, navigation, and usability concerns in regard to the current ESPEN data portal. In particular, this project aims to provide tools that assist drug administration programs in Africa. This project also aims to find areas of concern in regard to drug procurement. Since MDA efforts are supported by the generosity of pharmaceutical companies, minimizing waste is crucial to maintaining a healthy relationship with the donors. Furthermore, identifying under-allocated drug supplies in an area is necessary to ensure appropriate drug coverage to cover disease occurs.

1.2 Overview of the Report

This report will provide contextual information about the project, the process and methodology involved in the development of the solution, and an overview of the solution itself. Included in this report will be information about the diseases, definitions of formulas, description of the data sources, and an outline of the solution.

Chapter 2

Research Findings

2.1 User Research

According to user research performed in collaboration with the Bill and Melinda Gates Foundation, the current ESPEN data portal suffers from visualizations that are not well organized. More specifically, a "two map" problem exists where necessary and relevant data is presented on two different visualizations. Furthermore, the ESPEN data portal suffers from navigational, and usability issues that ultimately contribute to decreased use of the ESPEN data portal.

2.2 Neglected Tropical Diseases

This section will provide an overview of the various NTDs involved in this project.

Lymphatic filariasis (LF) - Commonly known as elephantiasis, is a painful and profoundly disfiguring disease. It is caused by infection with parasites classified as nematodes (roundworms) of the family Filariodidea that are transmitted through the bites of infected mosquitos. Mosquito-transmitted larvae are deposited on the skin from where they can enter the body. The larvae then migrate to the lymphatic vessels where they develop into adult worms, thus continuing a cycle of transmission.

All ages are affected where filariasis is transmitted. In endemic countries, lymphatic filariasis has a major social and economic impact. Lymphatic filariasis affects over 120 million people in 72 countries throughout the tropics and sub-tropics of Asia, Africa, the Western Pacific, and parts of the Caribbean and South America.

Schistosomiasis - a disease of poverty that leads to chronic ill-health. Infection is acquired when people come into contact with fresh water infested with the larval forms (cercariae) of parasitic blood flukes, known as schistosomes. The microscopic adult worms live in the veins draining the urinary tract and intestines. Most of the eggs they lay are trapped in the tissues and the body's reaction to them can cause massive damage.

Schistosomiasis affects almost 240 million people worldwide, and more than 700 million people live in endemic areas. The infection is prevalent in tropical and sub-tropical areas, in poor communities without potable water and adequate sanitation.

Onchocerciasis, also known as river blindness, is a disease caused by infection with the parasitic worm Onchocerca volvulus. Filarial worms (O. volvulus) are transmitted from person to person by the repeated bites of infected black flies (Simulium spp.) . These black flies breed in fast-flowing rivers and streams, mostly in remote villages located near fertile land where people rely on agriculture.

Chapter 3

Methodology

In the first iteration (Amount of Drug Procured compared to the number of people requiring treatment for a Disease), two data points were used in each of the drug sheets in the JRSM. These were Drugs Procured and the People Requiring Treatment. These values were used to obtain baseline information - see how many drugs were being procured in an area in comparison to how many people they expected to be treated. This ratio was standardized in an effort to easily see whether an area was procuring more drugs per person requiring treatment. The standardization process is stated in the Formulas section. There was one problem with this approach though, and that is verifying the accuracy of the People Requiring Treatment data. Ultimately, the accuracy of these values was left to the the strength of each country's data collection.

3.1 Establishing Baseline

In the first iteration (Amount of Drug Procured compared to the number of people requiring treatment for a Disease), two data points were used in each of the drug sheets in the JRSM. These were Drugs Procured and the People Requiring Treatment. These values were used to obtain baseline information - see how many drugs were being procured in an area in comparison to how many people they expected to be treated. This ratio was standardized in an effort to easily see whether an area was procuring more drugs per person requiring treatment. The standardization process is stated in the Formulas section. There was one problem with this approach though, and that is verifying the accuracy of the People Requiring Treatment data. Ultimately, the accuracy of these values was left to the the strength of each country's data collection.

3.2 Synthesizing Data sets

In the second iteration (Amount of Drug Procured Compared to the Number of People Treated for a Disease (MDA), we tried to quantify, to the best of our ability, whether the number of drugs procured was actually necessary. This was accomplished by looking at the MDA data for diseases (from 2017) and also from the ESPEN Portal. The 2017 data are the latest values available, and once the newer data is available, the results will more accurately reflect recent developments. The MDA data is more reliable because it provides the number of people who were actually treated for a specific disease. While each disease may have multiple drugs that could treat it (for example Ivermectin can be used to treat both Lymphatic Filariasis and Onchocerciasis), the number of people treated gives a better

estimate as to population treated. With this new data, comparisons to the ratio of the number of drugs being procured per state for a disease and the number of people that were treated with MDA in that state for that disease is between states were made.

3.3 Standardization

The result of the drug comparison is a ratio (Drug Procurement vs Treated) of how many drugs were procured compared to the number of people treated in MDA. Once this calculation was completed, it was then standardized (Standardized Drug Procurement vs Treated). By standardizing it, we are able to see how a country's ratio compares to the average based on the standard deviation. If the standardized value is positive, then that means they are procuring more drugs per person treated on average. If it is negative, then that means they are procuring less drugs per person treated on average.

3.4 Analysis

Determining if higher or lower than average values are expected can be accomplished by looking at the MDA coverage percentage. If the coverage is low but the standardized value is high, then that means they are procuring drugs but are not able to distribute them properly. If the coverage is high and the standardized value is high, then they are probably procuring more drugs than is necessary. The problem areas are displayed by highlighting the high and low standardized values as dark areas compared to the rest of the map. Hovering over the area with the mouse will bring up a tool-tip that shows the exact ratio. In an ideal scenario, the entire map would be a similar color. Another place to look at this data is the Standardized Procurement Ratio vs MDA Coverage scatter plot in the dashboard. This will allow you to easily identify the problem states as the outliers.

3.5 Data Sources

JRSM - (Joint Request for Selected PC Medicines) Excel spreadsheets found in the ESPEN Portal that are filled out by countries to help them quantify how many drugs are needed.

IU MDA Data - CSVs found in the ESPEN Portal that provide information on MDA treatment for a specific disease in a country.

IHME GBD Data - Data obtained from the IHME GBD portal includes YLD, YLL, and DALY statistics for the diseases and countries.

Shape Files - Either found in the ESPEN portal or from https://data.humdata.org/, depending on which one is more accurate.

Chapter 4

Formulas

4.1 Drug Ratio

The sum of all the drugs procured in each area divided by the sum of all the people requiring treatment in each state, as shown in the JRSM.

$$DR = \frac{Sum\ of\ drugs\ procured}{Population\ requiring\ treatment}$$

4.2 Drug Procurement vs Treated

The number of drugs procured in each area (from JRSM) divided by the number of people treated in the area (from IU Data).

$$DP = \frac{Number\ of\ drugs\ procured}{Population\ treated}$$

4.3 Standardized Drug Procurement vs Treated

The number of drugs procured in each area (from JRSM) divided by the number of people treated in the area (from IU Data). This value is then standardized.

$$SDP = \frac{DP - \mu}{\sigma}$$

4.4 Disease MDA Coverage

The number of people treated for a disease (from IU Data) divided by the total number of people who require treatment (from IU Data)

$$MDAC = \frac{Population\ treated\ for\ disease}{Population\ requiring\ treatment}$$

4.5 Disease YLD Value

The population of an area (from the JRSM) divided by the YLD rate for the disease (calculated in the IHME Data set)

$$DYLD = \frac{State\ population}{Disease\ YLD}$$

4.6 Normalized Drug Ratio

Normalized DR for each state to be used in the disease measure

$$NDR = \frac{DR - DR_{min}}{DR_{max} - DR_{min}}$$

4.7 Normalized YLD

Normalized YLD for each state to be used in the disease measure.

$$NYLD = \frac{YLD - YLDmin}{YLD_{max} - YLD_{min}}$$

4.8 Disease Measure

Normalized Drug Ratio in each area divided (calculated) by Normalized YLD value (calculated) for the disease in each area

$$NDR = \frac{NDR}{NYLD}$$

Chapter 5

Interactive Dashboard

5.1 Procurement vs Population Treated

Schistosomiasis: Compares the amount of PZQ procured compared to the population treated for Schistosomiasis through MDA (SDP).

Onchocerciasis: Compares the amount of IVM procured compared to the population treated for Onchocerciasis through MDA (SDP).

Lymphatic filariasis: Compares the amount of ALB and IVM procured for LF compared to the population treated for LF through MDA (SDP).

5.2 Disease Coverage

Percentage of population who were treated by MDA for each disease compared to population covered.

5.3 Standardized Procurement Ratio vs MDA Coverage

A scatter of the standardized procurement ratio and the MDA Coverage. The vertical line shows the 0 mark, and the distance from the 0 is how much extra or how much less a country procures. The distance from the 80 percent is our bench-line mark for a good MDA coverage.

5.4 Procurement vs Population Requiring Treatment

Schistosomiasis: Compares the amount of Praziquantel (PZQ) procured for an area and the population requiring treatment in the area (DR).

Onchocerciasis: Compares the amount of Praziquantel(PZQ) procured for an area and the number of people requiring treatment in the area (DR).

Lymphatic filariasis: This map does not exist here. The ALB procured for LF has a considerable amount of missing data in the required treatment field.

5.5 Areas of Interest

5.5.1 Schistosomiasis

Taraba - Low drug procurement rate and low coverage, assess procurement of more drugs.

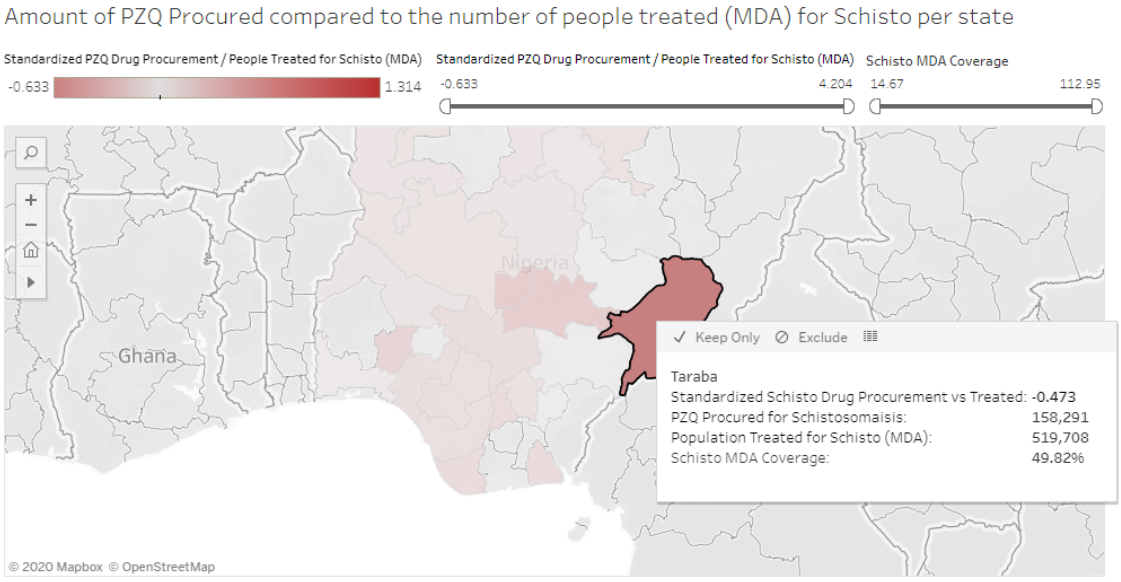

Figure 1: Procurement of PZQ in Taraba

Federal Capital Territory - High procurement of drugs but with a low coverage rate. Possibly need to improve distribution.

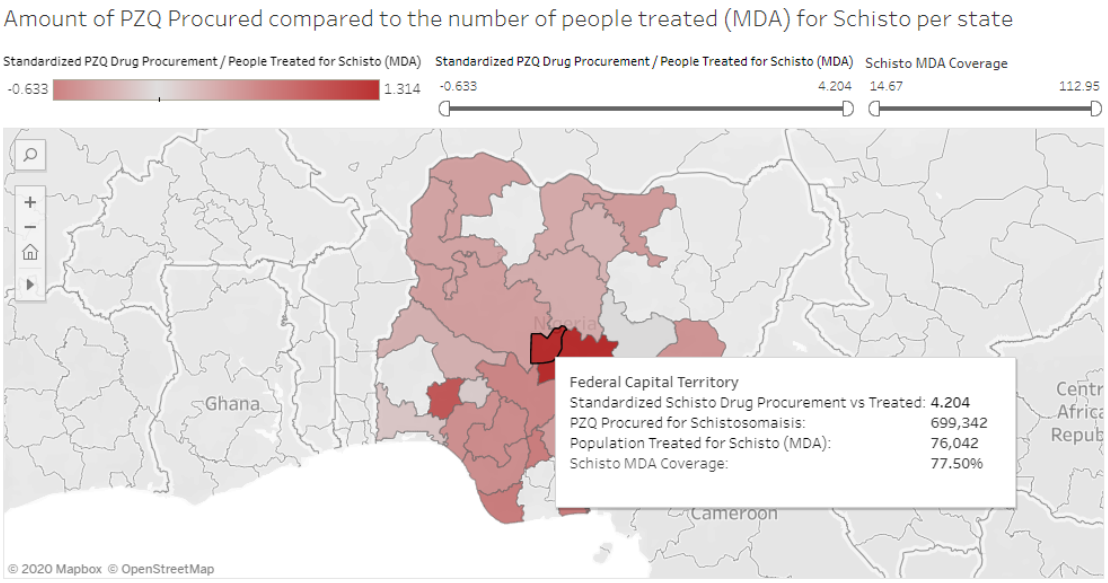

Figure 2: Procurement of PZQ in Federal Capital Territory

Osun - High procurement of drugs compared to people treated in MDA, but with a low MDA coverage. Need to improve distribution.

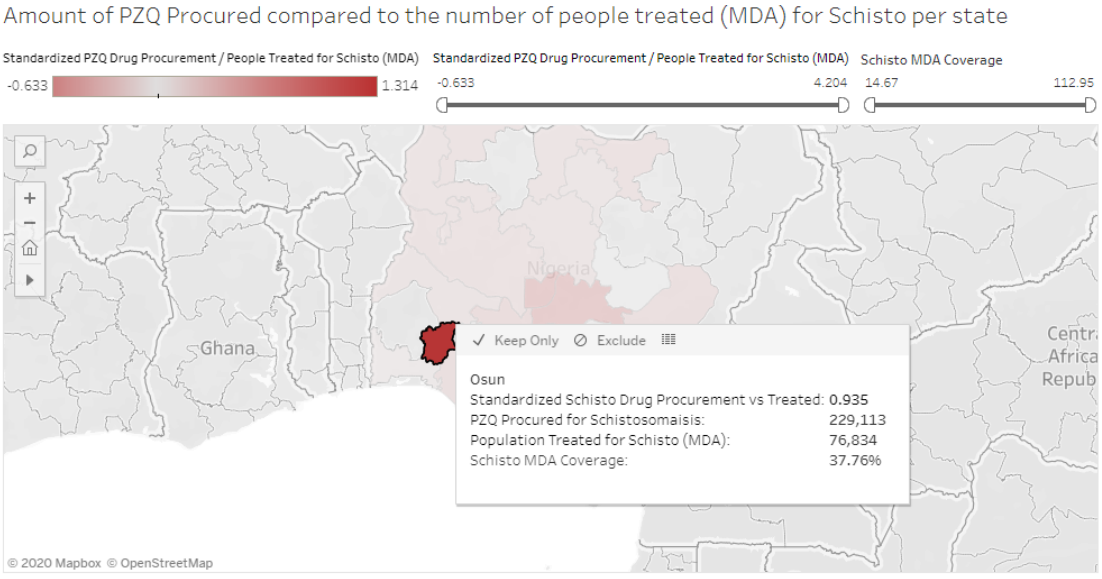

Figure 3: Procurement of PZQ in Osun

5.5.2 Onchocerciasis

Ogun - High number of drugs procured per person treated, but a low MDA coverage percentage. Need to distribute drugs better.

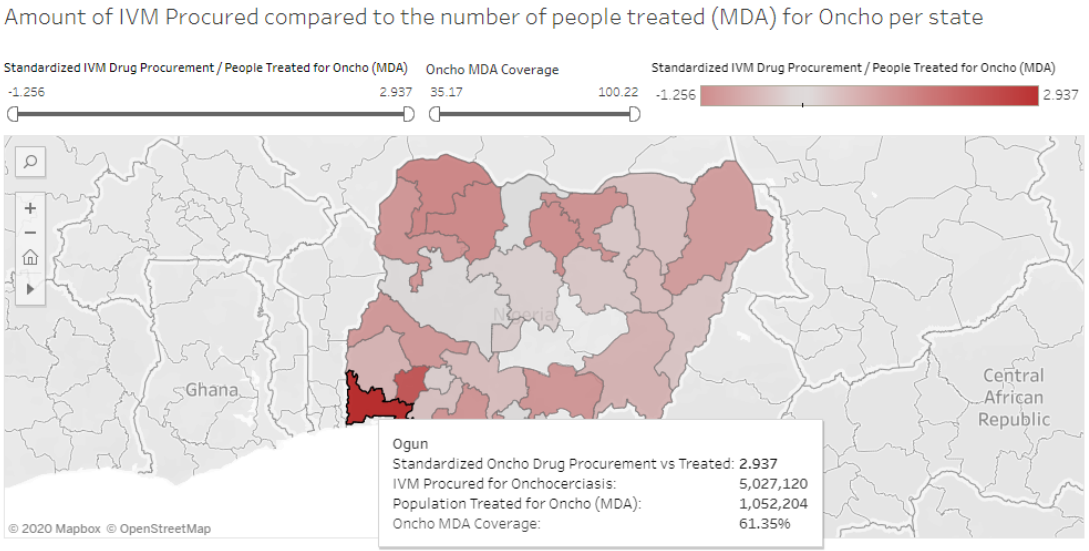

Figure 4: Procurement of IVM in Ogun

5.5.3 Lymphatic filariasis

Ogun - High number of drugs procured per person treated, but a low MDA coverage percentage. Need to distribute drugs better.

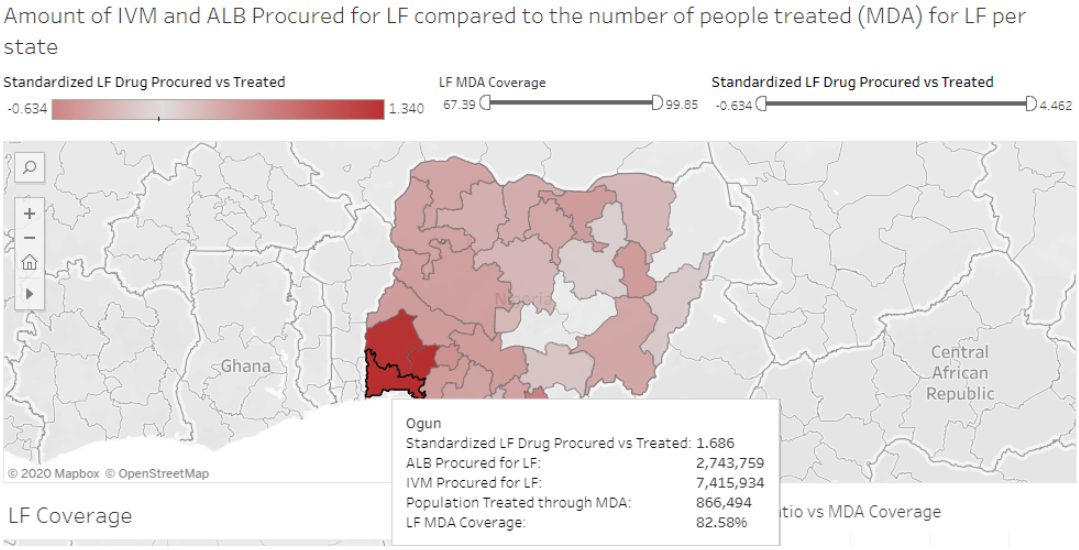

Figure 5: Procurement of IVM and ALB in Ogun

Oyo - High number of drugs procured per person treated, but a low MDA coverage percentage. Need to distribute drugs better.

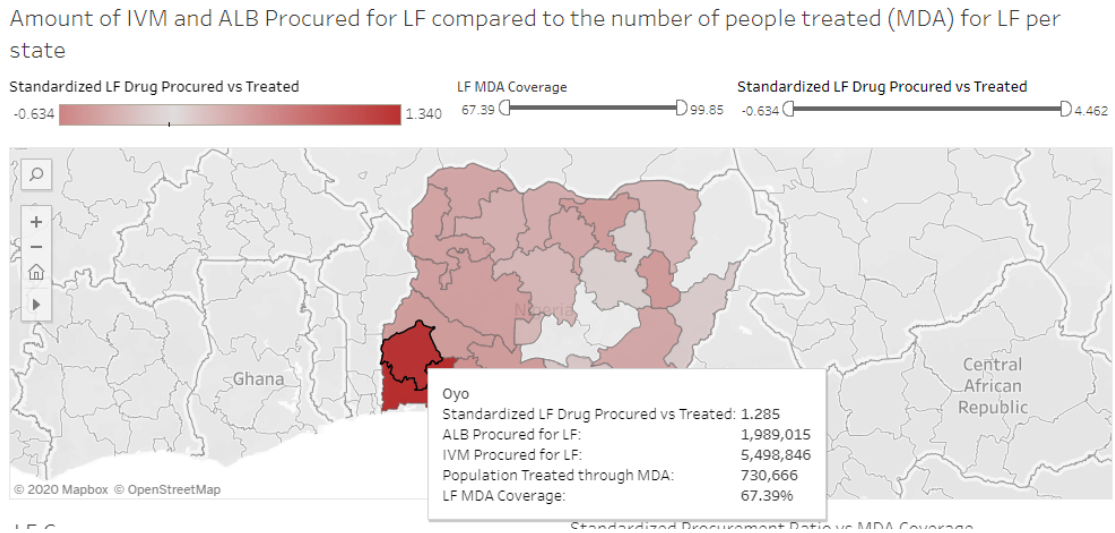

Figure 6: Procurement of IVM and ALB in Oyo

Chapter 6

Next Steps

After completing the interactive visualizations, we identified several avenues for expansion. First, the current solution has yet to be automated. As of writing this, the ESPEN API does not enable the application to easily be updated based on new data. Furthermore, the process of cleaning data and creating the visualizations could be fully automated for the remaining countries in Africa. Doing so would significantly reduce the amount of time necessary to work through and update each country.

The recent outbreak of COVID-19 presents an opportunity to explore the procurement of medication in African nations. Due to the dominant presence of COVID-19 that has currently halted progress of NTD control, analyzing the impact of the global pandemic on MDA programs may be incredibly useful for health ministries.

Lastly, our solution could be made more accessible by including language options that support the diverse set of languages spoken in Africa. Expanding upon the accessibility of our solution can be accomplished by creating a mobile friendly application.

Chapter 7

Glossary

NTD Neglected tropical disease

MDA Mass drug administration

ESPEN Expanded Special Project for Elimination of Neglected Tropical Disease

IHME Institute for Health Metrics and Evaluation

IU Implementation Unit

LF Lymphatic Filariasis

JRSM Joint Request for Selected PC Medicines

GBD Global Burden of Disease

YLD Years Lost due to Disability

PZQ Praziquantel

IVM Ivermectin

ALB Albendazole