



SITUATION ANALYSIS AND RECOMMENDATIONS

Antibiotic Use and Resistance in Tanzania



The GARP-Tanzania Working Group

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PREFACE	IV
CHAPTER 1: EXECUTIVE SUMMARY	1
BURDEN OF BACTERIAL INFECTIONS AND THEIR RESISTANCE RATES	2
FACTORS AFFECTING ANTIBIOTIC RESISTANCE AND REMEDIAL MEASURES	4
CURRENT ACTIVITIES WITH RELEVANCE TO ANTIBIOTIC RESISTANCE AND USE	7
RECOMMENDATIONS	9
CHAPTER 2: POPULATION AND HEALTH BACKGROUND	13
HUMANS	13
<i>POPULATION</i>	13
<i>ECONOMY</i>	13
<i>HEALTH SYSTEM</i>	13
<i>AVAILABILITY OF AND ACCESS TO ESSENTIAL MEDICINES</i>	20
<i>GOVERNMENT POLICES AND THE REGULATORY ENVIRONMENT</i>	25
ANIMALS	27
<i>LIVESTOCK FARMING</i>	27
<i>FOOD ANIMAL CONTRIBUTION TO THE ECONOMY</i>	27
<i>VACCINATION</i>	36
<i>GOVERNMENT POLICIES AND REGULATORY ENVIRONMENT</i>	37
CHAPTER 3: BURDEN OF DISEASE AND ANTIBIOTIC RESISTANCE IN	
HUMANS	43
<i>NATIONAL BURDEN OF DISEASE</i>	43
<i>BACTERIAL DISEASES IN HUMANS AND THEIR RESISTANCE RATES</i>	45
<i>SURVEILLANCE FOR BACTERIAL INFECTIONS</i>	71
CHAPTER 4: BURDEN OF DISEASE AND ANTIBIOTIC RESISTANCE IN	
FOOD ANIMALS	73
NATIONAL DISEASE BURDEN	73
<i>BACTERIAL DISEASE IN FARMED ANIMALS</i>	73
ANIMAL DISEASE SURVEILLANCE	77
RESISTANCE RATES	77
CHAPTER 5: ANTIBIOTIC USE AND SUPPLY CHAIN MANAGEMENT	80
HUMANS	80
<i>ANTIBIOTIC USE IN HUMAN HEALTH</i>	80
<i>ANTIBIOTIC SUPPLY CHAIN</i>	82
ANIMALS	88
<i>ANTIBIOTIC USE IN ANIMALS</i>	88
<i>ANTIBIOTIC SUPPLY CHAIN</i>	90

Preface

Antibiotics and other antimicrobial agents are invaluable life savers, particularly in resource-limited countries where infectious diseases are abundant. Both uncomplicated and severe infections are potentially curable as long as the aetiological agents are susceptible to the antimicrobial drugs. The rapid rate with which antimicrobial agents are becoming ineffective due to resistance acquired as a result of unchecked overuse and misuse threatens to undo the benefit of controlling infections. The evidence for resistant microorganisms, many times to more than a single antimicrobial agent, has been observed globally. In Tanzania, there is evidence in the form of few scattered studies conducted in different parts of the country in a multitude of settings including health care facilities, the community, domesticated animals and wild animals. The (multi-) resistant organisms observed in animals and animal products are passed on to even antibiotic naïve individuals through consumption of meat, milk and other animal products. This contributes to the steep decline towards ineffective antibiotics, a situation that can be likened to a siren that is getting progressively louder.

Conversely, access to high quality, life-saving antibiotics has remained a challenge and the need to institute control to conserve the power of antibiotics must not be misconstrued as an obstacle to access. We need to reach a balance where on one hand antibiotics are optimally available versus limiting access to unwarranted use on the other hand.

Several initiatives are part of an international response to the global health threat of AMR, which are having a ripple effect in low-and middle-income countries. This situation analysis is a locally generated report with proposed recommendations for immediate and long-term action plans. Prior to its development, the evidence had never been consolidated to give a summary picture of what is known of the entire country's antibiotic use and resistance status, both in the humans and animals. With the policy recommendations and areas of focus discussed, there is an urgent call for a coordinated response. Changing the status quo on irrational use of antibiotics among humans and their animal counterparts is a tangible road map towards the judicious use of antibiotics in Tanzania.

Some of the recommended changes may cause upheavals in what are accepted standard procedures and may be met with resistance. Hospital managers may not appreciate the added constraints on the budget that antibiotic stewardship may entail during the start-up of such a program. Some antagonism may be felt from drug outlets that profit from dispensing prescription-only as over-the-counter drugs. Patients may also offer some resistance due to the belief that treatment is incomplete without an antibiotic prescription. Farmers may be highly opposed to reducing antibiotics use in their livestock.

These anticipated reactions result from a prevailing lack of knowledge—which this report should start to remedy—and reluctance of those who should know better. With this report and further work, policies that will fill the current gaps can be developed and enforced. The GARP-Tanzania working group will continue to champion this noble cause by allocating technical and other expertise in meeting various milestones to mitigate the current AMR problem. We welcome ideas, comments and collaboration in this effort.

Said Aboud, MD, PhD

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CHAPTER 1: Executive Summary

Antibiotics are the ‘miracle drugs’ of the 20th century. They made possible great progress in turning many bacterial infections into illnesses rather than death sentences. Along with vaccines, they have transformed death in infancy and childhood from an ever-present danger into a rare event. Remarkably, Alexander Fleming, who discovered penicillin, warned of resistance in the 1930s. He made what may have been the first plea for antibiotic stewardship—use penicillin only when necessary and do not ‘under-dose’.

Unfortunately, the world has used penicillin and the rest of the available antibiotics, developed mainly in the 1940s and 1950s, at an ever-increasing rate, both when they are needed and when they are not, in human beings and other animals. The result is that today many antibiotics have lost their effectiveness against common bacterial infections and antibiotic resistance continues to increase in most countries before it has even been recognized as a major problem.

Antibiotic resistance is no longer a concern for the distant future but is a pressing issue, both globally and in Tanzania. Data on antibiotic resistance in Tanzania is scarce, but even in the 1990s, resistance to antibiotics in common use, such as ampicillin, tetracycline and trimethoprim-sulfamethoxazole, was significant. As part of global effort to preserve the effectiveness of antibiotics, the Global Antibiotic Resistance Partnership (GARP)-Tanzania aims to develop policy recommendations to govern prudent use of antibiotics. This situation analysis is a first step, creating a baseline for what is known and identifying the important information gaps to be addressed in order to create responsible and effective recommendations for policymakers to consider.

The aim is not to withhold antibiotics when they can save lives and health. Ample evidence—in the form of infant and child deaths from pneumonia—warns that many people have no access. The aim is to eliminate as much inappropriate use as possible and increase access where it is inadequate.

About GARP

Antibiotic resistance is a shared global concern, but the problems and solutions have strong local components. Progress against the problem is best made when national experts collaborate to understand all aspects of antibiotic access, use and resistance within their own country context, and then work to craft policy solutions tailored to meet their own needs. With the press of other health issues capturing most global attention—HIV/AIDS, tuberculosis, malaria, malnutrition and epidemics—few low- and middle-income countries had yet recognized antibiotic resistance, though certain scientists, clinicians and public health specialists in every country were aware of and concerned about it.

This was the reason for establishing the GARP, which is a project of the Center for Disease Dynamics, Economics & Policy (CDDEP), a non-profit research and policy organization with offices in Washington, DC and New Delhi. GARP is funded by the Bill & Melinda Gates Foundation. GARP creates conditions that enable local experts to occupy the multidisciplinary space to understand local conditions and identify policy opportunities related to antibiotics, especially (but not limited to) those affecting antibiotic resistance.

GARP began in 2008, in Kenya, India, South Africa and Vietnam, where working groups continue to develop a deeper understanding of antibiotic issues and have become trusted sources of information for all sectors. Those groups have become largely independent of CDDEP for financial support, but continue to collaborate and form a brain trust for the newer partners. After a successful 3-year phase, culminating with a major international conference, the 1st Global Forum on Bacterial Infections, held in New Delhi in October 2011, the Gates Foundation supported establishing GARP in a second group of countries: in addition to Tanzania, Nepal, Mozambique, and Uganda.

Burden of Bacterial Infections and their Resistance Rates

HUMANS

HIV/AIDS, malaria, lower respiratory infections (pneumonia) and diarrheal diseases are the top four diseases contributing to illness and death in Tanzania (Institute for Health Metrics and Evaluation, 2012). Of these four, bacterial pneumonia and a minority of diarrheal infections are the only ones requiring antibiotics for treatment, yet antibiotics are often prescribed (both by healthcare workers and by patients themselves) for all of them. This indicates an opportunity for reducing antibiotic use by both reducing the burden of infections and by sensitizing healthcare workers and the public about when antibiotics are needed and when they are not.

These top four categories of disease, along with bloodstream infections (including typhoid, sepsis, meningitis and bacteremia), urinary tract infections, sexually transmitted infections (gonorrhea and other bacterial infections), and healthcare-associated infections (such as methicillin-resistant *Staphylococcus aureus* or MRSA) are important in not only understanding the range of bacterial infections, but also for understanding contexts in which antibiotics are prescribed.

Tuberculosis is also a major infection that contributes to the growth of antibiotic resistance (via multidrug resistant tuberculosis, MDR-TB, and rarely, extensively drug resistant tuberculosis, XDR-TB); however, Tanzania has managed to maintain low prevalence rates for MDR-TB. For TB cases in general, the average rate of increase was 2 percent in the 2000s, a dramatic improvement from the average 10 percent increase in the 1990s. These rates indicate that efforts from the national TB control program have possibly helped maintain such low prevalence for both TB and MDR-TB (NTLP manual sixth edition, 2013).

While many bacterial infections are not part of the general top causes of disease death, their contribution to the growing threat of antibiotic resistance and their effects on overall antibiotic use require further attention among health professionals, patients and consumers, and the government. Additionally, bacterial co-infections with primarily non-bacterial causes of primary infections can play a role in contributing to the ever growing threat of resistance.

The mounting evidence of global antibiotic resistance demonstrates the need for national efforts for surveillance and control of disease. With a clearer understanding of the nature of bacterial infections in both hospitals and community settings, researchers are then able to test pathogens against antibiotics to determine resistance rates.

The next section gives a brief overview of the antibiotic resistance rates that have been found in Tanzania and the region. Complete details of the studies mentioned and others can be found in chapter 3.

Acute Respiratory Infections (ARIs)

Most acute respiratory infections are caused by viruses that result in common colds and coughs, but are not serious and resolve without antibiotics or other drugs. In fact, antibiotics are not effective at all against viruses, and so are wasted when used for common colds. But pneumonia, which can be caused by a variety of organisms, when caused by bacteria can be deadly and does require antibiotic treatment.

Data on antibiotic resistance of bacterial respiratory infections is very limited in Tanzania and few studies have been conducted among children. One study from an East African collaborative study including Tanzania, Kenya, and Uganda of children under five years of age found that resistance rates for trimethoprim-sulfamethoxazole among the common pathogen *Streptococcus pneumoniae* had increased rapidly between 2003 and 2006, with more than 25 percent resistant at the end of the period (Mudhune 2010). A Tanzanian study published in 2012 reported even higher rates—more than 80 percent resistance—of *S. pneumoniae* in children (Sabrina J Moyo et al., 2012).

Blood Stream Infections

Major blood stream infections (often referred to as bacteremia) include neonatal sepsis, typhoid and meningitis. These are often very serious and require antibiotic treatment. Studies in Tanzania have found high rates of blood stream infection in adults and children. Especially important are high rates of neonatal sepsis, which is a major cause of death in the first month of life. Blood stream infections are also common in people with HIV/AIDS.

Several antibiotics are commonly used to treat sepsis, including ampicillin, cloxacillin, chloramphenicol, gentamicin and ceftriaxone, depending on the patient and the infection. Even with effective antibiotics, some neonates die from sepsis, but survival is much worse when the infection is antibiotic resistant. Studies in Tanzania—both at Bugando Medical Center and at Muhimbili National Hospital—have demonstrated this risk.

Diarrheal Infections

Diarrheal infections present a serious threat to children in Tanzania, representing approximately nine percent of deaths in children under five years old. Rotavirus, a major causative agent for diarrhea cases in children, has historically been responsible for many of those deaths, but the introduction of rotavirus vaccine into the childhood vaccination program in 2013 is expected to reduce this toll significantly. Even without rotavirus, however, diarrhea is common in children. Bacteria are the dominant cause in children up to six months, while viruses have been the dominant cause in the seven to twelve month age group.

Diarrhea kills children by dehydration—the loss of fluid during days of diarrhea. That is the basis for the treatment that can successfully bring most children through bouts of diarrhea: oral rehydration therapy (ORT), regardless of the cause. Not surprisingly, high levels of antibiotic resistance have been found among diarrheal pathogens for all of these drugs.

Urinary Tract Infections

Urinary tract infections (UTIs) caused by several different bacteria are common in Tanzania, particularly among pregnant women, but among the general population, as well. The most common cause is *Escherichia coli*. UTIs are appropriately treated with antibiotics, including ampicillin, cotrimoxazole, amoxicillin/clavulanic acid and nitrofurantoin (first-line) and amikacin, ciprofloxacin and cefotaxime for infections resistant to first-line agents.

High resistance rates to both first and second line antibiotics have been documented in Tanzania among pregnant women, children and diabetic women with *E. coli* and other infections.

Sexually Transmitted Infections

Gonorrhea, chlamydia and syphilis are sexually transmitted infections (STIs) caused by bacteria that are curable with antibiotics. Several recent studies have quantified the burden of STIs in Tanzania, reporting a low prevalence of less than two percent among young women attending a rural antenatal clinic to as high as 14 percent among adults in a fishing community. STIs are important not only for the illnesses they cause, but they also predispose people to getting infected with HIV.

Gonorrhea and syphilis, in particular, have been studied over a long period of time, revealing significant increases in antibiotic resistance over the years, through a study published as recently as 2012. The most recent resistant rates were alarmingly high, reinforcing a need for new treatment guidelines.

Role of Co-infections

The burden of antibiotic-treatable disease is increased where malaria, HIV/AIDS and malnutrition are prevalent, as in Tanzania. These conditions weaken the immune system and increase the risk of acquiring bacterial infections that do require antibiotic treatment, even though the conditions themselves are not responsive to antibiotics. In the case of malaria, the problem is that, particularly in small children, the

symptoms of the disease may be indistinguishable from the symptoms of bacterial infections, so people often treat with both antimalarials and antibiotics. The growing use of rapid diagnostic tests for malaria may be reducing the use of antibiotics for children with confirmed malaria.

Healthcare Associated Infections (HAIs)

Hospitals can be dangerous places. In addition to the conditions that bring people to the hospital to begin with, the risk of acquiring an infection in the hospital—particularly a bacterial infection resistant to antibiotics—can be high. HAIs can be of many types: UTIs, infections of surgical incisions (surgical site infections; SSIs), pneumonia or blood stream infections.

Very few studies in Tanzania have investigated the rates of HAIs, but in the few that have, high rates have been reported. A recent study reported that about one-quarter of all patients admitted resulted in HAIs and many of these infections (as is the case around the world) are antibiotic resistant. MRSA has been noted to be on the increase at Muhimbili National Hospital, based on studies in 1999 (0.6 percent), 2004 (2 percent) up to an alarming 23 percent in 2010. Similar findings have been reported from other hospitals.

ANIMALS

Just as people suffer a high burden of infectious disease in Tanzania, so do domestic animals raised for food. This includes viral and parasitic diseases, but bacterial diseases figure prominently. Of greatest importance in terms of food animals are cows, goats, pigs, poultry and fish. The most common bacterial diseases are contagious bovine pleuropneumonia (CBPP) in cattle and contagious caprine pleuropneumonia (CCPP) in goats. For commercially grown chicken, salmonellosis, colibacillosis, mycoplasmosis and recently, infectious coryza, are common infections. Fish also have a variety of bacterial infections.

Even fewer studies than have been conducted in humans have been carried out about antibiotic resistant infections in other animals. These studies have reported multidrug resistant bacteria, however. These include studies in ducks, cattle, pigs, beef and dairy cattle, exotic and indigenous chickens. A recent study in farm-raised fish, where antibiotic use is prevalent, reported significant rates of antibiotic resistance.

Factors Affecting Antibiotic Resistance and Remedial Measures

Antibiotic resistance is a natural evolutionary response to the exposure of bacteria to antibiotics. Every time an antibiotic is taken by a person or animal, bacteria come in contact with it and those that are naturally resistant—because of a mutation or natural variation—have a survival advantage. When antibiotics are taken orally, a huge population of gut bacteria are exposed—not just pathogenic bacteria, but the ones that keep us healthy or live with us in equilibrium as well. Many exposed bacteria—both pathogenic and commensal—can pass on their resistant genetic material to other, even unrelated, bacteria.

Antibiotics should be used whenever they might save a life or cure an infection that is unlikely to be self-limited, but even those *appropriate* uses lead eventually to antibiotic resistance emerging. In those cases, mankind (or animalkind) has benefited from the use. However, resistance emerges equally from *inappropriate* use. The ideal would be to use antibiotics only when that use creates a benefit. In practice, that is a difficult ideal to meet, because diagnoses are difficult to make and many suspected bacterial infections are caused by viruses or other conditions. The aim, however, is to try to reduce antibiotic use without adversely affecting either animal or human health. At the national level, the six priorities are:

1. *Reduce the need for antibiotics* by reducing the burden of infection through vaccines and general public health measures,
2. *Improve hospital practices*, including infection prevention and control (IPC) and antibiotic stewardship, and surveillance for antibiotic prescribing and resistance,
3. *Rationalize antibiotic use in the community* by reducing inappropriate use and expanding access where needed, and surveillance for antibiotic prescribing and resistance,

4. *Reduce antibiotic use in animals* by increasing the use of vaccines for preventable infections, eliminating antibiotic use in growth promotion, reducing their use for disease prevention, and conducting surveillance for antibiotic resistance
5. *Educate* health professionals, policy makers and the public on sustainable antibiotic use, and
6. *Ensure political commitment* to meet the threat of antibiotic resistance

At the global level, the development of new antibiotics, alternatives to antibiotics and new diagnostics for bacterial and other infectious diseases is an important aspect of curbing antibiotic resistance, and these efforts should be increased.

Reduce the need for antibiotics

The best way to reduce the need for antibiotics is to reduce the burden of antibiotic-susceptible disease. Tanzania has taken steps toward this goal by introducing childhood vaccines for pneumonia, including *Haemophilus influenzae* and pneumococcal vaccines (PCV-7), and more recently, for the major cause of diarrhea, rotavirus. While rotavirus—a virus—is not susceptible to antibiotic treatment, children with diarrhea are routinely given antibiotics, so the introduction of the vaccine should avoid that inappropriate use.

Clean water, improved sanitation and uncontaminated food are extremely important in improving public health and, incidentally, in reducing the need for antibiotics, but we leave those to other sectors to address directly.

Improve infection control and antibiotic stewardship in hospitals and other healthcare facilities

The spread of infections in hospitals, including extremely dangerous multi-drug resistant infections, can be curtailed by implementation of a few proven measures in the rubric of IPC, including something as seemingly simple as healthcare workers washing their hands or using an alcohol rub between patients. Attention to venous and urinary catheters and ventilators will also pay dividends in reduced healthcare-associated infections.

Antibiotic stewardship programs in hospitals aim to improve the appropriate use of antibiotics by healthcare professionals while improving patient outcomes and minimizing any ill effects of antibiotic treatment. Antibiotic stewardship programs have also been shown to decrease rates of healthcare-associated infections and antibiotic resistance (Howard et al., 2014).

Many interventions fall within the antibiotic stewardship rubric—required use of prescribing guidelines, second opinions, formularies, pharmacist consultations and others. Ideally, this would include microbiological identification of the infecting organism and when bacterial, an antibiotic susceptibility profile. Tanzania has made substantial progress in clinical diagnostics for HIV and TB, but clinical microbiology, including bacteriology, has received little attention.

Another example is the treatment of children with watery diarrhea. WHO guidelines for Integrated Management of Childhood Illnesses (IMCI), which Tanzania has adopted, identify oral rehydration as the appropriate treatment. However, as many as 80 percent of children with watery diarrhea are given antibiotics inappropriately for diarrhea (Gwimile, Shekalaghe, Kapanda, & Kisanga, 2012)

Routine microbiology results are also the backbone of antibiotic resistance surveillance, which is needed to inform policy at the hospital level and above.

Rationalize antibiotic use in the community

Antibiotics may be prescribed by physicians and other healthcare workers inappropriately, such as without confirmation that an infection should be treated with an antibiotic, or they may be purchased directly by consumers without recourse to the healthcare system.

Only a few studies have documented either type of inappropriate use in Tanzania, but their results, in addition to an overwhelming amount of anecdotal information, suggests that both types are common, contributing to the reservoir of antibiotic-resistant bacteria in the country.

Regulations that govern which drug stores can sell antibiotics and which cannot exist under the auspices of the Tanzania Pharmacy Council, but in practice, antibiotics can be purchased without prescription from both authorized and unauthorized pharmacies and drug shops.

A recent study in accredited drug-dispensing outlets (ADDOs) in rural areas of the country reported dispensing without prescriptions and selling incomplete doses of antibiotics. The same is undoubtedly true, possibly to a greater extent, in less well-regulated outlets. As a result, many patients self-treat with antibiotics, including prior to hospital admission, which can contribute to increased resistance rates.

Little information is available on antibiotic resistance patterns and trends from the community, where most antibiotics are used. This information is likely to come first from hospitals, but should be on the longer term agenda at the community level.

Reduce antibiotic use in animals

Antibiotics are needed to treat bacterial infections in animals, just as they are in humans. However, it has become common practice to use antibiotics in food producing animals for two other purposes: 1) growth promotion and 2) to prevent disease. These two practices may be indistinguishable, as both rely on “sub-therapeutic” doses—small amounts of antibiotics mixed with animal feed at the retail level. Farmers have been using antibiotics to prevent disease in animals in place of improving sanitation and conditions for animals for decades. Use of antibiotics for growth promotion has been banned in Europe and some other countries, and has been deemed an inappropriate use of antibiotics.

Although there is a great deal of anecdotal evidence of antibiotic use in animals, few studies have documented the specific formulations and quantities used. Therefore, the quality and quantity of veterinary antibiotics being used are difficult to assess. Antibiotics for animals are commonly bought from informal vendors with no training, and the antibiotics themselves are often degraded because of poor storage conditions. Since the early 1990s, veterinary medicines and vaccines have been supplied by the private sector but the field suffers from a lack of availability, high costs, poor quality, low awareness and poor distribution systems.

The relationship between animal antibiotic use and antibiotic resistance in the human population is complicated and not well understood, but the fact of a connection is accepted. It is therefore, important to understanding the situation and developing appropriate policies that surveillance of antibiotic use and resistance is conducted in animals as it should be in humans.

Educate health professionals, policy makers and the public on sustainable antibiotic use

Educating healthcare professionals is an important component of ensuring the appropriate use of antibiotics at the health facility level. Educating policy makers is important to securing commitment, funding, and prioritization of antibiotic resistance initiatives at the local and national level. Finally, educating the public through awareness campaigns may help to promote appropriate use of antibiotics by consumers, an especially important area to target given the high levels of antibiotics currently available without a prescription.

Ensure political commitment to meet the threat of antibiotic resistance

Tackling the threat of antibiotic resistance requires a multi-sectoral approach, including experts and stakeholders from the human health, veterinary and agricultural sectors, in addition to pharmaceuticals, medical schools and others. GARP-Tanzania is an important mechanism to bring these diverse groups together and to focus efforts on combating resistance. Political commitment based on sound scientific evidence developed at the local level will be key to ensuring successful interventions.

Access to quality antibiotics

Despite our emphasis on the excessive use of antibiotics, it is important to remember what was introduced at the beginning of this report: that access to antibiotic treatment is also a problem. According to the Global Action Plan for the Prevention and Control of Pneumonia (GAPP), less than 25 percent of children in Tanzania with pneumonia are receiving antibiotics. These children's lives could be saved through the use of antibiotics. Although we are primarily concerned about resistance, the desire to preserve the effectiveness of antibiotics must be balanced with the overall aim to get antibiotics to as many people who actually need them as possible. No saving of antibiotic resistance is worth risking lives.

Barriers to access to medicines in Tanzania include human resource constraints, poor infrastructure (roads, transport, and communication), high operating costs, and counterfeit drugs. Antibiotics are one of the most commonly counterfeited products.

Current Activities with Relevance to Antibiotic Resistance and Use

Surveillance programs, microbiology laboratories, vaccination and prevention programs for public health, hospital IPC practices, and various government policies and regulations exist at some level in Tanzania. Their status is reviewed here.

Surveillance Programs

Human

The Integrated Disease Surveillance and Response (IDSR) system in Tanzania was introduced in 2011. Under this system, bacterial surveillance should be performed at the regional, zonal, and national laboratories, which have the capacity to diagnose bacterial infections. However, because supplies are lacking, culture and susceptibility testing are not routinely conducted, which means that accurate and consistent data are not reported. Hence, while a reporting system is in place, poor reporting remains an issue. Nevertheless, as part of the Integrated Disease Surveillance Program, specimens are collected from some levels, and the program follows specific guidelines stipulated by the WHO. For instance, the IDSR lab does a monthly mandatory reporting of cholera and *Shigella* cases, in addition to plague and meningococcal meningitis.

Animal

The Tanzania epidemiologic surveillance system includes the epidemiology unit of the Ministry of Livestock Development and Fisheries (MLDF) and the National Veterinary Laboratory System (Animal Disease Research Institute, Veterinary Investigation Centers), the Sokoine University of Agriculture, veterinary service providers and wildlife research institutes. The previous major surveillance approach was the use of community-based animal health workers (CAHW), as developed in 1997.

The One Health approach provided a promising model for disease surveillance and tracking with the formation of the Southern African Centre for Infectious Disease Surveillance (SACIDS) in 2008. SACIDS is a One Health consortium of academic and research institutions working on infectious diseases of humans and animals, and is currently developing a One Health mobile technology approach to disease surveillance in Tanzania (Rweyemamu et al., 2013).

Microbiology Laboratory Capacity

Human

The Ministry of Health and Social Welfare (MOHSW) has made substantial efforts to strengthen and expand laboratory capacity, and efforts are under way to accredit all regional, zonal and national laboratories to meet standards for quality services and patient safety. The MOHSW drafted National Policy Guidelines for Medical Laboratory Services in 2003 with the aim of establishing standards for all aspects of medical laboratories. Major challenges to improving microbiological capacity remain, however, as no laboratories have been accredited and poor quality continues to prevail.

Animal

The veterinary health system in Tanzania is currently not well regulated, though efforts are in place to formalize this sector. Tanzania is currently working towards providing a paraveterinarian in every village. Because there are no records of drug sales, consumption of veterinary medicines is difficult to monitor, and building the capacity of the drug sellers is a priority for developing the livestock industry. To respond to this need, the Tanzania Food and Drug Administration (TFDA), in collaboration with the MLDF, has developed a training manual for veterinary medicine sellers, and 42 trainers have been trained for this course (Cliffson Maro ADDO report, 2013).

Vaccines and Prevention

Human

Vaccination coverage rates have improved significantly in Tanzania. In April 2009, the *Haemophilus influenzae* type b vaccine was introduced as a part of the pertussis, diphtheria, tetanus and hepatitis b pentavalent formulation, and in 2011, 91 percent of eligible infants received three doses of this vaccine. A new immunization schedule started in 2012 through the Expanded Programme on Immunization (renamed Immunization and Vaccine Development (IVD) Program) and includes the oral polio vaccine (OPV), and the pentavalent vaccine at 6, 10, and 14 weeks. Additionally, since January 1995, Vaccine Preventable Diseases (VPD) surveillance activities have been conducted nationwide.

Animal

Bacterial diseases controlled by mass vaccination campaigns with relative success include:

East Coast fever (ECF), foot and mouth disease (FMD), Rift valley fever (RVF), Newcastle disease, Pestes des petit ruminantia (PPR), and CBPP. As previously mentioned, however, animal vaccines are not widely available and are currently underused.

Hospital IPC

The National IPC Guidelines for Health Care Services in Tanzania were issued in 2007, designed for healthcare workers and applicable to their day-to-day activities. Several other ministry-developed documents provide further guidance in this area. Another MOHSW directive is the establishment of a Quality Improvement Infection control committee (QI Team) responsible for making IPC related decisions at hospitals. Despite these positive developments, IPC is still generally non-existent in healthcare institutions.

Government Policies and Regulation

The national government has a strong role to play in all aspects of national wellbeing, including issues related to antibiotics. The *Tanzania Drug Policy of 1993* is the current national policy on medicine use.

The objective of the drug policy is to provide all Tanzanians with access to essential pharmaceutical products of proven quality at affordable prices. It also states that the government will improve the rational use of medicines, which is where the National Essential Medicine List (NEMLIT) plays a major role. Standard treatment guidelines and the NEMLIT were designed to provide standardized guidance for the appropriate

provision of healthcare for specific diseases and conditions. The treatment guidelines, in particular, serve as a platform for rationalizing prescribing practices, improving patient outcomes and optimizing the use of limited resources.

Some of the new health objectives of the current five-year plan, National strategy for growth and reduction of poverty II (in Kiswahili: MKUKUTA II) for the years 2010-2015, include providing universal primary health care at a maximum distance of 5 km, building stronger capacities to prevent and cure diseases, scaling up efforts to reduce child and maternal mortality and eliminate malnutrition, and continuing to expand water accessibility (Ministry of Finance and Economic Affairs, 2010).

For animals, there are also several policies in place. These are the National Livestock Policy of 2006; the Veterinary Act of 2003; the Food, Drugs and Cosmetics Act of 2003; the Fisheries Policy of 1997 and the Fisheries Act of 2003. Others include the East African Community Sanitary and Phytosanitary (EAC-SPS) Requirements (2012).

None of the current policies for human or animal health directly address the issue of antibiotic resistance.

Recommendations

In light of the national situation described in this report and the urgent global need for action on antibiotic use and resistance, GARP-Tanzania recommends as a goal the creation and implementation of:

A national strategic plan to govern antibiotic use, ensuring the sustainability and effectiveness of antibiotics for future generations and maximizing their potential to combat disease and save lives.

Development of a national plan for antibiotic resistance is an ambitious goal, requiring commitment and collaboration among sectors and involving many partners in human and animal health and environmental science.

The current priority is to recognize the facets that must eventually be part of a strategic plan, and to work toward its realization by carrying out some of the activities that will be included. Some areas (such as clean water and sanitation) are of value for many reasons other than antibiotic resistance and have focused constituencies that are better placed than GARP to develop and implement interventions, but are included below because they are also important to antibiotic resistance.

The GARP-Tanzania working group is in a strong position, with this report, to continue to inform stakeholders and other interested parties of the current situation regarding antibiotic resistance in Tanzania.

The major themes of a national strategy and some specifics that might be included are:

Reduce the need for antibiotics through public health measures

- Increase coverage of existing vaccines and incorporate new vaccines
- Improve access to clean water and sanitation and a safe and adequate food supply

Improve hospital infection control and antibiotic stewardship

- Improve prescribing guidelines for common bacterial diseases, taking local resistance patterns into account
- Implement antibiotic stewardship and infection control programs in hospitals
- Develop and improve surveillance systems for antibiotic use and resistance in hospitals
- Strengthen diagnostic laboratory capacity

Rationalize antibiotic use in the community

- Conduct regular reviews of prescriptions written by health care providers at the district and regional and zonal levels assessing the clinical and laboratory basis of those prescriptions
- Initiate surveillance and studies on antibiotic sales and use at the community level

Reduce antibiotic use in agriculture

- Improve regulation and registration of veterinary products, including antibiotics and vaccines
- Eliminate the use of antibiotics as growth promoters in food producing animals and reduce their use for disease prevention
- Implement a sentinel surveillance system for bacterial diseases in animals
- Conduct studies on current levels of antibiotic use and resistance in animals

Educate health professionals, policy makers and the public on sustainable antibiotic use

- Review and revise curricula and training materials on antibiotic prescribing practices for all levels of health care workers, including clinicians, nurses, pharmacists, community health workers, veterinarians and other allied health sciences
- Foster dialogue among stakeholders and policy makers by hosting national and regional meetings on antibiotic resistance
- Hold antibiotic resistance awareness events to coincide with international events

Ensure political commitment to meet the threat of antibiotic resistance

- Strengthen cooperation and raise awareness among relevant sectors to increase multi-sectoral and institutional cooperation
- Create national policies and implementation plans to combat antibiotic resistance

Finally, the life-saving potential of antibiotics cannot be realized if those who need them cannot access them, or if the drugs they access are of low-quality or counterfeit. Ensuring access to high quality antibiotics and preventing stock-outs, particularly for the poorest and most vulnerable populations who are most likely to lack access to health services, is a major focus for GARP-Tanzania's efforts.

Box: Potential Next Steps for GARP-Tanzania

GARP-Tanzania will serve as a galvanizing force, highlighting available information, generating interest and building collaboration to confront antibiotic resistance. The following areas will be prioritized during the next phase:

Strengthen IPC committees in hospitals

MOHSW guidelines require that all hospitals have IPC committees, but few hospitals have them and many that do exist are inactive. Strengthening IPC may require the MOHSW to run or support a program for hospital staff to be sensitized to the importance of IPC, provide up-to-date guidelines and develop curricula for all types of healthcare workers.

Vaccinate food-producing animals

Vaccination of food-producing animals is not currently required and most vaccines are available only in the private sector. The potential benefits of mandatory vaccination for specific bacterial diseases, including reduction of antibiotic use, could be explored. If found to be of value, vaccines could be subsidized and distributed by the government at affordable prices.

Phase out the use of antibiotics for growth promotion and disease prevention in agriculture

Antibiotics are frequently added to animal feed to increase growth, and farmers may need evidence that curtailing this use will not be economically harmful in order to change their practices. Demonstration projects could be conducted to produce locally relevant evidence on this question. Mass administration of antibiotics is also used to prevent disease in flocks and herds. Demonstration projects of improved husbandry practices to reduce this need could also be conducted.

Lay the groundwork for antibiotic resistance surveillance

Tanzania has no representative surveillance system for antibiotic resistance, though some individual hospitals collect data. Analyzing the available data on antibiotic susceptibility could help to identify trends and patterns in resistance, inform the creation of policies and interventions to curb resistance rates and encourage the start of a national surveillance system.

Improve microbiology laboratory capacity

Microbiology laboratories in Tanzania are poorly supplied with equipment and reagents, both a cause and effect of clinicians' infrequent reliance on microbiological test results. Improving the functioning of these laboratories and creating greater awareness among clinicians of the importance of identifying organisms and their antibiotic susceptibility patterns would be a major step toward improved patient care and antibiotic stewardship.

Improve the antibiotic supply chain

Access to antibiotics is often limited by stock-outs created by delays in the supply chain. Delays may also lead to reduced-quality or expired antibiotics being distributed. A top-to-bottom review of the supply chain, by or on behalf of MSD, could shed light on feasible improvements that would avert these problems.

The animal antibiotic supply chain is currently unregulated by government. A policy review could explore how government oversight could be established.

Involve universities in combating antibiotic resistance

Higher learning institutions could play an important role in promoting the prudent use of antibiotics. Research on antibiotic resistance could be considered a public service, and funding to these research areas could be increased. Students have the potential to serve as generators of evidence and potential

solutions, in addition to acting as educators throughout the research process.

Many disciplines can contribute to the scientific knowledge base, and efforts should be made to foster collaboration and communication among sectors. For instance, Good Agricultural Practices (GAP), Good Manufacturing Practices (GMPs), Good Hygienic Practices (GHPs), Hazard Analysis and Critical Control Point (HACCP) systems are some areas that may be coordinated to improve human health outcomes. Universities can also help to foster dialogue between regulators, public health officials and the animal industry.

Involve pharmacists in combating antibiotic resistance

Pharmacists and healthcare workers play important roles in granting and restricting access to antibiotics in hospitals and communities, in addition to monitoring supply chains, reviewing policies and providing valuable information to patients. Hospital pharmacists can improve the rational use of antibiotics by educating medical colleagues and patients, auditing local prescribing patterns, monitoring antibiotic consumption levels, participating in policy and essential medicine list reviews, supporting IPC and antibiotic stewardship programs, conducting research and monitoring the quality of antibiotics.

Build political commitment

Although antibiotic resistance has received increasing levels of attention at the global level, the threat is still not prioritized by stakeholders or the public, worldwide and in Tanzania. The creation of a task force within the MOHSW to raise awareness on the prudent use of antibiotics among policy makers, healthcare workers and the public could serve a valuable role in coordinating, energizing and leading national efforts to curb antibiotic resistance.

CHAPTER 2: Population and Health Background

HUMANS

Population

The United Republic of Tanzania, made up of mainland Tanzania and the islands of Zanzibar, has an estimated population of 44.9 million and an annual population growth of 2.82 percent. As of 2009, the majority of the population (73.6 percent) lives in rural areas and population density is relatively low at about 50 people per square km. The country faces population stress, with 44.8 percent of the population under the age of 15, and a high fertility rate of 5.01 children born/woman. The fertility rate is higher in rural areas (6.1 children per woman), where education levels and the use of modern contraception are both lower than in urban areas (3.7 children) (Tanzania Demographics Profile 2013; World Bank Data and Statistics 2011). Urbanization is occurring at an annual rate of 4.77 percent.

Economy

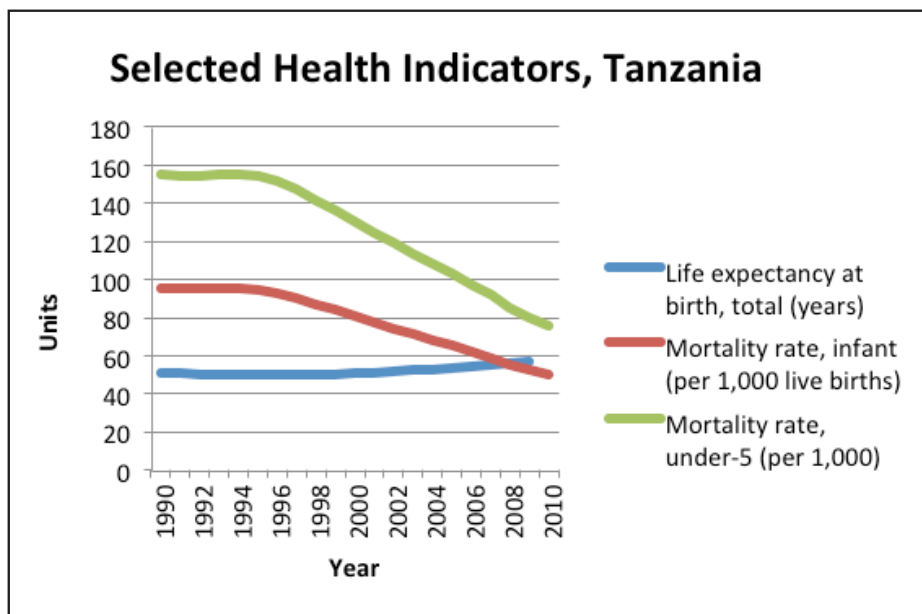
There has been political stability and economic growth in post-independence Tanzania. The Gross Domestic Product (GDP) growth rate in 2012 was 6.9 percent, compared to 5 percent in 1995 (Ministry of Finance and Economic Affairs, 2013b). The GDP per capita has also increased steadily, from US\$ 277 in 2003 to \$608.85 in 2012. As of 2009, 40 percent of the country's land was in agriculture, and in 2010 agriculture accounted for 28 percent of GDP. Industry and construction accounted 22.7 percent of GDP in 2011 while services make up 47 percent (World Bank Data and Statistics 2011). In 2007 48 percent of the population was below the international poverty line of \$2 a day, and 10 percent were below the national poverty line.

Health System

Health Indicators

Life expectancy at birth has increased from 51 years in 2002 to 60.76 years in 2013 (Tanzania Demographics Profile 2013). In an effort to meet the Millennium Development Goals (MDG) by 2015, Tanzania has made significant progress in its child survival programs by targeting and improving malaria prevention and treatment programs, implementing IMCI, starting vaccination programs and encouraging vitamin A supplementation. Tanzania has seen a dramatic fall in its under-5 mortality rate (see Figure 2-1). In 1990, the under-5 mortality rate was 158 deaths per 1,000 live births compared to 75 per 1,000 live births in 2010. Similarly, the infant mortality rate has decreased dramatically from 95 per 1,000 live births in 1990 to 50 per 1,000 live births in 2010 (World Bank Data and Statistics 2011).

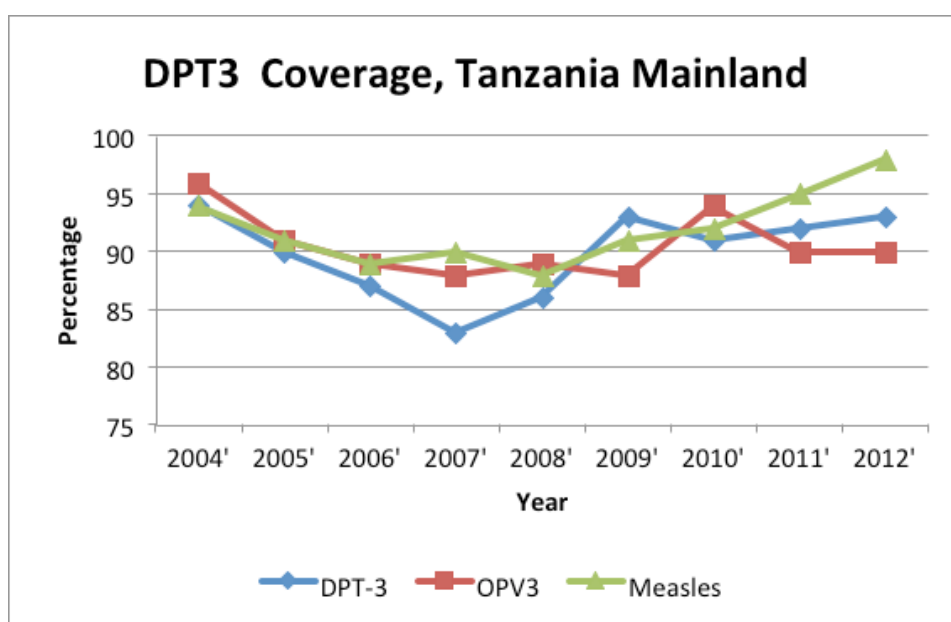
Figure 2-1: Selected Health Indicators from 1990 to 2010, Tanzania



SOURCE: World Bank, 2011

Immunization coverage has also improved over the past decade, and recent (2011) statistics show coverage rates at 98.6 percent for BCG, 95.1 percent for DTP-HepB, and 39.5 percent for measles. The Expanded Programme on Immunization (EPI) now renamed Immunization and Vaccine Development (IVD) Program, introduced a new immunization schedule in 2012, adding OPV/DTP-HepB-Hib/PCV13 at 6, 10, and 14 weeks. In January 2013, rotavirus and the pneumococcal conjugate vaccines (PCV13) were added by the Ministry of Health (Ministry of Health and Social Welfare, 2013a). The measles second dose has been introduced in January 2014 and HPV demonstration at Kilimanjaro region among primary female students in March 2014. There has been a rise of immunization and figure 2-2 shows the routine immunization coverage of OPV3, DPT-Hep-Hib3 and measles between 2004 and 2012.

Figure 2-2: DPT3, OPV and measles coverage, Tanzania Mainland – 2004 to 2012



SOURCE: Expanded programme on immunization 2010 - 2015 comprehensive multi year plan.

Maternal mortality still remains a major problem. The country ranks 148 out of 181 reporting nations in maternal mortality (Institute for Health Metrics and Evaluation, 2012), even though maternal mortality rates have declined by 47 percent in the past two decades from 870 maternal deaths per 100,000 live births in 1990 to 460 deaths per 100,000 live births in 2010. Health disparities persist between urban and rural areas and also by income status. (World Bank Data and Statistics 2011).

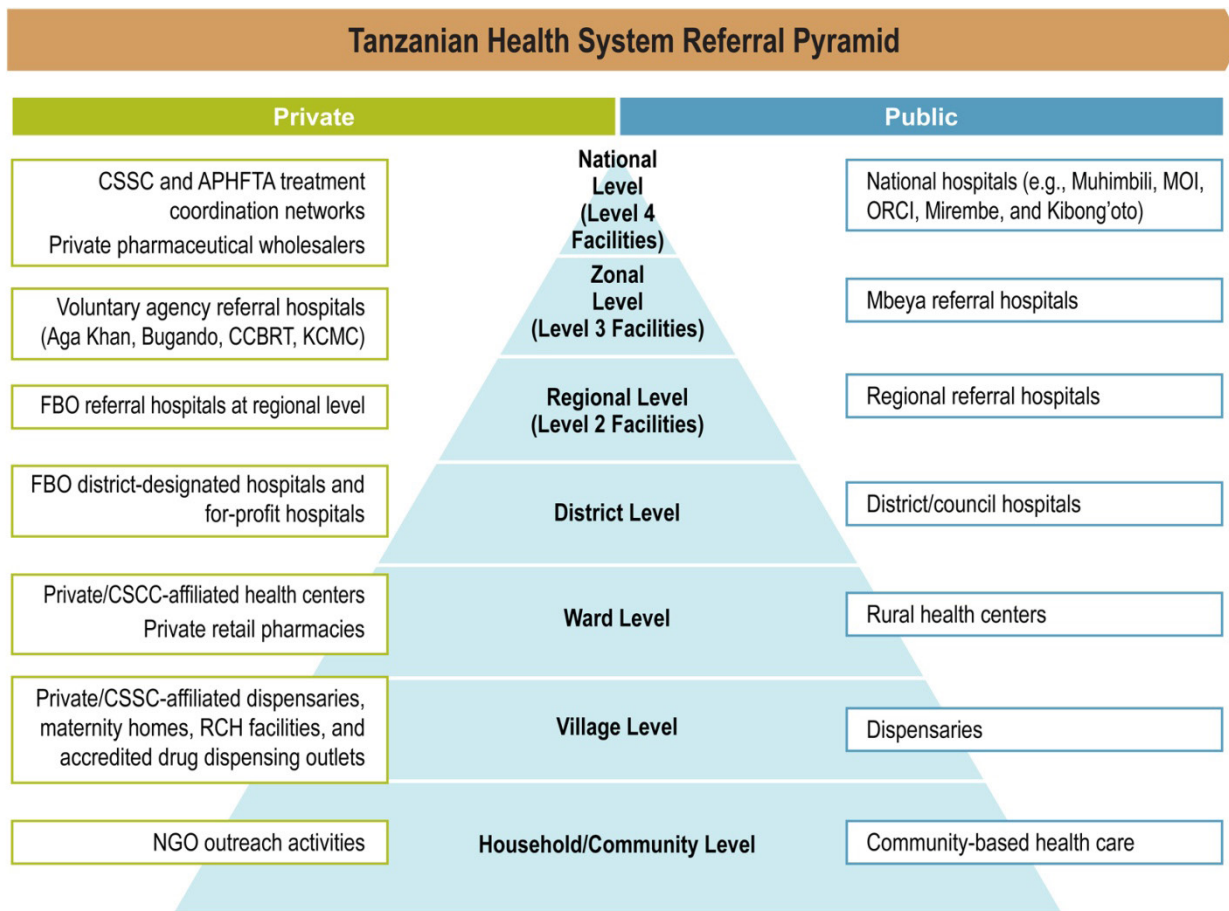
Organization of Health Services

Healthcare in Tanzania has historically been under the control of the state. In 1977, private for-profit health services were banned and health care was prohibited as a commercial service. In 1991, however, this was amended so that qualified medical practitioners and dentists could manage private hospitals with the approval of the Ministry of Health. The majority of health services continues to be offered by the government and is operated under the Ministry of Health and Social Welfare.

The system is organized hierarchically, extending from national specialized hospitals at the top through regional and district hospitals to more than 3,000 local dispensaries or clinics (Figure 2-3). There are six levels in referral, although referrals between facilities is poor due to lack of supervision, low motivation, lack of equipment, unreliable supply, poor transportation and poor communication (Kwesigabo et al., 2012).

At the lowest level, village health services are home-based with two village workers per village. One worker is responsible for environmental sanitation and the other for maternal and child health. Village workers receive compensation from the village government (Manji, 2009).

Figure 2-3: Tanzanian Health System Referral Pyramid



Notes: APHFTA – Association of Private Health Facilities in Tanzania, CCBRT – Comprehensive Community Based Rehabilitation in Tanzania, CSSC – Christian Social Services Commission, FBO – faith-based organization, KCMC – Kilimanjaro Christian Medical Centre, MOI – Muhimbili Orthopaedic Institute, ORCI – Ocean Road Cancer Institute, RCH – reproductive and child health

SOURCE: (Strengthening health outcomes through the private sector (SHOPS), 2013)

The next level up is the dispensary (around 4,600), each serving a population of 6,000-10,000 (MOHSW, 2009). Dispensaries operate on weekdays, but are usually understaffed. While each dispensary houses a labor room, only 7 percent can provide the required services for deliveries. The 481 Health Centres, most with about 20 inpatient beds, serve approximately 50,000 people each. They serve one administrative division and provide basic delivery services, ambulatory services, minor surgical procedures and intravenous infusions. In reality, only six percent were equipped to carry out these services (Manji, 2009).

Each of the 129 districts has at least one hospital, 55 of which are owned by the government, 13 are operated by faith-based organizations, and 86 are owned by parastatals or the private sector (Ministry of Health and Social Welfare, 2009b). District hospitals provide preventive services, ambulatory services, laboratory and x-ray diagnostic services, in-patient care and emergency obstetric care. Most are staffed by assistant medical officers who have two years of clinical training and nurses. District hospitals refer patients to one of the 18 regional hospitals, which provide specialist care. Regional hospitals are staffed with public health personnel, surgeons, physicians, pediatricians, specialized nurses and midwives (Kwesigabo et al., 2012; Manji, 2009).

In addition, there are four specialized referral hospitals some of which also serve as teaching hospitals: Bugando Medical Centre, Kilimanjaro Christian Medical Centre, Mbeya Referral Hospital and the national hospital: Muhimbili National Hospital (Manji, 2009; Ministry of Health and Social Welfare, 2009b). Other specialized hospitals serve as the highest levels in their individual disciplines: Muhimbili Orthopaedic Institute (MOI) for orthopedic cases and Ocean Road Cancer Institute for adult cancer care.

Following the 1991 amendment allowing private health care, a number of private non-profit and for-profit health centers were established, particularly in urban areas. As of 1997, private hospitals constituted 56 percent of the 224 hospitals in the country and private dispensaries constituted 36 percent of the 4,276 dispensaries (Tibandebage, Semboja, Mujinja, & Ngonyani, 2001). A study reported much lower prices at non-profit institutions, where the maximum price was just 16 percent of the average for-profit consultation. The study also examined the incentives in place for private providers to offer quality care, and found that little if any such incentives existed (Tibandebage et al., 2001). In terms of differences between healthcare professional knowledge in urban and rural settings from public and NGO clinics, a 2007 study compared hypothetical patients to actual patient observations. In NGO clinics, there was little difference between how much doctors in urban and rural areas knew. However, doctors in rural areas were less likely to apply their knowledge. In the public sector, the study found that there was a difference in knowledge between rural and urban providers. However, urban providers had better training and performance than their rural counterparts (Leonard & Masatu, 2007).

Health Workforce

There are 52,637 health workers in Tanzania, 27 percent of whom are nurses and midwives, compared to 50 percent in other African countries (Ministry of Health and Social Welfare, 2011b; WHO Afro, 2006). Distribution of health workers in urban and rural districts is uneven, with one rural district reporting 0.3 health workers per 1,000 compared to 12.3 health workers per 1,000 in an urban district (Munga, Songstad, Blystad, & Maestad, 2009).

WHO estimates that there are just 0.1 physicians per 10,000 population, compared to an average of 2.3 for the African Region and an average of 2.8 for all low-income countries (World Health Organization, 2011). World Bank data indicate that the number of physicians per capita has decreased from 0.4 per 10,000 population in 1990 to 0.2 per 10,000 population in 2002 to the current 0.1, a trend that must be reversed if the country is to see health improvements (World Bank, 2011).

The shortage of healthcare workers in Tanzania has worsened over the years, with a shortage of 82,277 health workers in 2009 and 96,448 in 2010. If this trend continues, by 2017, the shortage will reach 214,723 (Ministry of Health and Social Welfare, 2008a, 2009b). Staff shortages were estimated to be as high as 86 percent in private facilities and 65 percent in government health facilities in 2006 (Kwesigabo et al., 2012).

In addition, worker satisfaction was found to be poor. At the Muhimbili National Hospital, a 2003 survey reported 39 percent of support staff, 67 percent of auxiliary clinical staff and almost half of the doctors were dissatisfied for various reasons including low salaries, unavailability of equipment, and lack of concern by hospital management and inadequate performance evaluations. In 2012, strikes were held at Muhimbili National Hospital and several other hospitals in Tanzania demanding higher pay and better working conditions (Kwesigabo et al., 2012). Following the strike, in an effort to showcase the extent of migration by doctors from clinical practice, a study conducted in August to October 2012, involving 2,246 medical doctors showed that a staggering 39.6 percent were not practicing clinical medicine (SIKIKI & Medical Association of Tanzania, 2013).

Microbiology Laboratory Capacity

MOHSW has made substantial efforts to strengthen and expand clinical microbiology services in Tanzania. Microbiology laboratories in the country have been established at regional, zonal and national level facilities. MOHSW, with support from the American Society for Microbiology (ASM) and the Centers for Disease Control and Prevention (CDC), conducted five-day basic microbiology courses as well as five-day advanced courses for all zonal and regional laboratory personnel. ASM trained Tanzanian mentors who conducted six week mentorship programs at six laboratories in Kibong'oto National TB Hospital, Musoma, Amana Hospital in Dar, Mount Meru in Arusha and Bombo in the Tanga region.

The National TB and Leprosy Control Programme (NTLP) is strengthening TB diagnostics in Tanzania in response to the country's increasing TB burden, driven by HIV co-infection. The Kibong'oto National TB Hospital and Central TB Reference laboratory (CTRL) at Muhimbili National Hospital (MNH) are two laboratories that have capacity to perform TB culture using both Lowenstein Jenson media and drug susceptibility testing with the latter able to perform *Mycobacterium tuberculosis* PCR. Additionally, the gene Xpert assay for Mtb testing and rifampicin resistance is also conducted at CTRL and municipal hospitals.

While Tanzania has made substantial progress in clinical diagnosis for HIV and TB, clinical microbiology services, including bacteriology, parasitology, and mycology, have received little attention. Efforts are being made to accredit all regional, zonal and national laboratories to meet standards for quality services and patient safety. The MOHSW has drafted its National Policy Guidelines for Medical Laboratory Services in 2003 to establish standards for medical laboratory services, including requirements for laboratory structure, essential facilities, essential tests, appropriate techniques, recommended equipment, and laboratory staffing (personal communication with Nyombi Balthazar, 2013)

Challenges facing essential microbiological technologies include lack of supplies including equipment and reagents, lack of trained technicians and scientists, lack of quality assurance schemes, lack of referral systems, and lack of networks for external quality assurance for microbiological tests.

Community Drug Outlets

Tanzania's pharmacy workforce is composed of 1,002 registered pharmacists, 792 pharmaceutical technicians and pharmaceutical assistants, and 14,000 ADDOs dispensers (Pharmacy Council Database, May 2013). In 2008, Tanzania's pharmacist density per 10,000 population was 0.17, much lower than Kenya (0.73) and India (6.09). The density of pharmacy technicians was also low in Tanzania (0.11) compared to Kenya (0.61) (International Pharmaceutical Federation, 2009).

Tanzania had two types of community drug outlets: pharmacies that store and sell over-the-counter (OTC) medicines and all prescription-only medicines (POMs) under the supervision of a registered pharmacist; and ADDOs which sell OTC medication and selected POMs in the presence of a trained dispenser.

ADDOS

To address some of the problems with *Duka La Dawa Baridi* (DLDB) --poor quality of drugs, inadequate storage, high prices, and lack of knowledge of dispensing staff—the ADDO program was piloted in the Ruvuma region in 2003 by the MOHSW through Tanzania Food and Drugs Authority (TFDA) in collaboration with the Management Sciences Health (MSH)/Strategies for Enhancing Access to Medicines (SEAM). The program aimed to create essential medicine shops through improving the quality and affordability of medicines in rural and peri-urban areas and conducted training workshops for shop owners and dispensing staff, provided incentives to shop owners, improved customer awareness, and developed an accreditation system supported by TFDA and the MOHSW. An evaluation of the program in 2005 showed improvements in the quality, affordability and availability of medicines, the quality of dispensing services and improvements in the regulatory system when compared to DLDBs as control shops (Center for Pharmaceutical Management, 2008).

After the pilot evaluation, the MOHSW approved countrywide scale up of the ADDO initiative. TFDA in collaboration with MSH under the East Africa Drug Seller Initiative (EADSI) worked on the modality to implement the program through a decentralization process, involving local governments. The aim was to improve implementation efficiency, reduce implementation costs and increase stakeholders' participation and cost contribution. Implementation costs under EADSI were reduced by 50 percent and consumers were satisfied with the availability of medicines and knowledge of drug dispensers (Management Sciences for Health, 2011).

As of 2013, there are over 4,500 functioning ADDOs in 20 of the 21 regions in Tanzania (MSH/TZ, May 2013). In 2011, oversight roles were transferred from the TFDA to the Pharmacy Council. The ADDO program has been institutionalized in the Tanzanian health system through regulatory frameworks and a number of policy changes incorporating the program. Such policies include ADDO regulations under the Tanzania Food, Drugs and Cosmetics Act 2003, ADDOs acting as a delivery mechanism for ACTs by the National Malaria Control Program, and the National Health Insurance Fund utilizing ADDOs as a source of essential medicines for its clients (EADSI Final Report, 2011). ADDOs still pose operation challenges, e.g., ensuring appropriate drug dispensing, uneven enforcement of laws and regulations across regions, and competing priorities for funding in health budgets to support roll out and maintenance (MSH, 2011). MSH's Sustainable Drug Sellers Initiative aimed at supporting the maintenance and sustainability of ADDOs includes component on evaluating health care providers, consumers and other stakeholders' perception on use of antibiotics and the development of antimicrobial resistance (MSH, 2011).

Minzi and Manyilizu, 2013 compared antibiotic dispensing practices in 60 DLDB in Kibaha and 85 ADDOs in rural Mvomero, Kilombero and Morogoro by using mystery shoppers. Overall, they found that there were few differences between ADDOs and DLDB, and where they did differ, ADDOs fared worse. Both ADDOs and DLDB made verbal prescriptions, but more ADDOs dispensed antibiotics without prescriptions and in incomplete doses, inappropriately prescribed antibiotics, and made fewer referrals when compared to DLDB. In addition, 40 percent of ADDO dispensers had left, and untrained dispensers filled their positions. The authors also found poor enforcement of regulations, with no penalties for violation (Minzi & Manyilizu, 2013) or DLDB.

Health Care Financing

Tanzania's healthcare budget has doubled over the last few years from US\$ 20.3 million in 2006/2007 to US\$ 40.9 million in 2010/2011 (MOHSW, 2011a). For the 2012-2013 budget, the government allocated 10 percent to health. Of this, US\$ 156.6 million will be spent on procuring and distributing medicines, and US\$ 55.4 million will be spent on health insurance (Ministry of Finance and Economic Affairs, 2013a). Tanzania utilizes a mix of financing mechanisms for its health care system, combining tax revenues, out-of-pocket payments, and insurance. Taxes account for the majority of funds, which make up 70 percent of public funding. The National Health Insurance Fund (NHIF) and Community Health Fund (CHF) combine with user fees to make up the remainder of spending. In 2009 the country spent 5.2 percent of GDP on health, a significant drop from 2006 when spending peaked at 6.5 percent.

Despite the overall drop in percentage of GDP allocated to health, the government share in healthcare financing has increased rapidly, from 40 percent of total health expenditure in 2000 to 72.3 percent in 2008. In contrast, the average government share of health financing across sub-Saharan Africa is 50 percent, and across all low-income countries is just 41 percent. The Tanzanian government allocates twice as much of its budget to health (18 percent) compared to other low-income countries (9 percent).

The majority of health care funding in Tanzania comes from external sources, which accounted for 60 percent of funding in 2008, an increase from 44 percent in 2006.

Although many low-income countries offer free public health services, Tanzania uses a cost-sharing model of health financing, which means that people pay fees to access services. In 2010, a per-year user fee of US\$ 1 was charged for primary health care services. National policy dictates that access for pregnant women, children under 5, the elderly and the disabled should be free, although many health facilities still charge because the government does not subsidize the costs and instead expects facilities to absorb the loss (Deutsche Stiftung Weltbevölkerung website; Mhamba and Mbirigenda, 2010). In a study assessing some facilities in the Kyela district, for instance, were found to charge extra fees for medicines that were supposed to be free. The study also found discrepancies between prescription and patient registers, such that fewer patients were registered than those who had been provided medicines. The authors attributed this to be due to either poor record keeping or undocumented payments (Frerick, Kuper, & Tiba, 2011).

In addition to the pay-for-service scheme, Tanzania established several local funding plans, known as CHF schemes in 1996. It was run by the government's MOHSW and Prime Minister's Office Regional Administration and Local Government (PMO-RALG). These CHFs collect payments from households, receive a matching grant from the government, and then use these funds to contribute to the health costs of members. The CHFs can be used by members to pay for all visits to public health facilities, and in some cases they can also be used at private facilities (Mtei et al., 2007). The CHF covers the whole family in rural areas and can cost a family between TSh 5,000 – 30,000 per year (personal communication Jafary Liana, March 2013). Enrollment in a CHF is voluntary, and thus far utilization is low, likely due to the low cost of health care visits, high premiums, lack of information and accountability, and poor quality of public care, among others (Mtei et al., 2007).

A second national health insurance initiative began in 2001, and required all public servants to become members of the NHIF. The NHIF is funded by a 6 percent payroll contribution, split evenly between the employer and employee, and covers inpatient and outpatient care up to a maximum amount, generic medicines on the Essential Drug List and basic diagnostic tests. The NHIF covers up to six beneficiaries per member.

As of 2009, the NHIF took over the role of administering the CHF scheme from the government after a cabinet ruling (Cabinet 37/2007). For 2012/2013, the insurance coverage by these two schemes had grown to 13.9 percent of Tanzania population where NHIF coverage was 6.6 percent and CHF as 7.3 percent (National Health Insurance Fund, 2012).

Established in March 2013, but yet to feature in any formal manual, the NHIF has made it possible for an unemployed person to become insured by contributing a minimum amount of 964,800 TSh per annum. It is envisioned that mandatory health insurance will be extended to formal sector employees in the private sector, via health insurance contributions to the National Social Security Fund (NSSF), in the next phase (Mtei et al., 2007).

Availability of and Access to Essential Medicines

As part of its larger social and economic agenda, in the 1970s the government sought to produce all medications locally using local inputs. The government subsequently established two pharmaceutical companies, Keko Pharmaceutical Industries Ltd (in 1997) and the Tanzania Pharmaceutical Industry, TPI (in 1980). This led to massive shortages, and faced with local and international pressure, the country privatized these companies in 1997 (they are currently 60 percent private and 40 percent government owned). TPI was closed down in 2012 and is currently being investigated for production of counterfeit ARVs. In addition to Keko, the country has six other pharmaceutical manufacturing companies that are 100 percent privately

owned.

Local production accounts for just 30 percent of medication bought and sold throughout the country, most of which are antibiotics, analgesics, and antimalarials. The number of private pharmaceutical wholesalers has increased substantially in the past few years, and they operate in conjunction with the Medical Stores Department (MSD), the public distribution center (Management Sciences for Health, 2003).

Availability of Medicines

Most studies of medicine availability are outdated, since they date back to more than a decade ago; thus, the extent to which they reflect current conditions are currently unknown. In a 2002 baseline survey of the pharmaceutical sector, zonal warehouses were found to have 75 percent of key drugs¹. The Mbeya and Kilimanjaro regions were reported to have over 90 percent of key medicines in stock, whereas Mwanza and Dar es Salaam, the bigger and more populated of the four regions surveyed had around 80 percent of essential medications in stock (Ministry of Health and Social Welfare & World Health Organization (WHO), 2002). A 2010 pediatric drug assessment found only 32 percent of the lowest priced generic medicines and 45.3 percent of essential medicines available from 143 public facilities in Dar es Salaam, Manyara, Mbeya, Mtwara, Mwanza, Shinyanga, and Tabora regions. Unlike the 2002 survey, availability was similar in rural and urban areas (Ministry of Health and Social Welfare, 2011a).

In the private and non-governmental sectors, 34.4 percent and 32.1 percent, respectively, of pediatric generic medicines surveyed were available. Availability of pediatric medicines was higher in urban settings in the private sector, but no statistical difference was found between urban and rural settings in the non-governmental sector. Of the antibiotics surveyed, benzyl penicillin injection was almost always available (more than 85 percent of the time) in the public and NGO sectors, amoxicillin suspension and co-trimoxazole suspension were almost always available in the private and NGO sectors, and gentamicin ear/eye drops also had high availability in the private sector (81.3 percent) (Table 2-1). Co-trimoxazole tablets, and nalidixic acid were completely unavailable, and rifampicin was unavailable in the non-governmental sector. Low availabilities of gentamicin injection and ceftriaxone injection were found in all sectors (Ministry of Health and Social Welfare, 2011a).

Table 2-1: Percent availability of pediatric antibiotics in public, private and non-governmental sectors

Antibiotic	Strength	Public sector	Private sector	NGO sector
Amoxicillin suspension	125mg/5ml	55.3%	93.8%	87.5%
Amoxicillin+clavulanic acid suspension	125mg+31mg/5ml	0.0%	22.9%	8.3%
Amoxicillin+clavulanic acid tab	250mg+125mg	2.1%	10.4%	2.1%
Benzyl penicillin injection	5MU(3g)	87.2%	66.7%	87.5%
Ceftriaxone injection	250mg/vial	57.1%	25.0%	22.9%
Chloramphenicol injection	1gm/vial	46.8%	33.3%	52.1%
Co-trimoxazole tab	20mg+100mg	0.0%	0.0%	0.0%
Co-trimoxazole suspension	8+40mg/ml	61.7%	93.8%	87.5%
Erythromycin oral suspension	125mg/5ml	38.3%	75.0%	70.8%
Gentamicin eye/ear drops	0.3%	10.6%	81.3%	56.3%
Gentamicin injection	10mg/ml	21.3%	6.3%	18.8%
Nalidixic acid tab	250mg	0.0%	0.0%	0.0%

SOURCE: (Ministry of Health and Social Welfare, 2011a)

1 Key drugs were defined as medicines used to treat the top ten diseases as defined by the MOHSW. Drugs included were amoxicillin 250mg tablets, aspirin 300 mg tablets, chlorpheniramine 4mg tablets, co-trimoxazole 400/80mg tablets, ferrous salts 200mg, folic acid 5mg, mebendazole 100mg tablets, oral rehydration salts, paracetamol 500mg tablets, povidone iodine, procaine penicillin 4mu injection, quinine injection 600mg/2ml, sulfadoxine-pyrimethamine 500/25mg tablets, tetracycline eye ointment 1%, and whitfield ointment.

A 2010 study identified several barriers in access to medicines in Tanzania, including human resource constraints, poor infrastructure (roads, transport, and communication), high operating costs, and counterfeit drugs, the most counterfeited products in developing countries (Kelesidis, Kelesidis, Rafailidis, & Falagas, 2007).

In a baseline survey of the pharmaceutical sector conducted in 2002 in Mwanza, Kilimanjaro, Mbeya, and Dar es Salaam, 20 public health facilities 15 households, and one drug outlet were surveyed around each facility. Households were asked what type of facility they sought during a recent illness. Thirty-eight percent of the 370 people surveyed consulted a public health clinic/hospital, compared to 19 percent who sought a traditional healer and 18 percent who did not seek treatment (Table 2-2). Medicines were prescribed to patients in 77 percent of consultations, of which 79 percent of patients obtained all drugs from a facility, 12 percent obtained a few prescribed drugs, and 9 percent did not obtain any. In Mwanza, only 47 percent of prescribed drugs were dispensed. Affordability and stock-outs were cited as the main reasons for not buying all medication (Ministry of Health and Social Welfare & World Health Organization (WHO), 2002).

Table 2-2. Percentage breakdown of health care services sought

Health Service	Frequency	Percentage
Consulted traditional healer	69	19
Consulted public health clinic/hospital	142	38
Consulted private health clinic/hospital	32	9
Consulted pharmacies	15	4
Consulted drug seller	12	3
Sought advice from friends/neighbor/family	18	5
Bought medicine without consultation	10	3
Used medicine left from another illness	4	1
Did nothing	68	18
Total	370	100

SOURCE: (Ministry of Health and Social Welfare & World Health Organization (WHO), 2002).

In the same study, prescribing patterns revealed an average of 1.8 drugs prescribed per encounter, which decreased since 1990 when an average of 2.2 drugs was prescribed per encounter. Altogether, 42 percent of these prescriptions included an antibiotic. An analysis of prescriptions revealed high adherence to the essential drug list (98.5 percent). Patient knowledge of dispensed drugs was assessed by exit interviews, where 80 percent of patients were informed on how to correctly use medicines prescribed (Ministry of Health and Social Welfare & World Health Organization (WHO), 2002). Furthermore, the study found that 76 percent of medicines were appropriately labeled (drug name, strength, and directions for consumption) compared to 87 percent of labeled drugs found in 2001. The report cited negligence, work pressure, understaffing and poorly trained dispensers as the main reasons for poor labeling.

Cost of Antibiotics

Two major sources for determining the cost of medicines, including antibiotics, are the NHIF and the MSD. The NHIF's price list for essential medicines, including all antibiotics from the National Essential Medicine List, NEMLIT took effect in May 2012. The most expensive antibiotic is a 500 mg vial of a meropenam injection (TSh 72500, or US\$ 45), while the least expensive is 480 mg tablets of co-trimoxazole (TSh 35.00, or US\$ 0.02) (National Health Insurance Fund, 2012).

Currently, the MSD list contains only generic medicines, while the NHIF list has generic and brand medicines. This contributes to major differences in MSD and NHIF price lists, especially when NHIF services are incorporated into private drug outlets. Generally, the MSD procures the same medicines as the NHIF, but prices are low due to government subsidies. Medicines that are not on MSD's procurement list are procured from wholesale pharmacies with no subsidy price. This is a typical practice in Muhimbili National Hospital (MNH), for instance (Richard Silumbe, personal communication, November 18, 2013).

A study conducted from April to May 2012 assessed the availability, price and affordability of paediatric essential antibiotics in the Mbeya region. The study examined data from public hospitals (referral, regional, and district) and private medicine outlets (ADDOS and pharmacies). The prices for generic medicines available in both ADDOS and pharmacies were generally higher in ADDO shops. The median prices in pharmacies for the 20 lowest price generics (LPGs) were 1.8 times greater than the international reference prices, based on the MSH international drug price guide (Kabandika, 2012)

A similar paediatric drug study from 2010 assessed the availability and affordability of treating a range of acute and chronic conditions, including patients with acute pneumonia and septicaemia who were treated with antibiotics from a sample of health facilities. The 143 facilities studied were from the public, private and nongovernmental organization (NGO) sectors. It was found to cost 0.2 days' wages in the NGO and private business sector for a cotrimoxazole suspension to treat an acute pneumonia. Whereas for the treatment of septicaemia, it cost 0.2 days' wages in a public sector and 0.4 and 0.3 days' wages respectively for private and NGO sectors (see Table 2-3) (Ministry of Health and Social Welfare, 2011a).

Table 2-3. Affordability of treating acute conditions: number of days' wages the lowest-paid government worker would need to spend to purchase lowest priced generic medicines in the three sectors surveyed

Condition	Affordability in days' wages (hours)			Availability (%)		
	Public	Private	NGO	Public	Private	NGO
Pediatric upper respiratory tract infection						
• Cotrimoxazole suspension	0	0.2 (1.6)	0.2 (1.6)	61.7	93.8	87.5
Septicemia						
• Ceftriaxone injection	0.2 (0.8)	0.4 (0.8)	0.3 (0.8)	42.6	25	22.9

SOURCE: Ministry of Health and Social Welfare, 2011

Cost of Health Services

The cost of public health services varied across regions. In 2010, outpatient services (consultation, investigation and medicines) cost TSh 10,000 (US\$ 6.73) and inpatient services cost TSh 20,000 (US\$ 13.47) at the MNH in Dar es Salaam (MOHSW, 2011). In a 2010 study on children medicines, the cost per prescription regardless of the number of medicines was TSh 5,000 (US \$3.37) for inpatient medicines and TSh 1,000 (US\$ 0.67) for outpatient medicines (MOHSW, 2011). Cost of services at MNH falls within the categories shown in Table 2-4.

Table 2-4: Cost of services at MNH

NHIF		
Consultation	First visit (TSh)	Follow-up(TSh)
Specialist	40,000	25,000
Super specialist	45,000	30,000
General Practitioner	20,000	12,500
Intramural private practice Muhimbili, IPPM taken effect from October 2013		
First visit (TSh)	30,000	
Follow-up (TSh)	20,000	
Accommodation (inpatient)	20,000	
Standing charge such as cleaning	5,000	
Costs of regional referral cases for further management		
New case (TSh)	10,000	
Follow-up (TSh)	5,000	
Accommodation (TSh)	10,000	

Source: MNH revenue accountant's office November, 2012

Publicly insured patients pay 20,000 TSh for inpatient procedures including medications, while privately insured patients pay for each step in care, including consultation, bed charges, laboratory tests, and medications.

Publicly insured patients pay less than those privately insured because public and district-designated health facilities procure medicines and medical devices at subsidized prices from the MSD. Private facilities charge higher prices because they pay higher staff salaries and rely more on patients' payments to fund their operations.

Health Insurance Companies

The National Health Insurance Fund is a major source of funding for medication costs and health services. It is also one of the biggest insurance agencies in the country. The NHIF does not refund individuals, but instead refunds institutions through a fee-for-service system (effective October 2001). NHIF has 3,060 public health facilities, 490 religion health facilities, and 19 private pharmacies (MOHSW, 2005).

Other sources of health insurance programs include (Ministry of Health and Social Welfare, 2008d):

- National Social Security Fund
- AAR health services
- Prosperity Africa
- Momentum
- Tanzania Private Hospitals Consortium Services
- Ministry of Health for CHF

The CHF also has an urban version, which is known as Tiba Kwa Kadi, or TIKA. Both community and urban programs were set up with the assistance of the World Bank with the aim of reaching 60 percent of households by 2003. It is a voluntary pre-payment scheme with an annual membership fee of 5,000 – 10,000 TSh (US\$3-\$6). The government at district level matches member contributions. Benefits are less than those under the rural program, since expensive hospital care is not covered (Strengthening health outcomes through the private sector (SHOPS), 2013).

Government Policies and the Regulatory Environment

Government Policies

In conjunction with the MDGs, Tanzania has enacted several health policies, collectively called the National Health Plans.

The *National Health Policy* was passed in 2003 and last revised in 2007. This policy includes such goals as increasing access to quality primary health care for all, access to quality reproductive health services, reduction of infant and maternal mortality rates by three-quarters of 2003 levels, universal access to clean and safe water, life expectancy comparable to that achieved in middle-income countries, food self-sufficiency and security, and gender equality. In order to achieve these goals, the *National Health Policy* includes measures to strengthen district health services, strengthen the country's referral system, create a sustainable public-private partnership in health care delivery, implement a comprehensive human resource plan, and increase public awareness on prevention methods to some diseases of public health importance (Ministry of Health and Social Welfare, 2003).

The *Primary Health Care Service Development Programme (MMAM)* was launched in 2007 and runs until 2017. The main objective of this program is to provide primary health care for all by 2017. The program also seeks to double the existing health sector workforce and install a dispensary in each village and each health center.

The *Third Health Sector Strategic Plan (HSSP III)* was enacted in 2009, and is will be in operation from 2009-2015. The plan includes several initiatives, including strengthening quality assurance and accreditation, performance-based pay mechanisms, strengthening the link between tertiary level hospitals and primary care, increasing the health budget to 15 percent of the government budget, improving maternal and child health, increasing access to care for HIV/AIDS, TB, and malaria, and improving monitoring and evaluation (Ministry of Health and Social Welfare, 2009b).

In conjunction with the HSSP III, the *National Strategy for Growth and Reduction of Poverty II (NSGRP II/ MKUKUTA II)* is a poverty reduction strategy focusing on three broad clusters: growth and reduction of poverty, improvement of quality of life and social wellbeing (particularly reducing maternal deaths) and improving governance and accountability. According to the government's report, under MKUKUTA 1 (early February 2005 to 2010) the economy grew 7 percent and public services such as education, water, energy, telecommunications, and infrastructure, improved. For example, access to clean water increased from 53.7 percent in 2005 to 60.1 percent in 2010 in rural areas and to 84 percent in urban areas. Some of

the new health objectives of MKUKUTA 2 (2010-2015) include providing universal primary health care at a maximum distance of 5km, building stronger capacities to prevent and cure diseases, scaling up efforts to reduce child and maternal mortality and eliminate malnutrition, and continuing to expand water accessibility (Government of Tanzania, 2012a).

Tanzania Drug Policy of 1993 is the current medicines policy, and the overall objective is to provide all Tanzanians with access to essential pharmaceutical products of proven quality at affordable prices. The policy gives authority to the TFDA to monitor quality. In addition, the NEMLIT enables the government to improve rational use of medicines. The NEMLIT and the Standard Treatment Guidelines (STG), first published in 1991, were designed to standardized guidance in making decisions about appropriate health care for specific disease, conditions, and illnesses. The STGs, in particular, serve as platform for rationalizing prescribing practices, improving patient outcomes, and creating optimal use of limited resources. The fourth, most recent edition (July 2013) of the NEMLIT and STG includes symptoms and syndromes. The new version also has improved formats for treatment regimens, showing the classification of medicines by level of health care within both the STG and NEMLIT (Ministry of Health and Social Welfare, 2013b).

Most antibiotics in the NEMLIT overlap with the WHO's most recent Essential Medicines List, but some are excluded from both lists (World Health Organization, 2013). Missing antibiotics in NEMLIT but present in the WHO list include cefalexin, cefazolin, cefixime, cefotaxime, clarithromycin, imipenem+cilastatin, spectinomycin, and vancomycin. Antibiotics included in the NEMLIT list but not the WHO lists include azithromycin, co-trimoxazole, flucloxacillin, kanamycin, and nalidixic acid.

However, the list is still long, containing over 700 items. Currently, most antibiotics in the Tanzania NEMLIT overlap with the WHO's most recent list (2013). As listed below, some antibiotics in the NEMLIT are also missing from the WHO's list, as well as medicines in the NEMLIT which are excluded from the WHO list.

NEMLIT also specifies the lowest level center that is to stock medicines, such as dispensaries, health centers, district or sub-district hospitals, and regional or referral hospitals. NEMLIT also specifies that all facilities higher than the lowest level should carry the products well. In a baseline survey assessing the pharmaceutical sector in 2002, Standard Treatment Guidelines (STGs) were found in only 20 percent of health facilities surveyed (MOHSW & World Health Organization, 2002). A 2008 report by the ministry found a copy of the essential drug list was found in only half of health facility pharmacies (Ministry of Health and Social Welfare, 2008b).

The Pharmacy Act 2011 establishes the Pharmacy Council under section 3 and guidelines and provisions for the Council's operations and management. It also lays the foundation for regulating the pharmaceutical industry (Parliament of Tanzania, 2011).

Originally, the 1978 *Pharmaceuticals and Poisons Act No. 9* established the Pharmacy Board. However, with various government reforms, this Act was repealed in 2002 and replaced with the Pharmacy Act No. 7 of 2002, which established the Pharmacy Council, and the Tanzania Food Drugs and Cosmetic Act No. 1 of 2003, which established TFDA. Unlike the 1978 Act, the 2002 Act more directly addressed pharmacy practices rather than pharmaceutical products. The Pharmacy Act No. 1 of 2011 further expanded on with more oversight of pharmacy practice issues, which was lacking in the 2002 Pharmacy Act.

Regulatory Environment

The MOHSW is responsible for providing all health services to Tanzanians. In addition, non-governmental organizations, faith-based organizations, parastatals, and private facilities offer health services. As part of the decentralization process, local governments have assumed greater responsibilities for implementing district-level services. The central government's role is moving towards focusing on policymaking, facilitation and regulation of non-governmental services (Manji, 2009).

The Minister of Health, followed by the Deputy Minister, Permanent Secretary and Chief Medical Officer (CMO) are primarily in charge of ministerial activities (Manji, 2009). Three divisions comprise the CMO's office: preventive services, curative services, and human resource development (Parliament of Tanzania, 2011). Under the Ministry are seven regulatory bodies: the Registrar of Private Hospitals, the National Food Control Commission, the Optical Council of Tanganyika, the Medical Council of Tanganyika, the Pharmacy Council of Tanzania, the Tanzania Nurses and Midwives Council, and the Private Health Laboratories Board (Ministry of Health and Social Welfare, 2008a).

The Pharmaceutical Services Section of the Health Quality Assurance Division is responsible for antibiotic policy development. The Pharmacy Council advises the Minister on matters relating to pharmacy practice. The Council is also responsible for registering, enrolling and tracking pharmacist, including premise licensing, licensing practice monitoring, and enforcement of laws in both pharmacies and ADDOs (Pharmacy Council, 2013).

TFDA is an autonomous body responsible for “controlling the quality, safety and effectiveness of food, drugs, cosmetics and medical devices” and for controlling “importation, manufacturing, labeling, distribution, storage, promotion and sale of regulated products.” The TFDA issues manufacturing licenses, retail, wholesale, import and export permits (TFDA, 2012).

At the regional level, health management teams made up of a regional medical officer, nursing officer, health secretariat, and four others work to supervise and support health districts. Council Health Management Teams are responsible for paying district-level health workers and for stocking drug supplies. They receive a budget from the Prime Minister's Office of Regional Administration and local governments (Manji, 2009).

ANIMALS

Livestock Farming

The most recent agriculture census in Tanzania was conducted during the 2007-08 fiscal year and covered smallholder farmers in rural areas as well as medium and large-scale farms. Tanzania mainland has 50 million hectares of land suitable for grazing, and its livestock population is the third largest in Africa. Over 70 percent of livestock is reared in arid and semi-arid regions in northern, central and western Tanzania (Ministry of Livestock and Fisheries Development, 2006). The regions in which most cattle are raised are Shinyanga, Tabora, Arusha, Manyara, Mwanza, Singida, Mara and Dodoma.

Based on the 2007-08 census, there were 1,006 large-scale and 1.66 million smallholder farms on the Tanzanian mainland. The average number of cattle, goats, sheep, pigs and chicken kept by smallholders was between three and 13 animals, respectively. Nearly all (99.1 percent) livestock, including cattle, goats, sheep and pigs, are kept by smallholder farmers in mainland Tanzania. Other animals such as ducks, guinea pigs, turkeys, rabbits and donkeys do not make a significant contribution to the livestock sector (Government of the United Republic of Tanzania, 2012).

Direct small-scale farmer to consumer transaction is common. In 2003 more than 86 percent of livestock products reached consumers directly through farmer to consumer interactions (International Livestock Research Institute, 2011).

Food Animal Contribution to the Economy

In 2008, the agricultural sector contributed to 26 percent of country's Gross Domestic Product (GDP). Livestock alone contributed to 4.7 percent of the annual GDP. Within the livestock sector, beef cattle contributed to 40 percent and dairy to 30 percent of GDP (Ministry of Finance and Economic Affairs, 2008). The 5-year Livestock Sector Development Program (2011-2016) aims at increasing the contribution of the livestock sector to annual GDP to 7 percent (Ministry of Livestock and Fisheries Development, 2011).

The majority of animal products are sold for domestic consumption in the informal sector. In 2009, less than one percent of the beef, shoat² and milk products and only 20 percent of poultry was sold in the formal sector (International Livestock Research Institute, 2011). In 2009, the sale of live animals and animal products (excluding meat) accounted for US \$162,535 in domestic sales, while export sales were negligible. Domestic sales of dairy and egg products accounted for US \$10.8 million (Ministry of Industry and Trade, 2012).

Fishing contributed to 1.4 percent of annual GDP in 2010, but decreased to 1.2 percent in 2011 due to the use of poor fishing gear, destruction of fish hatcheries and increased competition in the world market (Government of Tanzania, 2012b).

Between 2003 and 2008 the annual growth rate for number of cattle, goats, sheep, pigs and chickens in Tanzania was between four and ten percent (Government of Tanzania, 2012b). Total meat production increased by 27 percent between 2001 and 2007. Over the same period, milk production increased from 814 million to 1.5 billion liters and egg production from 600 million to 2.69 billion eggs (International Livestock Research Institute, 2011).

NGOs and international donors fund projects to increase the capacity of the Tanzanian livestock and dairy sector. The World Bank funds the Tanzania Agriculture Sector Development Program which aims to provide farmers with better access to the use of agricultural knowledge, technologies, marketing systems and infrastructure and to promote agricultural private investment based on an improved regulatory and policy environment (World Bank, 2013).

One of the goals of the second national strategy for growth and reduction of poverty (MKUKUTA II) is to increase the growth of the livestock sub-sector from 2.3 percent in 2009 to 4.5 percent by 2015. Another goal is to pilot and scale up livestock insurance to help cushion livestock farmers and fishermen from the impacts of famine and drought resulting from environmental and climate change (Ministry of Finance and Economic Affairs, 2010).

Markets

In 2011, there were 300 primary, four terminal and 10 border markets for livestock. In addition, there were 13 holding grounds, 10 railway cattle loading ramps and 15 veterinary checkpoints for cattle (International Livestock Research Institute, 2011). Regional councils run primary markets, and the ministry of Livestock Development And Fisheries runs secondary and border livestock markets (Ministry of Livestock and Fisheries Development, 2006).

Cattle

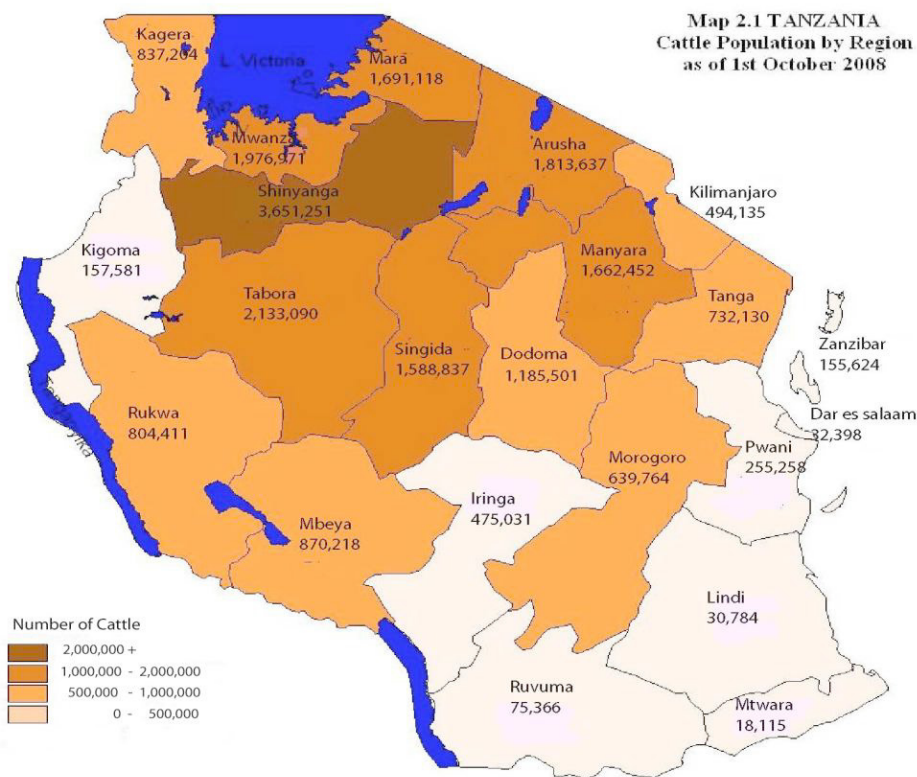
In 2006, cattle constituted 53 percent of the red meat production. Most cattle are reared in an agro-pastoral³ system (80 percent), followed by the pastoral⁴ system (14 percent) and commercial ranches and dairy herds (6 percent) (National Livestock Policy, 2006). About 21 million cattle were raised in Tanzania in 2008; the areas with the largest numbers of cattle were Shinyanga, Tabora, Mwanza, Arusha, Manyara, Singida, Mara and Dodoma. Improved cattle breeds were more common in large-scale farms: Fifty-six percent of the approximately 119,000 cattle held on large-scale farms were improved breeds.

² Shoat refers to a combination of sheep and goat meat.

³ Agro-pastoral farming is the farming that includes both growing crops and raising livestock.

⁴ Pastoral farming is farming aimed at producing livestock rather than growing crops.

Figure 2-4: Distribution of Cattle by region, October 1, 2008



SOURCE: Ministry of Agriculture et al., 2012

Goats and Sheep

Sheep and goats contribute to about 22 percent of the national meat supply (Ministry of Livestock and Fisheries Development, 2011). There are approximately 15.7 million goats in Tanzania. Regions with the highest goat populations are Shinyanga, Arusha and Manyara. Like cattle, a high percentage (97 percent) of goats on the mainland is indigenous type. There are approximately 5.7 million sheep, mostly in the northern regions of Arusha, Shinyanga and Manyara, but indigenous sheep production accounts for a smaller proportion of the livestock industry than goat production (Government of the United Republic of Tanzania, 2012).

Pigs

In 2008, the total number of pigs in the livestock sector was approximately 1.6 million, a 10 percent increase from 2003. The average number of pigs kept by pig-keeping households on the was three. The region with the most pigs was Mbeya, followed by the Iringa, Ruvuma and Kilimanjaro regions. (National Livestock Report, 2012).

Slaughterhouses

There are 85 slaughterhouses in regional and district slaughterhouse headquarters, and 1,000 slaughter slabs throughout district, divisions, wards and villages. There are seven abattoirs of which two deal with export of meat. These are the Dodoma Abattoir with the capacity to slaughter 214 cattle and 200 goats/sheep per day. The second one is Sumbawanga Agricultural & Animal Feeds Industries (SAAFI) in Sumbawanga with the capacity to slaughter 200 cattle and 200 goats/sheep per day (SAGCOT, 2012). There are an additional seven small-scale meat processing plants across Tanzania (International Livestock Research Institute, 2011).

Dairy

Cows accounted for over 99 percent of the 2.5 billion liters of milk produced in Tanzania in 2008 (the remaining one percent is from goats). The largest dairy producing regions are Shinyanga, Arusha, Tabora, Mwanza, Manyara, Singida, Dodoma and Mara. Seventy percent of the milk in Tanzania comes from small-scale livestock farmers with indigenous cattle (National Livestock Policy 2006). Milk production grew 5.2 percent increase from the 1.65 billion liters in 2009/2010 to 1.85 billion liters in 2011/2012 (Ministry of Livestock and Fisheries Development, 2012).

The Tanzania Milk Board regulates the dairy sector. In 2006, 22 privately owned small- and medium-scale milk processing plants operated in Tanzania at less than 30 percent of their maximum capacity (National Livestock Policy, 2006). Milk produced in rural areas enters the market through urban trading centers. Only 10 percent of the milk produced in Tanzania annually reaches the market. The rest of the milk is either consumed at home or not collected due to a lack of collection systems (National Livestock Development report, 2011).

Several projects are being implemented to further develop the dairy sector in Tanzania. For instance, The East African Dairy Productivity Programme is funding regional dairy research projects in Tanzania through a four-year World Bank loan. The funded projects address dairy value chains in the Eastern Zone as well as the Southern Highlands (East Africa Dairy Development Phase 2, 2012).

In addition, the Tanzania Milk Producers Association (TAMPRODA), established in 2002, assists in the development of milk production in the country by bringing together stakeholder organizations and relevant institutions (Tanzania Milk Producers Association, 2006). TAMPRODA also contributes to dairy management and extension programs for cattle and other potential dairy livestock in order to improve milk production (Tanzania Milk Producers Association, 2006).

The Tanzania Milk Processors Association (TAMPA) forms one of the major pillars of the Tanzania Dairy Board and was established in 2001 as a non-governmental organization. TAMPA works to create a better business environment for milk processing in the country. TAMPA coordinates, promotes, advocates and lobbies to improve milk processing capacity and increase dairy consumption in the country (The Tanzania Milk Producers Association, 2006).

Poultry

Most poultry (over 99 percent) are raised on small farms or in households. Just one percent are raised on large-scale farms. The most popular chicken rearing regions for smallholder farmers are in Shinyanga Mbeya Mwanza and Tabora (Ministry of Agriculture, Food Security and Cooperatives et al, 2012). Of all the livestock raised in Tanzania, chickens are the most widely and evenly distributed throughout the country. Poultry production in Tanzania occurs mainly through small-scale village or backyard poultry systems. The semi-intensive and intensive poultry production system is typically occurs in peri-urban and urban areas. The former supplies most of the meat and eggs consumed in rural areas and about 20 percent in urban areas.

The Food and Agriculture Organization classifies poultry production into four sectors:

Sector 1--industrial and integrated production. Tanzania has large-scale commercial systems of breeder farms with their own feed mills, but none use Global Positioning System (GPS) operations.

Sectors 2 and 3--other commercial production systems. Sector 2 comprises large commercial poultry production. In Tanzania, these farms are mostly in Pwani (6), Dar es Salaam (6), Arusha (2), Mwanza (2), Mbeya and (1) Ruvuma (2). Most poultry production in Tanzania are classified as Sector 3 farms. In 2003, there were over 25,000 small-scale commercial production farmers raising commercial layers (1.2 million) and broilers (590,000).

Sector 4--village or backyard production. The Tanzanian local chicken production system fits well into Sector 4 FAO classification. Village chickens are the most important poultry species in Tanzania (H.M. Msami & Young, 2005).

Bio-security is highly deficient in the Sector 4 extensive village chicken production system, not fully adhered to in sector 3 and better adhered in sector 2.

Mkuza Poultry Farms (with their processing plant at Kwala, Kibaha, about 50km west of Dar es Salaam) and Interchick Company are the two major slaughtering companies, producing 30 and 60 tons per month, respectively. From 2006-2007, 72,197 tons of meat were produced in the country. Publicly designated abattoirs specifically for poultry (similar to slaughterhouses and slabs for domestic ruminants) do not exist in Tanzania. Tanzania's first public poultry abattoir is to be constructed in the Iramba District in order to transform the indigenous poultry sector into a commercial business sector (Food and Agriculture Organization of the United Nations (FAO), 2008).

Slaughtering facilities are generally not well-designed or constructed, which can create bio-security risks for spread of infectious diseases from slaughtered animals to other farms or humans.

Eggs

There were 367 million eggs produced by sector 4 smallholders and 910 million eggs produced by sector 2 and 3 large-scale commercial farms in Tanzania in 2002-2003 (Food and Agriculture Organization of the United Nations (FAO), 2008). In 2007-2008, smallholder production increased to 1.2 billion eggs. The main regions producing eggs were Mbeya, Shinyanga, Tabora and Iringa. Egg production is projected to increase to 4.7 billion eggs by 2016 (Government of the United Republic of Tanzania, 2012).

Production is mainly geared towards supplementing household consumption. According to the Tanzania National Panel Survey (2008-2009), the main source of livestock product consumption in both rural and urban areas is dairy followed by poultry and eggs. Dairy is mostly purchased, while eggs and poultry are more often home produced in rural areas. Urban households consume twice as much meat, poultry and dairy and four times as many eggs compared to rural households.

Commercial layer production is predominantly in Dar es Salaam (28 percent), Kilimanjaro (15 percent), Pwani (11 percent) and Dodoma (11 percent). Layer growth rate has been consistently at 12 percent per year.

Fish

In 2011, the fishing sector grew by 1.2 percent, and the contribution of fishing activities to the GDP remained constant at 1.4 percent. The fishing sub-sector decreased by 0.3 percent from 2010-2011 due to the use of poor fishing equipment, destruction of hatcheries, and greater competition in the world market, mainly between Nile perch from Lake Victoria and farm-raised *Pangasius* (a genus of "shark catfishes") from China and Vietnam (Government of Tanzania, 2012b).

In Tanzania the contribution of fish and fishing to GDP has been declining gradually since 2007. Fish exports have declined from 58,000 tons in 2007 to 40,000 tons in 2011. More than 90 percent of fish exports come from the Nile perch from Lake Victoria. About 50 tons of raw fish per year were produced in 2007 and 2008, earning an annual revenue of US \$174 million. Figure 2-5 shows the total number of fish exports by value and volume from 2007 to 2011 (Ministry of Livestock and Fisheries Development, 2012; United Nations Industrial Development Organization (UNIDO), 2009).

Figure 2-5: Fish exports by value and volume 2007-2011

Year	Volume(Tons)	Value (US \$)
2007	57,795	173,272,670 .44
2008	51,426	174,409,214 .42
2009	41,148	161,053,645.66
2010	39771.8	187,427,053 .5
2011	37,996.4	152,973,356.8

SOURCE: (Ministry of Livestock and Fisheries Development, 2012)

The majority of the fish farming occurs in Ruvuma, Mbeya, Iringa and Manyara regions (Ministry of Livestock and Fisheries, 2013). Ninety-nine percent of fishing households farm tilapia.

Animal feed

Most feed additives in Tanzania are imported to improve growth, milk yield, feed efficiency, and to control diseases (National Livestock Policy, 2006). These feed additives contain enzymes, growth promoters, antibiotics and probiotics. One of the objectives of the National Livestock Policy is to “promote rational use of feed additives for increased livestock production and productivity” (National Livestock Policy, 2006). There is no formal feed manufacturing industry and no regulations currently exist governing feed manufacturers or imports (Food and Agriculture Organization of the United Nations (FAO), 2008).

Veterinary Health System

In Tanzania, both the public and private sectors play a role in veterinary health care. The Ministry of Livestock and Fisheries Development is responsible for livestock development policy, livestock research, extension services, and veterinary services. Community-level veterinary care is delivered through the public sector, while animal health care centers and clinics are provided by the private sector.

The veterinary health system in Tanzania is currently not well regulated, though efforts are in place to formalize this sector. Lack of staff at the village level has led villagers to visit informal pharmacies and traditional medical practitioners to obtain antibiotics. To address this situation, Tanzania is working towards providing a paraveterinarian in every village. Other factors that contribute to an unregulated veterinary health system are as follows:

1. Antibiotics are commonly bought from hawkers and informal dealers who have no training and inadequate storage capabilities.
2. Farmers and pastoralists often treat animals based on their own diagnosis and with medications stored at their homes.
3. In 1998, the government structure changed leaving two parallel systems: a centralized system with the national government at the center and a decentralized system with the 148 local governments responsible for their own districts. These local governments are responsible for enforcement of laws but are not accountable to the national Director of Veterinary Services. Local governments may act more politically than on scientific-based best practices. Furthermore, local government field staff are often trained in crop production but not in livestock farming. This decentralized governance system has led to a weak inspectorate system and a weak veterinary service delivery system, without a strong chain of command (personal communication with Dominick Kambarage, April 2013 and Hamisi Nikuli June 2013).

Veterinary Education and Certification

The Sokoine University of Agriculture (SUA) is one of the two universities in Tanzania that provides training in veterinary medicine. SUA offers a 5-year Bachelor of Veterinary Medicine as well as a 2-year diploma program (SUA, 2008). The university had 603 graduates from 1984 to 2004, most of whom were male (Sokoine University of Agriculture, 2008).

In 2012, the six livestock training institutes (LITIs) around the country became part of the Livestock Training Agency. These institutes were in Tengeru, Mpwapwa, Buhuri, Madaba, Morogoro, and Temeke. These campuses offer pre-service training at the certificate and diploma levels (National Livestock Policy, 2006). While the Buhuri institute only conducts short courses on animal husbandry, the other five offer longer courses at both the certificate and diploma level, in addition to farmer training. Training at these institutes corresponds with the framework of the National Livestock Policy of 2006, the Veterinary act of 2003 and the Animal Disease Act of 2003 (OHCEA, 2011), as well as levels five and six of the National Qualification Framework (Tanzania Commission for Universities, 2012).

Certificate and diploma-level fisheries training, as well as some vocational training, are offered at the Fisheries Education and Training Agency campuses in Nyegezi (Mwanza) and Mbegani (Dar es Salaam). Other collaborators in livestock training include the Open University of Tanzania, the Vocational Education Training Authority, as well as some NGOs (National Livestock Policy 2006). Two private veterinary institutions located in Mpwapwa and Sumanjiro offer an animal health certificate, an animal health diploma, and tertiary training.

The Veterinary Act of 2003 outlines specifics for registration for those working in the veterinary field as well as certification of veterinary practice facilities. The Veterinary Council is the licensing board for veterinarians, veterinary specialists, veterinary practice facilities, paraprofessionals (diploma holders) and paraprofessional assistants (certificate holders). All veterinary practice facilities are required to register with the Veterinary Council and adhere to prescribing standards. A registered veterinarian or veterinary specialist must run all veterinary practice facilities. Licenses for these professionals must be renewed annually. If qualifying as a veterinarian outside of Tanzania, each individual must pass an examination before registering with the Veterinary Council. Veterinarians or veterinary specialist must supervise paraprofessionals and paraprofessional assistants (Veterinary Act 2003). In-service training is not part of the veterinary curriculum in Tanzania.

Informal veterinary education, known as Indigenous Technical Knowledge (ITK) or ethno-veterinary knowledge, plays a large role in the livestock sector. This refers to knowledge and skills that have been passed down from generation to generation. In livestock production, most farmers in rural areas use this traditional knowledge to control animal diseases and improve productivity (National Livestock Policy 2006).

Veterinary Workforce

As of 2011, there were 615 degree-holding veterinarians working in private clinics, animal health care centers, and serving administrative roles as district veterinary officers and regional livestock advisors. Certificate and diploma holders are able to serve as field officers or veterinary field service providers. There are currently 1,000 veterinary paraprofessionals (diploma level) and 800 veterinary paraprofessional assistants who hold certificates (personal communication with Abdu Hayghaimo at Veterinary Council, MLDF, 2014).

Paraprofessional assistants deliver animal health services at the community level. Since the private sector has weak service delivery, a number of NGOs have developed initiatives to train Community Animal Health Workers (CAHWs), which are not recognized by the Veterinary Council (Allport, Mosha, Bahari, Swai, & Catley, 2005). CAHWs are selected by their communities and trained to treat a limited number of animal diseases as well as how to deliver vaccinations and deworming services. As part of the Veterinary Act 16 (2003), CAHWs are to be supervised by a registered veterinarian.

Field staff who are hired by local government bodies are often mistaken as veterinarians. Although they are supposed to be trained in both crop production and livestock rearing, this is rarely the case. To address this confusion, the government has reduced training programs to two primary courses: Range Management and Animal Health, with the aim of having a graduate from each program as part of each local government (Dominic Kambarage, personal communication, 2014).

Although traditional healers are not officially recognized as veterinary health providers, they play a large role in veterinary health in Tanzania by diagnosing and treating animals using traditional medicines (OHCEA, 2011).

Veterinary Pharmacies

The TFDA regulates veterinary medicines. Since the early 1990s, the private sector has supplied veterinary medicines and vaccines, but there are often shortages of these medicines, medicines are often of poor quality, and the cost is high (Cliffson Maro, personal communication, June 12, 2013).

Veterinary pharmacies in Tanzania fall into three categories: 1) Wholesale Veterinary Pharmacy, 2) Retail Veterinary Pharmacy and 3) Part II Poisons shop (Duka la Dawa Muhimu), also known as Accredited Veterinary Medicine Outlets (AVMOs). A pharmacist must supervise retail veterinary pharmacies, while a veterinarian may also supervise wholesale veterinary pharmacies. Individuals who have received a diploma or certificate in an animal health course may supervise Part II poisons shops.

As of August 2014, there were 78 registered wholesale veterinary pharmacies in the country (see Table 2-5) and 704 accredited veterinary medicine outlets, with the highest concentration in Manyara, Arusha, Shinyanga and Iringa. The license for wholesale veterinary outlets must be renewed annually (Tanzania Food, Drugs and Cosmetics Act 2003). There are currently no registered retail veterinary pharmacies in the country; however, in practice, wholesale veterinary pharmacies participate in both retail and wholesale business (Cliffson Maro, personal communication, June 12, 2013).

There are only 257 qualified personnel to dispense veterinary medicine in ADDO shops. The inspection of various ADDO shops revealed that unauthorized medicine was being sold, unqualified personnel dispensed drugs, and record keeping and documentation remained inadequate. In addition, due to uneven distribution between shops, some communities lacked access to any medicines, which contributed to inappropriate drug use. Because there are no records of drug sales, consumption of veterinary medicines is difficult to monitor. The TFDA, in collaboration with the MLDF and the Global Fund, developed a training manual for veterinary medicine sellers, in order to build capacity for drug sellers (Cliffson Maro, personal communication, June 12, 2013).

Table 2-5. Location of Wholesale Veterinary Pharmacies, August 2014

Location	Number of Pharmacies
Dar es salaam	30
Mtwara	1
Coast	1
Morogoro	1
Dodoma	1
Kigoma	1
Arusha	21
Kilimanjaro	2
Tanga	1
Mbeya	5
Mwanza	13
Shinyanga	1

SOURCE: Mary Masanja, personal communication, August 2014

Microbiology Laboratory capacity

There is a lack of laboratories in the country for veterinary (and human) testing, as well as a lack of a formalized national laboratory network with sufficient infrastructure. Only one Biosafety Level (BSL) 2 veterinary laboratory exists in Tanzania.⁵ For this reason, most veterinary treatments are not supported by laboratory-based diagnosis (OHCEA, 2011).

Tanzania Veterinary Laboratory Agency

The Tanzania Veterinary Laboratory Agency (TVLA) was officially established in 2012 when the various existing veterinary laboratory organizations joined together in accordance with Executive Agency Act CAP 245 (Revised Edition; R.E 2009) and facilitated by the Ministry of Livestock and Fisheries Development (MLFD) and the President's Office – Public Service Management (PO- PSM). Such organizations included Central Veterinary laboratory (CVL), Tsetse and Trypanosomiasis Research Institute (TTRI), Temeke Teachers Resources Centre (TTRC) and Veterinary Investigation Centers (VICs). The Executive Agency was established in order to provide diagnostic services, assess and eliminate issues related to medicines, herbal drugs, devices and cosmetics, and to use ethno-veterinary medicinal plants to control animal diseases (Ministry of Livestock and Fisheries Development, 2015).

CVL

The Animal Diseases Research Institute (ADRI), in Temeke, Dar es Salaam, also known as the CVL is part of the TVLA. Further veterinary diagnostic facilities are located at the Livestock Production Research Institute, Mpwapwa, and veterinary Investigation Centers in Iringa, Arusha, Mwanza, Mtwara and Tabora. These laboratories are responsible for providing technical support for disease surveillance, diagnosis, quality control and supervision of field vaccination campaigns.

VICs

VICs are divided into the TVLA and Epidemiology Unit of the Ministry of Livestock and Fisheries Development. The former deals with diagnostics and research and the latter is involved with local governments and disease control. Each epidemiology unit is located in a specific zone and associated with a specific zonal veterinary center. There are currently 200 zonal veterinary centers dealing with sanitary inspectorate services and surveillance.

Additional Laboratories

Additional laboratories are found at SUA and the Tanzania Wildlife Research Institute (TAWIRI). Private laboratories augment the veterinary laboratory system, but overall, the veterinary laboratory system has inadequate facilities, infrastructure, technical expertise and has a weak institutional organization (National Livestock Policy 2006).

The National Fisheries Quality Control laboratory (NFQCL), located in Mwanza, is a laboratory for the fisheries sector. The main function of this laboratory is to ensure the quality and safety of fish and fish products from Lake Victoria for both domestic and export markets.

Livestock Extension Services

In 2008, livestock extension services⁶ were provided to 55 percent of livestock rearing households in mainland Tanzania (compared to 16 percent in 2003), and 26 percent in Zanzibar. On the mainland, there were regional differences in proportions of households receiving these services, ranging from 22 percent in Lindi to 75 percent in Manyara. The main extension messages were about disease control, housing and proper feeding of animals (National Livestock Report 2012).

⁵ A BSL2 laboratory is suitable for work involving agents of moderate potential hazard to personnel and the environment (this includes various bacteria and viruses that cause only mild disease to humans or are difficult to contract via aerosol in a lab setting)

⁶ The methods/techniques used to deliver livestock/Fisheries technology to livestock/fish farmers

Currently, extension services have been deemed inadequate. The Ministry of Livestock and Fisheries Development is responsible for coordinating national livestock extension programs, led by the officer-in-charge of livestock development in the regional secretariat (Livestock Extension Services Implementation Guidelines 2011).

National Livestock Research Institute

The National Livestock Research Institute, also known as the Livestock Production Research Institute, is located in Mpwapwa. The Department for Research and Training, which is a part of the Ministry of Livestock and Fisheries Development, is responsible for the operation of the institute. Laboratory attendants, technicians and technologists are involved in the animal health research. As of 2011 there were 27 veterinary personnel with a diploma in lab technology, and three with a certificate (OHCEA, 2011).

Vaccination

Maintaining animal health ensures a nutritious supply of food and economic activity via domestic and international trade of livestock and their products (hides, skins, fibers). Common animal diseases, such as FMD, CBPP, rabies, CCPP, PPR, RVF, ND, African swine fever (ASF), east coast fever (bovine theileriosis), coccidiosis, babesiosis and trypanosomiasis can threaten animal and human health and economic development. Diseases controlled by mass vaccination campaigns in the country include:

1. FMD, a highly contagious disease of cloven-hoofed animals first reported in Tanzania in 1927. There is a low mortality rate (<5 percent) for adult animals but a relatively high mortality rate (>50 percent) for young animals. The disease is endemic and widespread in Tanzania. Prevention strategies typically include biannual vaccinations and control of animal movements. Vaccinating against foot and mouth diseases is difficult, however, because there are multiple serotypes and topotypes and there is a short period of immunity following vaccination. The Tanzanian government plans to introduce subsidies for foot and mouth disease vaccines by 2015 in order to reduce incidence of the disease by 50 percent. The government aims to achieve 80 percent vaccination coverage for animals susceptible for certain serotypes and topotypes of the disease.
2. CBPP, which was introduced from Kenya in 1990. By 1995, “ectopic outbreaks” were confirmed throughout the country. After being declared a national disaster, a vaccination control programme was launched in 2001 by the Vaccines for Control of Neglected Animal Diseases in Africa (VACNADA). Nearly three million cattle were vaccinated in Arusha, Kilimanjaro and Manyara. In 2009/2010 an additional 4.5 million cattle were vaccinated in Shinyanga and Kagera. Since the vaccination campaign, outbreaks have decreased significantly from 35 outbreaks per year in the southern highland zone in 2002 to none in 2008. Outbreaks of CBPP were reported in a few regions in Tanzania in December 2013 and January 2014. The government set aside one billion TSh to purchase CBPP vaccine for 2014.
3. RVF, a vector-borne viral disease that affects cattle, buffalo, sheep, goats, and camels. The disease can also infect humans. RVF was reported for the first time in Tanzania in 1977 with further outbreaks in 1997 and 1998, and most recently in 2007. It causes mortality and abortions in almost 100 percent of livestock fetuses. In humans, the disease can be mild or cause hemorrhagic fever, encephalitis or blindness. The 2007 RVF outbreak affected animals in 11 regions and 29 districts, causing abortions or death in 16,973 cattle, 20,913 goats and 12,124 sheep. RVF was confirmed in 309 patients, of whom 144 died. As a result of the 2007 outbreak, the government increased RVF surveillance in all zones, initiated mass vaccination of livestock, and conducted awareness campaigns. The vaccination campaigns reached 344 villages, vaccinating 2.3 million cattle, 1.2 million goats and 543,000 sheep. The government ordered 1,000,000 doses of RVF vaccine for 2014.

4. PPR, most common in the southern region of Mtwara. PPR was first confirmed in Tanzania in 2008. By 2009 – 2011, the disease spread to other regions, causing financial harm and food insecurity. The ministry of livestock development and fisheries, in close collaboration with FAO, carried out risk-based targeted vaccination campaigns in 30 districts, achieving 80 percent coverage of about 1.3 million sheep and goats between April of 2012 and March of 2013. In 2012/2013, FAO set aside US \$150, 000 to purchase PPR vaccines, and the government ordered 1,000, 000 more doses from KEVEVAPI, Kenya for 2014.
5. ND, found throughout Tanzania. There were about 7,000 cases in 2009, dropping to about 2,000 in 2012 (“Newcastle Disease in Tanzania, 2008-2012,” 2013). The government produced 37 million doses of the thermotolerant ND 12 vaccine in 2010, distributed mostly by the Veterinary Investigation Centres, (VICs). The Lasota vaccine, is imported, and mostly used in commercial farms because of its refrigeration requirement and bulk packing (minimum of 1,000 doses).
6. ECF, a tick-borne illness that occurs throughout Tanzania. Pesticides were commonly used to control ticks, but recently live attenuated ECF vaccine is being used in combination with tetracycline to control the disease. In 2009, 80 percent of Tanzanian calves were vaccinated against ECF.

Other vaccines

Anthrax and black quarter vaccines are combined into one vaccine called Blanthrax, and this vaccine is manufactured in Tanzania at the TVLA, although it is not widely used. Diseases such as brucellosis are controlled at farm level using S19 vaccine.

Government policies and regulatory environment

Government policies

The inspectorate system in Tanzania is weak, based on the zoosanitary inspectorate services (ZIS) established in 1996 under the directorate of veterinary services, sub directorate of transboundary animal diseases and zoosanitary inspectorate services (TADs & ZIS). Currently, the zoosanitary inspectorate manages 36 border posts, 19 quarantine stations and 381 internal checkpoints. TADs and ZIS is responsible for import and export control of animals and animal products.

To export meat and meat products, the exporter must apply to the Director of Veterinary Services. Import requirements depend on the country the meat or meat product is being exported to (Ministry of Livestock and Fisheries Development, n.d.). International trade of animals and animal products requires a zoosanitary certificate. Certificates are provided at entry and exit points, slaughter facilities, checkpoints, holding grounds, hatcheries, and livestock markets (Ministry of Livestock and Fisheries Development, 2006).

National Livestock Policy 2006

The National Livestock Policy, 2006 established the Animal Health Services in order to control, eradicate and prevent the introduction of animal diseases (National Livestock Policy, 2006) The goals of the National Livestock Policy of 2006 are threefold: 1) To encourage the development of commercially oriented, efficient and internationally competitive livestock industry; 2) To support the emergence of a more diverse structure of production with a large increase in the numbers of successful smallholder livestock producer enterprises; and 3) To conserve livestock resources and establish policies and institutions for sustainable resource development and use.

The policy aims to establish a livestock sector by 2025 to be commercially run, sustainable, and uses improved livestock to insure food security and household and national income, while conserving the environment (National Livestock Policy, 2006). The policy also aims to use organic livestock farming supported by both the government and the private sector (National Livestock Policy, 2006).

The policy also requires regulation of veterinary practices and delivery services by requiring service providers to adhere to a stipulated code of ethics enforced through the Veterinary Act No. 16, 2003 (Dr. Abdu Hayghaimo, Policy antimicrobial use presentation).

Veterinary Act 2003

The Veterinary Act 2003 provides protocol and regulations for the registration of veterinarians and veterinary specialists and the enrollment or enlistment of paraprofessionals and paraprofessional assistants (Veterinary Act of 2003). This act also a provision obliging registered veterinarians, veterinary specialists, enrolled paraprofessionals, and enlisted paraprofessional assistants to adhere to a code of conduct.

Food, Drugs and Cosmetics Act 2003

The Tanzania Food, Drugs and Cosmetics Act of 2003 has a number of rules that apply to animals and animal products. These rules include regulating the sale of veterinary medicines, the slaughter of animals, the transport of animal products, disease notification and surveillance of milk and milk products (Food, Drugs and Cosmetics Act, 2003)

Fisheries Policy 1997

The objective of this policy is to promote effective farm and fish management. These improved practices include increased hygienic measures, vaccinations and improved fisheries products utilization and marketability that are required to meet international quality standards (Dr. Abdu Hayghaimo, antimicrobial use presentation, June 19, 2013).

Fisheries Act 2003

This act mandates the Minister of Livestock and Fisheries Development to ensure consumers access to safe, wholesome fish and fishery products by performing microbiological, chemical, and physical analyses to fish and fishery products before they are released for human consumption (Dr. Abdu Hayghaimo, antimicrobial use presentation, June 19, 2013).

East African Community Sanitary and Phytosanitary (EAC-SPS) Requirements (2012)

To ameliorate some of the risks with trading, the World Trade Organization's (WTO) Sanitary and Phytosanitary (SPS) Agreement was formulated to require member countries to control aquatic animal feeds, feed ingredients and veterinary medication through a regulatory environment. The agreement also sets forth requirements for chemical residues and requires safe use of hormones (both synthetic and biological) and vaccines. Additionally, the agreement sets forth requirements for inspection and provision of certifications.

Existing legislative tools guiding antibiotics use in animals

There are several additional legislative tools that guide antibiotic use in animals. These include:

- The Animal Disease Act No. 17 of 2003; Section 50 (1-4) which restricts the use of unapproved antibiotics in animals by the competent authority
- Fisheries Regulations of 2009; section 33 (f) which requires production of quality fish feeds free from antibiotics
- Fisheries Regulations of 2009; section 33 (i) which prohibits the use of human or pig manure as aquaculture inputs (excluding other animal wastes)

- Fisheries Regulations of 2009; section 33 (j-l), which prohibits use of unapproved antibiotics by the competent authority in fish disease treatment.
- Harmonized EAC SPS measures (under review) Section 2.8-(2.8.1) which enforces regulatory requirements for ensuring safety of aquatic animal feeds and feed ingredients and the use of veterinary drugs.
- Section 3.7-(3.7.5) which states that veterinary therapeutic products and medicinal premixes for inclusion in fish feeds shall not be applied to fish unless they are approved for use by a competent authority (e.g Director of Aquaculture or Director of Veterinary services).
- Section 3.7-(3.7.6) of the SPS, which requires samples of fish, feed to be analyzed to determine the food value including presence of veterinary drugs.
- Section 3.12 of the SPS, which requires sanitary fish harvesting and observation of withdrawal period following antibiotic use.
- Tanzania Foods, Drugs and Cosmetics Act of 2003 part IV (a), (b) and (d) which stipulates conditions regarding drugs including restrictions on the conduction of a pharmacy business, registration of medical devices and herbal drugs. This Act provides for the governing import and export of drugs and limiting to good quality pharmaceuticals and drugs.

Surveillance

Currently there is no institutionalized surveillance system for foodborne diseases, nor is there a regular monitoring program for chemical or microbiological food contaminants. In 2011 the TFDA began conducting a pilot foodborne diseases surveillance system in 17 districts of the Dodoma, Singida and Manyara regions. Since much of Tanzania's animal agriculture is smallholder-based, only larger outbreaks tend to be recorded.

Rules for Transport of Animal and Animal products

Tanzania has many regulations for transporting animals and animal products meat within the country. The 2006 Tanzania Food, Drugs and Cosmetics Regulations on the transport of meat requires licensing of individuals to transport meat. The regulation also specifies the type of container that meat can be transported in, as well as establishes hygienic standards for the transport of meat (Tanzania Food Drugs and Cosmetics Regulations, 2006).

Regulatory Bodies

TFDA

The TFDA administers the Tanzania Food, Drugs and Cosmetics Act, which provides for regulation of medicines, food, cosmetics and medical devices for humans and animals. This regulation applies to registration, inspection and licensing of medicines, performing quality control, and post market surveillance. Guidelines and standard operating procedures (SOPs) developed under the TFDA govern the evaluation for registration of medicines for quality, safety and efficacy, compliance with standards (e.g, GMP), appropriateness of labels and product information.

Challenges range from non compliance with regulations by applicants who import, or lack of GMP among local manufacturers. Other challenges are from the TFDA's own lack of sophisticated equipment and bioequivalence study facilities in East Africa, hence goods that are otherwise substandard are registered. This is clearly the case for animal products as well as those for humans, including unauthorised labelling and poor quality and animal feeds with antibiotics mixed in, and counterfeit antibiotics.

In addition to their registration requirements, post registration regulations include pre-marketing inspection for GMP in manufacturing and importing, inspection of ports of entry of the imported goods.

The final post registration activity of the TFDA is the post market surveillance where samples from the market are tested for their quality which, may lead to withdrawal of the medicine from the market. This happened in 2014, when cloxacillin capsules and suspensions were withdrawn (TFDA, 2013).

TFDA also conducts post market surveillance of adverse reactions (post-marketing Adverse Drug Events (ADE) surveillance). Adverse reactions are, however, under-reported by healthcare professionals.

TFDA is responsible for food control, while the food chain itself falls under the mandate of various government ministries, departments and institutions (Lusato R Kurwijila et al., 2011). The central government is responsible for livestock policy formulation, guidelines and technical support. Local government authorities and the private sector are the main actors in the delivery of extension services (TFDA, 2013).

Directorate of Veterinary Services

The Directorate of Veterinary Services at the Ministry of Livestock and Fisheries Development (Epidemiology Unit) is responsible for acting during disease outbreaks to identify diseases, monitor the progress of the outbreak and determine the effectiveness of control strategies. The TVLA is in the same directorate.

TVLA is responsible for meat hygiene, the safety and quality of milk, inspections of abattoirs, veterinary drugs control and developing and producing vaccines. The TVLA also conducts research and surveillance on livestock diseases and develops technologies for control and eradication of disease vectors, particularly ticks and tsetse. The agency collaborates with other international laboratories to validate tests and standards for animal disease research and diagnosis. Additionally the agency collaborates with other diagnostic and research laboratories within the country such as TAWIRI in wildlife disease research and SUA.

Tanzania Bureau of Standards (TBS)

The TBS is the only standards body in the country. Currently, the only microbiology laboratory accredited by International Organization for Standardization (ISO standards) is the TBS. It is responsible for ensuring quality and safety in industries and setting and enforcing standards along with their inspection. This is both for the locally manufactured commodities and imported. This is in line with an Act of Parliament; the Standards Act No. 3 of 1975, amended by Act No. 1 of 1977. The TBS also provides facilities and arranges for testing and calibration of precision instruments and other scientific apparatus and issues certificates for industrial products.

Local Governments

The local government authority, which is under the PMORALG, is responsible for employment of all veterinarians providing professional services. The local government is involved in inspection of food, control food hygiene and preparing sanitation regulations for food establishments. There is, however, poor coordination between the central and local government level in provision of services (Ndabikunze, Chove, & Mongi, n.d.).

Tanzania Dairy Board

The Tanzania Dairy Board was appointed and officially inaugurated in 2005, though regulation of the dairy industry in Tanzania dates as far back as independence. Their responsibilities include developing and conducting market research, and promoting a competitive environment among stakeholders in the dairy industry. They also monitor the execution of contracts and marketing arrangements between bodies related to the dairy sector and reconcile parties in disputes. The Board also liaises with the TFDA on licensing and inspection of all dairy facilities and training and improvement of skills in technological advancement in the industry. The Board monitors plans designed to achieve and maintain self-sufficiency and efficiency in milk production, processing and marketing. The Board represents dairy industry stakeholders in international

matters. The Board promotes advocacy of the dairy industry and organizes participation of stakeholders in dairy shows at home and abroad.

Tanzania Meat Board

The Tanzania Meat Board, established by the Meat Industry Act No. 10 of 2006 and officially inaugurated on 14th of November 2008, collaborates with various meat industry stakeholders (including livestock producers, traders, processors, quality control institutes, regulatory organs, consumers and service providers to restructure and develop the meat industry to make it efficient and productive of high quality meat products. Its functions as stipulated by the Act are to advise the Minister for Livestock Development on issues pertaining to development of the meat industry. The Board collaborates with other quality control institutions to develop meat and meat products, as well as ensure quality control of livestock, meat, and meat products (Ministry of Livestock and Fisheries Development, 2014).

Fisheries Department

The Fisheries Department is involved in fish inspection, fish regulations, training of fishermen and processors and control of fish export. Quality control is implemented by the National Fish Quality Control Laboratory (NFQCL). The role of the laboratory is to verify the effectiveness and efficiency of quality assurance management systems in fish processing factories around the Lake Zone to ensure that they meet the requirements of international export markets. Among the functions of the laboratory is to monitor the types and levels of antibiotics and their residues in water, fish and fish products (Mhongole, 2005).

Government Chemist Laboratories Agency (GCLA)

GCLA is a legal referral laboratory under the Ministry of Health and Social Welfare. GCLA is involved in forensic investigations of a broad array of samples from food and environmental sources (Ministry of Health and Social Welfare, 2015)

Table 2-6: Regulatory bodies with responsibilities in animal health and the animal agriculture sector

Institution	Executive Branch	Responsibilities
Tanzania Food and Drugs Authority	Ministry of Health and Social Welfare	Registration of product and premises, sanction in collaboration with judiciary, laboratory services, food safety control, audit local council inspection training of inspectors and food export health certification
Tanzania Bureau of Standards	Ministry of Industry and Trade	Standard setting, training for industries on quality and safety assurance, standard enforcement including inspection of plants and processing of TBS certified products
Tanzania Veterinary Laboratory Agency	Ministry of Livestock and Fisheries Development	Testing for meat hygiene, animal health, abattoir inspection, animal traceability, veterinary drugs control, milk safety and quality
Local governments	Prime Minister's Office Regional Administration and Local Government	Employment and supervision of workforce involved in delivering of health services.
Tanzania Dairy Board	Ministry of Livestock and Fisheries Development	Milk and dairy products regulation
Meat Board of Tanzania	Ministry of Livestock and Fisheries Development	Meat and meat products regulation
Fisheries Department	Ministry of Livestock and Fisheries Development	Fish inspection, fish regulations, training of fishermen and processors, quality control of fish products for export market
Government Chemist Laboratories Agency	Ministry of Health and Social Welfare	Forensic analysis

SOURCE: Adapted from Kurwijila et al., 2011

CHAPTER 3:

Burden of Disease and Antibiotic Resistance in Humans

National Burden of Disease

The Global Burden of Disease Study listed HIV/AIDS, malaria and lower respiratory infections (pneumonia) as the top three diseases contributing to years of life lost due to premature death in Tanzania. From 1990 to 2010 premature deaths from pneumonia fell by 34 percent, diarrheal diseases by 58 percent and meningitis by 15 percent. Neonatal sepsis, responsible for almost 3 percent of total years of life lost, ranked number eight in the top 25 causes for premature mortality in 2010 (Institute for Health Metrics and Evaluation, 2012).

HIV contributed to a total of 84,000 deaths and an estimated 1,600,000 people were living with HIV in 2011 (United Nations Programme on HIV/AIDS (UNAIDS), 2013). HIV prevalence in Tanzania has decreased over the last four years (figure 3-1). The 2011 – 2012 HIV/AIDS and Malaria Indicator Survey reported 5.1 percent national prevalence: 6.2 percent in women and 3.8 percent in men. HIV is more common in urban areas and varies across regions from under 1 percent in Pemba to 14.8 percent in Njombe.

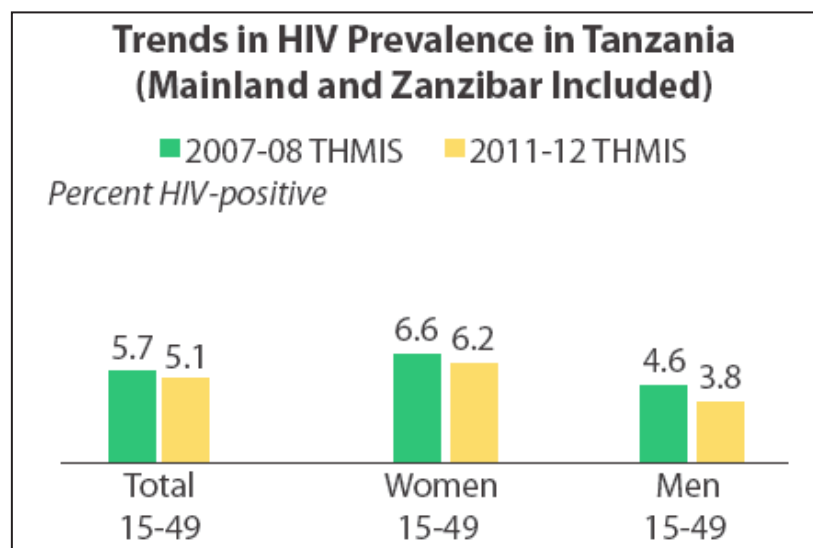


Figure 3-1. HIV prevalence trends in women and men according to the Tanzania HIV/AIDS and Malaria Indicators Survey (Tanzania Commission for AIDS (TACAIDS), Zanzibar AIDS Commission (ZAC) & Statistics (NBS), Office of the Chief Government Statistician (OCGS), 2013).

Malaria has seen a downward trend since 2000 (figure 3-2). In 2009, malaria was responsible for 21 of 266 deaths per 100,000, compared to over 50 percent of deaths in 2000 (World Health Organization, 2010). Malaria now ranks number two in the top causes of premature death (Institute for Health Metrics and Evaluation, 2012). The Tanzania HIV/AIDS and Malaria Indicator Survey reported 9 percent malaria prevalence in children aged 6-59 months. Prevalence was found to be higher in rural areas (10 percent) than urban areas (3 percent), with some regions such as Geita reporting prevalence as high as 32 percent (Tanzania Commission for AIDS (TACAIDS), Zanzibar AIDS Commission (ZAC) & Statistics (NBS), Office of the Chief Government Statistician (OCGS), 2013).

Tuberculosis (TB) is more prevalent in males than females according to the first national TB prevalence study and that prevalence of HIV infection among TB patients is 4.8 per cent and the prevalence of HIV in TB patients is 6.5 per cent.

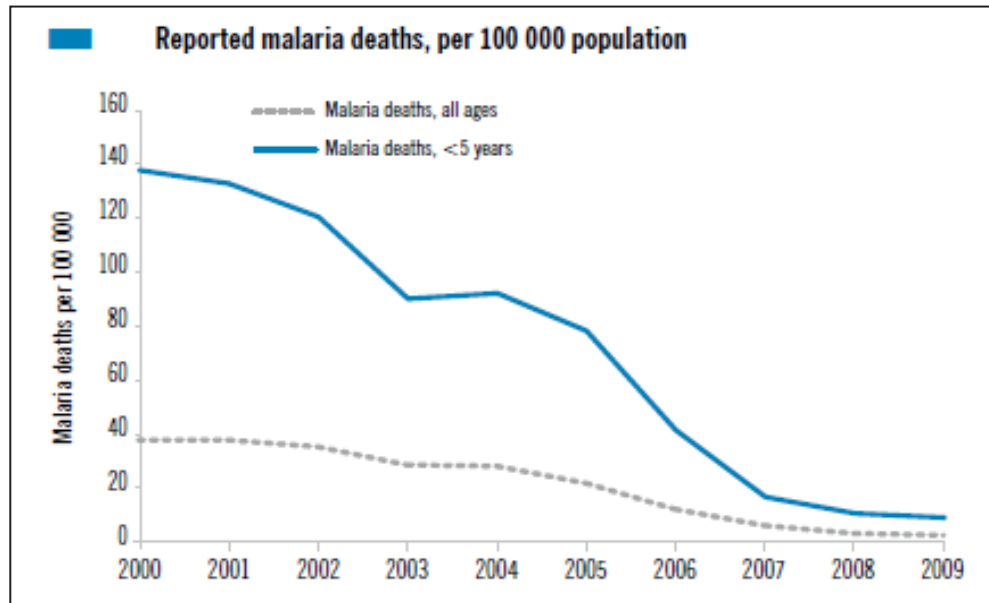


Figure 3-2. Malaria trends from 2000 to 2009 (WHO, 2010).

TB saw a sharp rise of an average 10 percent increase in the 1990s, resulting in almost three-fold increase from the 1980s. The trend, as shown in the figure, below slowed for the next decade, with an average of 2 percent increase per year during the 21st century (Ministry of Health and Social Welfare National Tuberculosis and Leprosy programme, 2013).

In 2013, there were 64,053 new cases of TB, of which 25,241 were new bacteriologically confirmed pulmonary TB cases, 23,371 were new clinically diagnosed pulmonary TB cases, 15,016 were extra-pulmonary TB cases and 1,101 were relapses. For the same year, prevalence was determined as 172 per 100,000 population, including HIV positive patients with TB. In 2013, 530 cases were new cases detected as Multi-drug-resistant tuberculosis (MDR-TB) from pulmonary tuberculosis totaling to 616 reported cases tested when retreatment (86) cases are included (World Health Organization (WHO), 2014).

Data from a survey of 1,019 new patients and 148 retreatment ones, a sample considered nationally representative, showed that resistance of *Mycobacterium tuberculosis* strains to one of the four first line drugs was 8.3 percent, and 1.1 percent were MDR-TB. For the retreatment group, the crude prevalence for single drug and multi drug was 20.6 percent and 3.9 percent, respectively (Ministry of Health and Social Welfare National Tuberculosis and Leprosy programme, 2013).

Although the WHO classifies Tanzania as one of 22 countries with a high TB burden, the country has met all 2015 targets for reductions in TB cases and deaths. It has also seen generally good outcomes for treatment of MDR-TB patients (≥ 70 percent cured) (World Health Organization (WHO), 2014).

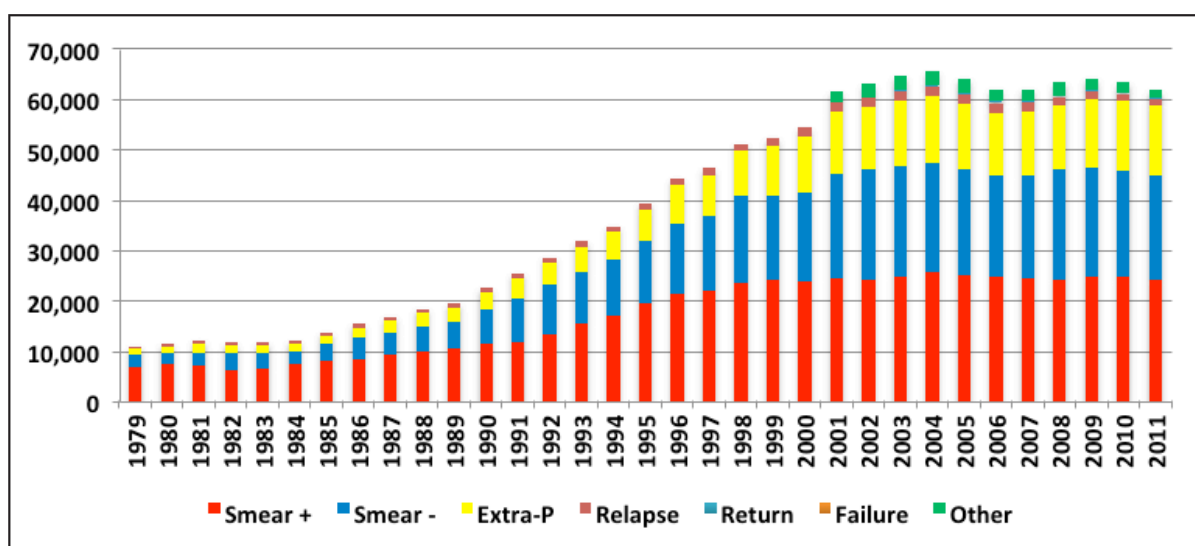


Figure 3-3. Trends in case notification rates for all forms of TB, 1979–2011.

Source: NTLP manual 2013 (Ministry of Health and Social Welfare National Tuberculosis and Leprosy programme, 2013)

Bacterial Diseases in Humans and their resistance rates

The high disease burden caused by respiratory infections and enteric infections in all age groups makes them critical disease priorities and underscores the importance of ensuring universal access to antibiotics and their appropriate use.

The notifiable bacterial diseases being monitored by the health sector are dysentery, typhoid, meningitis and cholera. In children (both under and over five years of age), most cases reported were typhoid and dysentery (Ministry of Health and Social Welfare, 2009a). With little national information available on the bacterial disease burden in Tanzania, studies from 2005 – 2013 are reviewed below in order to gain a preliminary overview.

It is worth mentioning first a study conducted recently amongst children younger than 10 years of age (median 18 months) from rural (Ifakara) and urban (Dar es Salaam) locations. Findings were that, out of the 1005 children investigated in the outpatient clinics, 70.5 percent had a viral disease (57.2 percent was solely viral disease) and 22 percent had a bacterial infection (10.4 percent was bacterial disease alone). Another 10.9 percent had parasitic disease (6.4 percent was parasitic without coinfection). No microbiologic cause of illness could be found for 11.8 of children (D’Acromont et al., 2014).

Acute Respiratory Infections (ARIs)

Prevalence and resistance rates

Acute respiratory infections—particularly pneumonia—are a leading cause of global childhood mortality (Williams, Gouws, Boschi-Pinto, Bryce, & Dye, 2002). Caretakers of children under five years old who were surveyed for the Tanzania Demographic Health Survey 2010 reported that 4.7 percent (6.7 percent in Zanzibar) of children experienced symptoms of ARIs in the two weeks prior to the survey, of whom 71 percent were taken to health facilities, an increase from the 57 percent reported in 2004–05 (National Bureau of Statistics & ICF Macro, 2011).

In 2003, the Network for Surveillance of Pneumococcal Disease in the East African Region (netSPEAR) was established to collect and monitor data on pathogens detected in hospitals in Kenya, Uganda and Ethiopia, including two in Tanzania. High rates of *H. influenzae* and *S. pneumoniae* infection were found in cerebrospinal fluid (CSF) and blood samples. There was also a gradual increase in resistance to cotrimoxazole

over the study period. In 2003, 19 percent of isolates from CSF samples and 27 percent of isolates from blood were resistant to cotrimoxazole. By 2006, resistance rates had risen to 69 percent and 60 percent of such samples, respectively. The findings of this collaborative cross-border work, which also typed isolates, provided the rationale for adoption of the 7-valent vaccination programmes in the region (Mudhune & Wamae, 2009). A study done later among 300 children found a high proportion of carriage of penicillin-non susceptible pneumococci (PNSP; 68.6 percent resistant) and 16.5 percent were multi drug resistant (Sabrina J Moyo et al., 2012). The only study conducted to determine the nasal carriage of *S. aureus* and methicillin resistant *Staphylococcus aureus* (MRSA) in Tanzania was at Muhimbili National Hospital (MNH) among under five year olds. It found 40 percent of the study participants to bear nasal carriage of *S. aureus* and of these 10.5 percent were MRSA. Resistance was noted among the isolates, significantly to cotrimoxazole (65.8 percent). None of the isolates were resistant to vancomycin (S Moyo et al., 2014).

Prevention

The WHO recommends immunization for primary prevention of pneumonia. These include *Haemophilus influenzae* type b (Hib) conjugate and pneumococcal conjugate (PC) vaccines and measles and pertussis. The current programme of immunization in Tanzania covers all of these infections (Ministry of Health and Social Welfare, 2013a). Hib and *Streptococcus pneumoniae* are the leading causes of bacterial pneumonia, meningitis, and sepsis and in 2000 collectively accounted for 1,197,000 deaths in children aged 1-59 months globally, mostly in low income countries. *S. pneumoniae* causes about 11 percent (range: 8-12 percent) of all deaths in HIV-negative children aged 1-59 months (O'Brien et al., 2009; Watt et al., 2009). One study found that the 7-valent vaccine (PCV7) covered many of the resistant pneumococci strains that were isolated from nasopharyngeal swabs of healthy children (Sabrina J Moyo et al., 2012). Of note is that the vaccine was rolled out in Tanzania in 2012, but coverage data have not yet been reported.

For diagnosis and treatment of ARIs, Tanzania has adopted the WHO guidelines for Integrated Management of Childhood Illnesses (IMCI), which states that ARI should be suspected in every child who seeks care for cough or difficulty breathing. These guidelines offer specific clinical examinations which can be undertaken by the healthcare worker, leading to improved diagnoses and hence improvement in appropriate prescribing and use of antibiotics (Bryce et al., 2005).

Diagnosis

A 2008 study observed doctor-patient interactions in two hospitals in Tanzania and found that a small minority of doctors actually performed the appropriate examinations. Of 1,081 observations, 554 (51 percent) of children had a cough, while 617 (57 percent) had difficulty breathing. Of these children, only 5 percent had their respiratory rate counted, 14 percent had their chest observed, and 25 percent were examined with a stethoscope. The authors used regression analysis to show that both personal characteristics and the clinical setting influence the likelihood that an examination was completed (Chandler et al., 2008). Similarly, among outpatients (1181), only 9 percent of the 657 children with a cough had their respiratory rate counted and 28 percent of those with difficulty breathing had their chests exposed (Reyburn et al., 2008).

Treatment

Antibiotic treatment, which is recommended in the IMCI guidelines for treatment of pneumonia and severe pneumonia, reaches only a small portion of the children who need it. According to the GAPP, less than 25 percent of children in Tanzania with pneumonia are receiving antibiotics (World Health Organization (WHO) & The United Nations Children's Fund (UNICEF), 2009).

A study of the effect of mass treatment with azithromycin (a macrolide antibiotic) in an area endemic for trachoma found no significant development of resistance over the period of 6 months studied (August 2000 to February 2001). However, they found high resistance rates to other antibiotics, including 84 percent PNSP and 53 percent cotrimoxazole resistant (Batt et al., 2003).

Table 3-1. Studies of acute respiratory infections with relevance to antibiotic resistance

Study Population	Sample taken	Results and etiologic agents	Significance	Author and year
7Children under 5 years of age hospitalized and requiring lumbar puncture and/or blood culture with suspicion for pneumococci disease sent for confirmation of species and serotyping.	Cerebrospinal fluid (CSF); MNH: 749 HospitaliTeule: 641 Blood samples; MNH: HospitaliTeule: 2375	Both samples resulted in high confirmation rates. <i>Streptococcus</i> isolates were mostly sensitive (less than 1.5% resistance rates) to commonly used antibiotics (penicillin, cefotaxime, erythromycin and amoxicillin). Gradual increase in resistance to cotrimoxazole over 3 years. Serotyping of isolates found a high coverage of the PCV7 vaccine (about 50% in the entire network).	Tanzania immunization schedule roll out is with the PCV13 which for this study was found to have a high coverage (at least 79%) for the whole region.	(Mudhune & Wamae, 2009)
300 healthy children under five years old attending Child Health Clinic at Muhimbili National Hospital	Nasopharyngeal swabs for culture	Nasopharyngeal carriage rate of <i>S. pneumoniae</i> was 35.0% and 67.8% were penicillin-non susceptible. <i>S. pneumoniae</i> (PNSP) of which 17.9% were also multidrug resistant. The isolates were particularly resistant to cotrimoxazole (82.6%).	High rates of resistant strains of <i>S. pneumoniae</i> documented which were covered by the PCV7 vaccine. Rational use of antimicrobials with institution of an appropriate vaccination programme were advocated by the authors.	(Sabrina J Moyo et al., 2012)
285 children under five at the Muhimbili National Hospital in Dar es Salaam, Tanzania	Nasal swabs were obtained for culture	<i>S. aureus</i> was isolated in 40% of participants and of these, 10.5% were MRSA. Resistance of <i>S. aureus</i> was greatest to cotrimoxazole (65.8%) and least to ciprofloxacin (4.4%). Resistance to gentamicin and tetracycline were 27.2% and 23.7%, respectively. No isolates were resistant to vancomycin.	The study team called for strengthened infection control measures and health education amongst health care workers	(Sabrina John Moyo et al., 2014)
5001 Children aged 7 or below living in Rombo District, a trachoma endemic region in northern Tanzania	Throat swabs (oropharyngeal swabs) taken prior to the administration of azithromycin and at 2 and 6 months after it.	The <i>S. pneumoniae</i> carriage rate was 11% at baseline and 12% and 7% at 2 and 6 months respectively which was a low figure and no isolates were resistant to azithromycin. Resistance to cotrimoxazole was high, assumed to be due to easier access than to the macrolides. Serotyping of the <i>S. pneumoniae</i> isolates found that 60% would have been covered by the PCV7 vaccine.	This was an area meso-endemic to trachoma and before introducing the expensive, uncommonly used macrolide, it was essential to check for development of resistance due to cross-resistant pathogens or azithromycin-resistant strains.	(Batt et al., 2003)

7 Network for Surveillance of Pneumococcal Disease in the East African Region (netSPEAR). 4 Eastern African hospitals; Kenya, Uganda, Tanzania (Muhimbili National Hospital and Hospitali Teule), and Ethiopia.

Abbreviations

CSF: Cerebrospinal fluid

MNH: Muhimbili National Hospital

MRSA: Methicillin resistant *Staphylococcus aureus*

PCV7: 7-valent pneumococcal vaccine

PCV13: 13-valent pneumococcal vaccine

PNSP: Penicillin-non susceptible *S. pneumoniae*

RCH: Reproductive and child health

Bloodstream Infections (BSI)

Prevalence

BSIs, also referred to as sepsis or bacteremia, are caused by the invasion of bacteria into the bloodstream through a portal of entry either by a wound or surgical procedure, or through infection or site of injection.

A study of febrile adults in northwestern Tanzania found prevalence rates of 9.5 percent for blood stream infections (Meremo et al., 2012). Hospitalized febrile children from different parts of the country have also been studied, with the following BSI rates detected: 10 percent in children under 14 years; as high as 13.9 percent in children under 7 years; 7.5 percent in children under three years (Mtove et al., 2010; Blomberg et al., 2005; Christopher et al., 2013). A study including both children and adults found BSI in 8 percent but only 4 percent considered pathogenic bacteria from the other 4 percent contaminants (Thriemer et al., 2012). Recently, it has been found that neonatal sepsis rates are high (39 percent of neonates admitted) and *S. aureus* is a common etiological agent (Kayange et al. 2010; Mhada et al. 2012). A study established that for community acquired BSI, non-typhoidal *Salmonella* spp (39.4 percent) were predominant among Gram-negative organisms, especially among HIV-positive patients (92.3 percent). *S. pneumoniae* (15.2 percent) were the predominant Gram-positive bacteria (Meremo et al., 2012).

Treatment

The antibiotics used to treat sepsis in Tanzania include ampicillin, cloxacillin, chloramphenicol, gentamicin and ceftriaxone (Thriemer et al., 2012; Blomberg et al. 2007; Kayange et al. 2010; Vaagland et al. 2004).

At Bugando Medical Center, survival among children with sepsis was significantly associated with antibiotic susceptibility (Kayange, Kamugisha, Mwizamholya, Jeremiah, & Mshana, 2010). Case fatality rates were higher among those with extended spectrum beta lactamase (ESBL) and MRSA isolates than among those with sensitive isolates (Blomberg et al., 2005). Inappropriate treatment of bloodstream infections was a significant risk factor for death in children admitted at MNH between August 2001 and August 2002 (independent of underlying diseases), and was also associated with increased duration of hospitalization (median 10 days versus 6 days) (Blomberg et al., 2007). Table 3-2 summarizes the studies conducted in Tanzania to describe common organisms and their resistance patterns.

Role of co-infections in BSI and overall effect in antibiotic resistance rates

The high prevalence of risk factors such as HIV infection, malnutrition, malaria and sickle-cell disease pose an additional challenge in the management of bacterial infections and overall prudent consumption of antibiotics. For instance, even though the prevalence of malnutrition (0.4 percent), meningitis (0.2 percent) and HIV-related disease (0.1 percent) was relatively low amongst a paediatric population admitted at MNH, those children had the highest case fatality rates (Reyburn et al., 2008).

Malnutrition prevalence has dropped from 25 percent of children under 5 in 1991 to 16 in 2010 (index mundi, 2014). HIV, too, has decreased from a prevalence of 7 percent among women and men aged 15-49 in 2003/04 to 5 percent in 2011/12 (TACAIDS, NBS, & ICF, 2013). These non-bacterial infections and disease states require the frequent use of antibiotics to prevent or treat co-infections that can occur with them. For instance, HIV patients are put on lifelong cotrimoxazole prophylactic treatment.

A study conducted among children 7 years and younger, revealed 14 percent of the study population had a BSI, and one-third of them died. Inappropriate antimicrobial treatment was associated independently of other underlying diseases with increased risk for death. The highest case fatality rates were in children with HIV (17 percent), malnutrition and antimicrobial resistance. Among survivors, longer hospital stays were associated with inappropriate antimicrobial treatment (Blomberg et al. 2007).

Most of the *Salmonella* spp. (all of which were non-typhoid) was found in one study to be amongst HIV positive patients (92.3 percent). This supports published findings that immunocompromised patients have higher rates of bacteremia (Meremo et al., 2012).

Table 3-2. Studies of blood stream infection with relevance to antibiotic resistance

Study Population	Sample taken	Results and etiological agents	Significance	Author and Year
1798 Children aged 0-7 years admitted to MNH paediatric department with a fever of $\geq 38^{\circ}\text{C}$ or other signs of severe infections.	Blood specimen	High rates of ESBL-producing <i>E. coli</i> (25%) and <i>Klebsiella</i> spp (14%)	Patients with ESBL-producing organisms causing septicemia had a notably higher fatality rate (71%) than with non-ESBL isolates (39%)	(Blomberg et al., 2005)
300 neonates with sepsis at BMC	Blood sample	<i>K. pneumoniae</i> (33.6 %) was the predominant isolate, 49% of which were ESBL producing. 21% were <i>S. aureus</i> isolates (28% were methicillin resistant). <i>Escherichia coli</i> (15%) was the third commonest with ESBL rate of 45.5%. These common Gram-negative bacteria were resistant to first line drugs; ampicillin (100%) and gentamicin(67%) as were Gram-positive bacteria resistant to cloxacillin.	Multi-resistant Gram-negative bacteria are significantly associated with morbidity and mortality of both early and late onset of sepsis among neonates.	(Kayange et al., 2010)
300 pregnant women attending antenatal clinic and their newborns (180) delivered at MNH	High vaginal and rectal swabs were collected at 37 weeks of gestation using sterile swab stick. Umbilical swabs, ear canal and nasal swabs were collected from neonates within one hour post delivery.	Group B <i>Streptococcus</i> (GBS) was confirmed in 23% of pregnant women and 9% of neonates. The isolates were found resistant to clindamycin, erythromycin, and penicillin	Asymptomatic GBS colonization in pregnant women is a cause of drug-resistant septicemia, meningitis and pneumonia in neonates	(Joachim, Matee, Massawe, & Lyamuya, 2009)
1787 children aged 0-7 years admitted at MNH with signs of infection as defined in the IMCI	Blood	When resistance rate between those with prior antimicrobial treatment and those without were compared, it was found that antimicrobial treatment prior to blood culture was significantly associated with resistance. This was seen for cotrimoxazole (83% versus 69%) and chloramphenicol (59% versus 42%) for Gram-negative bacteria and erythromycin (36% versus 0%) and chloramphenicol (46% versus 0%) for <i>S. aureus</i> . <i>Salmonella</i> and <i>Escherichia coli</i> at prevalences of 17.4% and 15.5% were the most common isolates in community acquired infections, and <i>Klebsiella</i> (24.5%) and <i>S.aureus</i> (12.2%) were the most common in hospital-acquired infections.	Despite two thirds of the study population having received antibiotics prior to culture, there was a high BSI rate (13.9%) found. This suggests that this number may actually be an underestimate of the true prevalence rate.	(Blomberg et al., 2007)
Retrospective analysis of 13 833 blood culture results obtained at microbiology section of the Central pathology laboratory (CPL) of MNH between 2005 and 2009	blood	MRSA was at a prevalence of 12 percent Bacterial pathogens were detected in 13.4% of cases, of which 82.1% were Gram-positive. The most common pathogens were coagulase-negative staphylococci (67.4%), <i>S. aureus</i> (13.2%), <i>E. coli</i> (7%) and <i>Klebsiella</i> spp. (7%). High-level resistance was observed to first-line agents: penicillin G (70.6%), ampicillin (62.3%) and (moderately) chloramphenicol (45.2%). 23. 3% were MRSA.	Recommended routine screening for ESBL production and methicillin resistance among Gram-negative rods and <i>S. aureus</i> from blood cultures	(S Moyo, Aboud, Kasubi, & Maselle, 2010)

Study Population	Sample taken	Results and etiological agents	Significance	Author and Year
346 febrile adult patients at BMC	Blood	9.5% BSI prevalence with 48.5% of these patients were HIV positive. The commonest isolates in descending order of prevalences were: <i>Salmonella</i> sp (39.4%), <i>E. coli</i> (24.2%), <i>S. pneumoniae</i> (15.2%), and <i>S. aureus</i> (12.1%). 92.3% of the <i>Salmonella</i> spp were non-typhoidal, NTS and from HIV positive patients. High resistance rates were seen by <i>Salmonella</i> spp and <i>E. coli</i> with prevalences of 84.5% for chloramphenicol and 69.2% ampicillin for <i>Salmonella</i> and 75% each for ampicillin and cotrimoxazole by <i>E. coli</i> species. Gram-positive resistance was seen at 30% and 40% to ampicillin and cotrimoxazole respectively. The authors suggested that most of the bloodstream infections in this study were acquired from the community, as most of the Gram-positive bacteria was <i>S. pneumoniae</i> , and non-typhoid <i>Salmonella</i> were the most common Gram-negative bacteria	Specialized care should be taken for HIV patients presenting with a BSI at the centre as they are mostly affected by multi resistant NTS sp.	(Meremo et al., 2012)
Admitted neonates (300) at MNH	blood and pus swab isolates	Prevalence of BSI was 24%. <i>S. aureus</i> as the most common blood and pus swab isolates and <i>Klebsiella</i> spp. was the second most common among blood cultures but predominant among those aged below 7 days. Both blood culture and pus isolates were highly resistant to ampicillin and cloxacillin at rates of 81.1% and 89.9% for ampicillin and 78.4% and 85.2% respectively for cloxacillin. Blood samples had additionally moderate resistance to ceftriaxone (14.9%) for swabs) and cefuroxime (18.9%).	These resistance rates call for caution in antibiotic choice and hence need for set up of a routine antimicrobial surveillance.	(Mhada et al., 2012)
2,209 patients of all ages with history of fever at Pemba district hospitals (ChakeChake, Mkoani District and Wete).	Blood	3.6% had a BSI with one patient (0.04%) had a co-infection of with malaria (<i>P. falciparum</i>), whereas 28 (1%) had malaria (<i>P. falciparum</i>) with a negative blood culture. <i>S. Typhi</i> (58%) was the most frequent pathogenic bacteria followed by <i>S. pneumoniae</i> (15%). <i>S. typhi</i> was moderately resistant to ampicillin (51%), chloramphenicol (49%) and cotrimoxazole (49%) and 42% were multidrug resistant including 21% which were resistant to nalidixic acid.	An area with very low malaria incidence had high rates of <i>S. typhi</i> and <i>S. pneumoniae</i> and the authors thought a vaccine could decrease the occurrence.	(Thriemer et al., 2012)
6, 836 severely ill and febrile from two paediatric in-patient wards of the Teule District hospital in Muheza aged two months to < 15 years	Blood	Bacteremia prevalence was found at 10% and 28% had severe malaria and coinfection of the two (malaria and BSI) in 2%. During the four year study period; there was a significant decrease in the occurrence of malaria and non-typhoidal <i>Salmonella</i> (NTS) disease.	Interventions towards malaria control show greater benefit than for this disease alone.	(Mtove et al., 2011)
1,502 children aged 2 months to 14 years at Teule district Hospital in north-eastern Tanzania.	Blood	9% had <i>S. Typhi</i> , 29% had NTS making the total of invasive salmonellosis 38%. Older children with longer duration of fever were associated with a typhoidal infection and non-typhoidal was associated with mainly malaria and its complications (anemia, jaundice and hypoglycemia)	Clinical features may be used to distinguish invasive salmonellosis from other febrile illness.	(Mtove et al., 2010)

Abbreviations

BMC: Bugando Medical Centre

BSI: Blood stream infection

ESBL: Extended spectrum beta lactamase

GBS: Group B *Streptococcus*

IMCI: Integrated management for childhood illnesses

MNH: Muhimbili national hospital

NTS: Non-typhoidal *Salmonella* infection

Urinary Tract Infections

Prevalence

Urinary tract infections (UTIs) occur when bacteria enter the urinary tract via the urethra. UTI is the second most common site of infection (after ARI) in the community and incidence varies by age, gender and health status (Harding & Ronald, 1994). In Mwanza, in symptomatic and asymptomatic pregnant women, UTI prevalence was 17.9 percent and 13.0 percent, respectively (Masinde, Gumodoka, Kilonzo, & Mshana, 2009); and 39.7 percent and 20.3 percent among the febrile and afebrile children (Festo, Kidenya, Hokororo, & Mshana, 2011; Msaki, Mshana, Hokororo, Mazigo, & Morona, 2012). From MNH, prevalence of bacteriuria was 21 percent amongst pregnant patients (Sabrina J Moyo, Aboud, Kasubi, & Maselle, 2010) and 16.8 percent in febrile admitted children (Fredrick, Francis, Fataki, & Maselle, 2013). Most studies have found that 30 to 50 percent of UTIs are *E. coli*, followed by *K.pneumoniae*.

Diagnosis

Leukocyte esterase, nitrite, blood, and protein are biochemical markers of UTI that can be observed by a dipstick urinalysis. Screening of all markers with a negative result indicate absence of UTI where as if one is present, a culture is justified (Patel, Livsey, Swann, & Bukhari, 2005).

The usefulness of the dipstick urinalysis has been questioned whereby a method known to be cheap and quick cannot forego the need for accuracy and reliability. One study conducted in children, obtained 56.4 percent as the highest sensitivity when serial use of combination of nitrite test and urine WBC microscopy (Festo et al., 2011). One study calls for use of urine dipstick as effective enough when laboratory facilities are scarce (Fredrick et al., 2013) while another recommends routine urine culture and susceptibility testing to expectant mothers at antenatal booking (Masinde et al., 2009).

Treatment

Delays or ineffective treatment during the early years (infancy and childhood) have been associated with long-term complications, including renal damage in 40 percent of and renal scarring in 5 percent of children (Echeverri et al., 2014; Habib, 2012; Smellie, Poulton, & Prescod, 1994). However, not all studies have found this (Hannula et al., 2012; Toffolo, Ammenti, & Montini, 2012).

Individuals with UTI may be symptomatic or have no symptom, which is known as asymptomatic bacteriuria (ASB). ASB need not be treated in most people (healthy school girls and young women, diabetic women and patients with indwelling catheters or intermittent catheterization). Treatment is reserved for pregnant women, children (mainly 5-6 years) and prior to invasive genito-urinary procedures, such as transurethral resection of the prostate (TURP) (Raz, 2003). Although one study claimed ASB a complication in diabetic women hence requiring treatment (Geerlings et al., 2000). The importance of ASB to be detected in pregnant

woman is such that a process of enhanced urinalysis was investigated and recommended for by a team in Nigeria (Aigere, Okusanya, Eigbefoh, & Okome, 2013). This emphasizes the importance of laboratory workup in diagnosing UTI particularly amongst populations known to be susceptible to the infection such as children who are most vulnerable to long term complications associated with the infection (Fredrick et al., 2013).

WHO recommends amoxicillin, cotrimoxazole and nitrofurantoin recommended as first-line treatment for UTIs (Finnell et al., 2011). Second-line agents are amikacin, ciprofloxacin and cefotaxime. These agents are specified similarly in Tanzania's Standard Treatment Guidelines, although studies show waning effectiveness. The duration of treatment for UTI has been shown to be effective in a 10-day course of therapy (Fitzgerald, Mori, Lakhanpaul, & Tullus, 2012).

Resistance rates

Resistance developed by *E.coli* and *Klebsiella* spp. has seen to lessen effectiveness of empirical treatment of UTI as mentioned previously these are the most prevalent etiological agents. There are therefore prioritized in this section.

Resistance of the uropathogen E. coli to antibiotics.

In 2003, at MNH it was found that 92 percent of the 179 *E. coli* in samples from children were resistant to ampicillin. Similar resistance patterns were observed at BMC, where more than 92.7 percent of *E.coli* isolates from urine specimens were found to be resistant to ampicillin (Festo et al., 2011). The resistance of *E.coli* to amoxicillin/clavulanate in Tanzania ranges from 37.5 percent among diabetic women in Muhimbili to more than 85 percent among children at BMC (Festo et al., 2011; Lyamuya, Moyo, Komba, & Haule, 2011).

The increasing resistance trend to gentamicin among *E. coli* has been observed with resistance ranging from 6.9 percent at MNH in 2003 to more than 44 percent in the same hospital in 2011 ((Lyamuya et al., 2011) Dar es Salaam. Three hundred diabetic women attending clinic at MNH from June to November 2010 were included in the study. Demographic and clinical information were collected using a structured questionnaire. Urine specimens were collected for urinalysis, microscopy, culture and antimicrobial susceptibility testing. Significant, asymptomatic and symptomatic bacteriuria was found in 13.7% (41/300, Rimoy et al., 2006). At the Bugando Medical Centre, gentamicin resistance ranges from 5.9 percent among pregnant women to 21.9 percent among febrile children (Festo et al., 2011; Masinde et al., 2009).

The resistance of *E. coli* to cotrimoxazole has been found to range from 50 percent in diabetic women to 97 percent among children from the community attending at the Makongoro Clinic in Mwanza City (Msaki et al., 2012).

Fluoroquinolones, particularly ciprofloxacin, are reasonable choices for empirical treatment of UTIs where resistance to cotrimoxazole is over 20 percent.

E. coli was found to be more susceptible to ciprofloxacin with a resistance rate between 8.1 percent and 30.4 percent (Festo et al., 2011; Lyamuya et al., 2011).

At BMC, the rate of resistance of *E. coli* to ceftriaxone increased from 14 percent in 2009 to 29.4 percent in 2011 (Festo et al., 2011; Masinde et al., 2009). At MNH, 50 percent of *E. coli* isolates from urine specimens were found to be resistant to cefotaxime in 2008 (Sabrina J Moyo, Aboud, Kasubi, Lyamuya, & Maselle, 2010).

Similarly findings of resistance to commonly used antibiotics were observed in *Klebsiella* spp. studied as well. A recent review of studies from African countries shows that *Klebsiella* spp. resistance to various antibiotics is rising (Mshana et al., 2013).

ESBL production

Contributing to the high rate of resistance of Gram-negative bacteria is the production of ESBL by the pathogens. ESBL confers resistance to all beta-lactam antibiotics. The prevalence of ESBL among *E. coli* ranges from 25 to 45 percent, and up to 50 percent of *K. pneumoniae* isolates are ESBL producers (Masinde et al., 2009; Sabrina J Moyo, Aboud, Kasubi, Lyamuya, et al., 2010). ESBLs are more common in hospitals than in the community or outpatient settings (Sabrina J Moyo, Aboud, Kasubi, Lyamuya, et al., 2010; Stephen E Mshana, Kamugisha, Mirambo, Chakraborty, & Lyamuya, 2009). One study reported higher ESBL rates in pathogens infecting children (54.9 percent) than adults (32.5 percent) (Sabrina J Moyo, Aboud, Kasubi, Lyamuya, et al., 2010).

Carbapenems are drugs of choice to treat ESBL producing bacteria (Paterson et al., 2001). However, they are expensive and not widely available in Tanzania. Though fourth generation cephalosporins like cefepime may serve this purpose with a lesser financial burden, its use is determined greatly by susceptibility patterns of ESBL (Stephen E Mshana, Kidenya, & Kataraiya, 2011). With knowledge of the antibiotic sensitivity pattern of the pathogens, we can expect to improve the management of UTI.

Table 3-3. Studies of urinary tract infection with relevance to antibiotic resistance

Study Population	Results and etiological agents	Significance	Author and year
247 pregnant women at Bugando Medical Centre in Mwanza.	Bacteriuria prevalence: symptomatic women (31.5%), asymptomatic women(68.4%) Organisms: <i>E. coli</i> (47.2%); <i>Enterococcus</i> spp (22.2%) Resistance: <i>E. coli</i> resistance: ampicillin (53%), tetracycline (58.8%), cotrimoxazole (64.7%), gentamicin (5.9%), ciprofloxacin (11.8%), nitrofurantoin(5.9%), imipenem (0%).	<i>E. coli</i> is resistant to the commonly administered antibiotics, but sensitive to some.	(Masinde et al., 2009)
All children with fever, median age 18 months (range: 2 to 60 months) with no indwelling catheters, at BMC.	Prevalence of UTI: 39.7% by culture Organisms: <i>E. coli</i> (64/147, <i>K. pneumoniae</i> (52/147). Resistance rates: <i>E. coli</i> : ampicillin (98.4%), cotrimoxazole (95.3%), amoxicillin/clavulanicacid (87.5%), cephalixin (61%).	To accommodate for the low sensitivity of dipstick urinalysis, urine culture and susceptibility pattern is recommended as routine for in all febrile children suspected with UTI.	(Festo et al., 2011)
Blood and urine culture of 231 febrile children under five years, Mwanza health centre.	UTI, 20.3%; malaria, 9.5%, bacteremia, 7.4%. Dual infection: 11.5% Triple infection: one child Uropathogenic <i>E. coli</i> were maximally resistant to resistant to ampicillin (100%), cotrimoxazole (97%) and amoxicillin/clavulanic acid (85%).	Improvement in detecting differential diagnoses for fever will both ensure effective treatment and control for unnecessary antibiotics usage.	(Msaki et al., 2012)
300 diabetic women attending clinic at MNH.	14.5% of symptomatic and 13.4% of asymptomatic women had significant bacteriuria. The rate was the same among diabetic women. Organisms isolated most often were <i>E. coli</i> (39.0%) and <i>K. pneumoniae</i> (22.0%). Resistance of Gram-negative organisms: ampicillin (62.55%), penicillin (53.1%), cotrimoxazole (50%), cefotaxime (18.8%). Resistance of Gram-positive organisms: naldixic acid (55.6%), cefotaxime (0%).	Gram-negative bacteria are highly resistant to cephalosporins because of ESBL production.	(Lyamuya et al., 2011)

Study Population	Results and etiological agents	Significance	Author and year
Retrospective analysis of 200 urine specimens from pregnant women at MNH.	Bacteriuria: 21% of specimens Organisms: <i>E. coli</i> (33.3%) <i>Klebsiella</i> spp (21.4%) Resistance rates: first-line drugs: nitrofurantoin (18.7%), cotrimoxazole (38.5%), ampicillin (57.7%) Second-line drugs: ciprofloxacin (13.6%), amikacin (5%), cefotaxime (31.2%). Vancomycin and methicillin resistance: 25% each in the Gram-positive isolates ESBL rates: 31.2% amongst pregnant women.	Supports screening for ESBL production amongst <i>E. coli</i> and <i>Klebsiella</i> spp found resistant to cefotaxime.	(Sabrina J Moyo, Aboud Kasubi, & Maselle, 2010)
Urine samples from the Central Pathology Laboratory (CPL). 56.7% from paediatric patients, 43.3% from adults	270 isolates: <i>E. coli</i> (51.1%) and <i>Klebsiella</i> spp ESBL rate: 45.2% Resistance rates: ESBL producing <i>E. coli</i> had resistance rates of 90.7%, 46.3% and 61.6% to cotrimoxazole, iprofloxacin and nalidixic acid, respectively. ESBL producing <i>Klebsiella</i> had rates of 92.6%, 25.0%, 66.2%, respectively. All ESBL producing <i>Klebsiella</i> were resistant to cefotaxime and ceftazidime. ESBL producing <i>E. coli</i> had rates of 92.6% and 94.4%, respectively.	Supports improved detection of ESBL among <i>E. coli</i> and <i>Klebsiella</i> spp (predominant ESBL- producers) in urinary isolates.	(Sabrina J Moyo, Aboud Kasubi, Iyamuya, et al., 2010)
235 ESBL producing isolates from clinical specimens including urine, wound swabs, pus and blood from BMC	ESBL producers: <i>Klebsiella</i> (69%), <i>E. coli</i> (31%). Susceptibility to ceftaxime: <i>Klebsiella</i> , 4.3%; <i>E. coli</i> , 15.1%.	Supports susceptibility testing before treatment.	(S E Mshana, Imirzalioglu, Hain, & Domann, 2011)
382 children under five years with fever admitted in the general paediatric ward.	Isolates from 16.8% of children: <i>E. coli</i> (33.7%), <i>K. pneumoniae</i> (24.1%), <i>Pseudomonas</i> spp (12.2%). Resistance: ampicillin (79.9%), cotrimoxazole (89%), amoxicillin/clavulanate (70.3%), amikacin 12.5%).	The importance of screening of UTI in febrile children and to abandon use of ineffective antibiotics by adoption of guidelines reflecting the current situation.	(Fredrick et al., 2013)
800 clinical samples; urine (41.4%), wound swab, pus, blood, aspirate, sputum at BMC.	ESBL production among Gram-negative bacteria was 29.2%, highest in ICU (78%) predominantly <i>Klebsiella</i> spp (84%). ESBL rates: <i>K. pneumoniae</i> , 63.7%; <i>E. coli</i> 24.4%; <i>Acinetobacter</i> spp, 17.7%. 95% of ESBL isolates were resistant to ceftaxime.	Emphasis on better infection control and intervention programmes alongside routine antibiotics susceptibility testing.	(Stephen E Mshana et al., 2009)

Abbreviations

ASB: Asymptomatic bacteriuria
BMC: Bugando Medical Centre
ESBL: Extended spectrum beta-lactamase
GNB: Gram-negative bacteria
MNH: Muhimbili National Hospital
UTI: Urinary Tract Infection

Diarrheal Infections

Prevalence and etiologic agents

Diarrheal infections are a serious threat to children in Tanzania and represent 1 of the 5 diseases accounting for 70 percent of childhood deaths (World Health Organization, 2005). 19 percent (1.87 million children) of global under five child deaths were attributed to diarrhea. 1.46 million were in WHO South East Asia and Africa region where by Tanzania was among the 15 developing countries bearing 73 percent of (1.46 million) (Boschi-Pinto, & Shibuya, 2008). WHO African and South-East Asia Regions combined contain 78percent (1.46 million) of all diarrhea deaths occurring among children in the developing world; 73 percent of these deaths are concentrated in just 15 developing countries.

In a 2010 demographic and health survey given to women in households with children under 5 years old, respondents were asked to report if the child had diarrhea in the two weeks prior to the survey. Most (77 percent) respondents came from rural areas. Approximately 15 percent of caretakers reported that the child had had diarrhea in the two weeks prior to the survey. Diarrhea was significantly more common in the younger age groups (ages 0-11 months and 12-23 months) compared to children two years of age and older. It was found that almost half of the children (49 percent) with diarrhea had been given antibiotics and for 63 percent of children receiving antibiotics, no other treatment was given (Kahabuka, Kvåle, & Hinderaker, 2013).

Diarrheal diseases can be caused by a number of organisms including bacteria, viruses, and parasites. The WHO recommends oral rehydration and zinc supplementation for treating diarrhea, and does not routinely recommend treatment with antibiotics, as they are ineffective against many pathogens that cause diarrhea (MOST, 2005). Antibiotics are only recommended for diarrhea treatment in the cases of dysentery (blood in stool) and cholera, which do not account for the majority of diarrhea cases in Tanzania, as described in the following section.

A study seeking to determine the etiology of disease amongst children under 5 presenting to study sites in Dar es Salaam with diarrhea was able to determine an etiologic agent in about two-thirds (67 percent) of cases. From pathogens tested (see table 3-4 for more information), bacteria and viruses accounted for a similar proportion of diarrhoeal infections (33.2 percent and 32.2 percent, respectively), whereas parasitic pathogens were identified for only 19.2 percent of infections. Results, however, differed by age group. Bacterial pathogens (mainly diarrheagenic *E. coli*, DEC) were the most common cause of diarrhea in children aged zero to six months, while viruses were most common among children in the seven to twelve month age group (Sabrina J Moyo et al., 2011). Caution should be used in interpreting the percentages of infections attributable to bacteria, viruses, and parasites, as some known diarrhea-causing pathogens were not tested for.

Stool samples from children in Dar es Salaam and Ifakara both found DEC to be most prevalent (Sabrina J Moyo, Maselle, Matee, Langeland, & Mylvaganam, 2007; Vargas et al., 2004). One found seasonal variation of the pathogens were two isolates were more common in the dry season; enteroaggregative *E. coli* (63 percent versus 35.5 percent) and *Shigella* spp. (24 percent versus 12 percent). Enterotoxigenic *E. coli* (51.6 percent versus 20 percent) was more prevalent in the rainy season (Vargas et al., 2004)

Rotavirus, one type of pathogen causing diarrheal disease, was responsible for about 6 percent of deaths in children under five in Tanzania in 2008 (PATH, 2012). As mentioned earlier, as of January 2013, rotavirus vaccine was incorporated into routine immunizations and since then as a component of surveillance, the country started to implement the Rotavirus Vaccine Impact Assessment and Intussusception Surveillance within 7 rotavirus surveillance sentinel sites: Bombo Hospital (Tanga Region), Bugando (Mwanza), Mbeya Referral Hospital (Mbeya Region), MnaziMmoja (Zanzibar), Mwananyamala Hospital (Kinondoni) Temeke Hospital (Temeke), Mawenzi Hospital (Kilimanjaro) and Dodoma Hospital (Dodoma) (Ministry of Health and Social Welfare, 2013a). As of yet, there is no information on the status of rotavirus coverage.

Treatment

In practice, most cases of diarrhea are treated empirically with antibiotics (Gwimile et al., 2012), particularly erythromycin and cotrimoxazole as a part of the IMCI and it is these drugs that sensitivity tests have revealed a steep decline for their effectiveness as outlined in the table below. A met-analysis of more than 200 studies in the 1970s and 1980s showed that utilization of Oral rehydration solution, ORS could reduce diarrhea mortality by up to 93percent (Munos, Walker, & Black, 2010). It has been shown consistently that trained personnel in IMCI translate to a better care given at all levels of a health facility (Gouws et al., 2004). This includes justified antimicrobial use and relevant critical information to the caregivers of young children (Schellenberg et al., 2004). Children were more likely to be given ORS/HRS if they had attended a healthcare facility but with differing practices amongst level of health care facility. When patients were attended solely at a higher level hospitals they were most prescribed with ORS (75.9 percent) followed by primary health centre (73.4 percent). Pharmacies scored lowest at 57.5 percent (Kahabuka et al., 2013).

As far back as in the 1990s, studies in Ifakara, have revealed multiresistant organisms in diarrheal disease etiologic agents. One found 38 percent of DEC to be multi-resistant (Vila et al., 1999) and another found *Shigella* strains resistant to various antibiotics (Navia et al., 1999). Nalidixic acid-resistant *E. coli* strains were detected and the authors predicted increasing quinolone resistance (Navia et al., 1999; Vila et al., 1999). This has however not been demonstrated in studies to date (Sabrina J Moyo et al., 2011; Temu et al., 2007). In these more recent studies, DEC had high rates of resistance to cotrimoxazole (90.6 percent) and ampicillin (96.9 percent) and moderately so to chloramphenicol (56.2 percent) (Sabrina J Moyo et al., 2011). A smaller study conducted later on, extracted samples from health facilities in Mwanza and examined the antimicrobial susceptibility of *Shigella* species isolated from patients presenting with bloody diarrhea. All of the strains were highly resistant to ampicillin, tetracycline, cotrimoxazole and chloramphenicol (Temu et al., 2007).

Prevention

The early introduction of potentially contaminated food or water to infants likely contributes to diarrheal disease in Tanzania. In a study mentioned earlier, only 11.8 percent of infants aged 0-6 months were exclusively breastfed (Sabrina J Moyo et al., 2011). A review of studies conducted globally, examined populations of low- and middle-income countries conducted over 20 years on the enteric pathogens; *Shigella*, *S. enterica* serotype typhi, and enterotoxigenic-*E. coli* (ETEC). This study determined a notable decreasing incidence of diarrhea with better sanitation practices concluding that enteric infections are environmentally determined and therefore critical role of prevention (Miller, Sentz, Rabaa, & Mintz, 2008). Several ministries—Health and Social Welfare, Education and Vocational Training, Water and Infrastructure, and the PMO-RALG—have shown dedication to improving water, sanitation and hygiene for better health outcomes. The interventions carried out are outlined within a Memorandum of Understanding between all involved (Government of the United Republic of Tanzania and UNICEF 2010). Amongst 25 of the most important causes of disability adjusted life years (DALYs) in Tanzania, diarrheal diseases have exhibited the largest decline in mortality with a 56 percent decrease in 20 years (1990 to 2010) (Institute for Health Metrics and Evaluation, 2012).

Table 3-4. Studies of diarrheal infections with relevance to antibiotic resistance

Study Population(children under five year)	Results and etiological agents	Significance	Author and year
280 children in Dar es Salaam with acute and persistent diarrhea hospitalized at MNH.	DEC was detected in 22.9%, of which enteroaggregative- <i>E. coli</i> (EAEC) was most prevalent, accounting for 14.6% of all cases of diarrhea.	Typical strains of EAEC and EPEC are common in children in Dar es Salaam.	(Sabrina J Moyo et al., 2007)
451 stool specimens collected (348 from the dry season and 103 from the rainy season) from patients admitted for diarrhea in St. Francis Hospital in Ifakara, 1996-1997.	DEC accounted for 35.7% of cases, followed by <i>Shigella</i> (24%) during dry and wet season and rotavirus (12.6% in dry season, 3.9% in wet season).		(Vargas et al., 2004)
280 children in Dar es Salaam with acute and persistent diarrhea hospitalized at MNH	Pathogens identified included bacteria (<i>E. coli</i> , <i>Vibrio cholerae</i> , <i>Salmonella</i> spp and <i>Shigella</i> spp.), viruses (rotavirus, norovirus, adenovirus and astrovirus) and intestinal protozoans (<i>Cryptosporidium parvum</i> and <i>Giardia lamblia</i>)	DEC, <i>C. parvum</i> , rotaviruses and noroviruses are major causes of acute watery diarrhea, which is common, particularly in the dry season.	(Sabrina J Moyo et al., 2011)
Stool specimens of 346 children with acute diarrhea in Ifakara, Tanzania.	DEC is highly resistant to first-line antibiotics, including erythromycin (90.6%) and cotrimoxazole (90.6%) Only DEC results reported. Resistance rates: cotrimoxazole: EAggEC (90.8%), ETEC (79.5%), EPEC (90.4%) ampicillin: EAggEC (83.1%), ETEC (84.1%) EPEC (90.4%). All susceptible to ciprofloxacin.		(Vila et al., 1999)
Children admitted to St Francis Designated District Hospital.	86 <i>Shigella</i> spp. isolates: <i>S. flexneri</i> (90%), <i>S. dysenteriae</i> (4.6%), and <i>S. sonnei</i> (4.6%) Resistance rates for <i>S. flexneri</i> ampicillin (92%), cotrimoxazole (91%). All susceptible to nalidixic acid, ciprofloxacin, cefotaxime, ceftazidime, cefoxitin.		(Navia et al., 1999)
489 children and adults with bloody diarrhea (median age 20 years, 27% inpatients) attending Sekouture Regional Hospital and Butimba Health Centre	62 isolates: <i>S. flexneri</i> (90 %), <i>S. dysenteriae</i> (10%). Resistance to ampicillin and cotrimoxazole approaching 100% for both pathogens.		(Temu et al., 2007)

Abbreviations

DEC: Diarrheagenic *Escherichia coli*

EAggEC : Enteroaggregative *E. coli*

EPEC: Enteropathogenic *E. coli*

ETEC: Enterotoxigenic *E. coli*

Sexually Transmitted Infections (STIs)

Prevalence

The bacterial pathogens *Neisseria gonorrhoeae*, *Chlamydia trachomatis* and *Treponema pallidum* are responsible for gonorrhea, chlamydia and syphilis, respectively. Together with *Trichomonas vaginalis*, a protozoan parasite, they comprise the four readily curable STIs. STIs have a multitude of negative consequences such as pelvic inflammatory disease, cervicitis, infertility, neonatal conjunctivitis (WHO, 2014). Adverse pregnancy outcomes of syphilis such as miscarriages, low birth weight, premature births and others have been studied in Tanzania (Watson-Jones et al., 2002). Furthermore, the presence of certain STI increases the risk of acquiring HIV through unprotected sex.

Women with gonorrhea were found to have a 5.5 times the risk of intrauterine HIV. In addition, syphilis infected women were more likely to transmit HIV during pregnancy (Chiduo et al., 2012). The WHO African region had an estimated 92.6 million incidences of STI and prevalence of 74.4 million in 2008 (WHO, 2012). According to the Tanzania Demographic and Health Survey conducted in 2010, 3 percent of men and women self-reported experiencing STI symptoms, although this number may be low due to underreporting (National Bureau of Statistics & ICF Macro, 2011). Several recent studies have quantified the burden of STIs in Tanzania (Table 3-5.1).

Diagnosis and Treatment

In Tanzania, as in many countries, most STIs are diagnosed clinically, without laboratory confirmation. Because many infections cause no symptoms, however, many cases are missed. Several studies confirm this. In one study, the sensitivity of syndromic diagnosis was only 2 to 17 percent (Ghebremichael, 2014).

Another study concluded that the syndromic approach is a failed approach (Yin et al., 2009). The need for improved diagnosis and consequently treatment of these infections is critical in confronting the challenges in the Millennium Development Goals 4, 5 and 6. This means seeing to a reduction in infant mortality, maternal morbidity/mortality and incidence of HIV (WHO, 2012).

In Tanzania, the syndromic management of STI follows guidelines that specify benzathine penicillin, cotrimoxazole, doxycycline, with or without metronidazole in women (Ministry of Health and Social Welfare, 2013b).

In Tanzania, pregnant women diagnosed with syphilis are treated with benzathine penicillin. The prevention of mother to child transmission of HIV (PMTCT) programme was seen as an opportunity for improving syphilis screening (Watson-Jones et al., 2005) drawing lessons for strengthened antenatal services for the PMTCT.

Resistance rates

Gonorrhoea and syphilis are often resistant to first-line antibiotics. Increasing resistance of *N. gonorrhoeae* has been documented worldwide (Unemo & Shafer, 2014). Two studies in Tanzania, 13 years apart, support this (see table 3-5.2). In the earlier study, isolates were susceptible to all antibiotics tested (ciprofloxacin, ceftriaxone, cefuroxime and spectinomycin), except a 9 percent resistance to cotrimoxazole (the first-line treatment). The more recent study in 2012, though conducted within a small study group, showed high resistance rates to ciprofloxacin (77.7 percent) which had replaced cotrimoxazole as first line, such that the authors urged for a fresh review of current STI guidelines (Buhalata et al. 2013 ; Changalucha et al. 2002).

Prevention

Tanzania has made considerable efforts in prevention of STIs, mainly aimed at HIV prevention. The government has released a number of health messages through mass media that advocate for condom use. Access to condoms has been studied amongst commercial sex workers. A study in high-risk areas found steadily increasing access, the latest figure being 76 percent access in 2009 (Central and Northern zone, 80 percent; Lake zone, 55 percent) (PSI, 2009).

Despite these efforts, a recently published study found little behavioral change, with young people engaging in unprotected sex (male: female 40.0percent: 37.5percent) and multiple sexual partners (10.6percent of males and 15.9percent of females). Up to 50 percent were unaware of the HIV status of their partners (Mhalu, Leyna, & Mmbaga, 2013). Male circumcision has been found to reduce the rate of HIV transmission by 60percent (Auvert et al., 2005), hence a worthy intervention to encourage in light of the challenges associated with behavioral change. However, Voluntary Medical Male Circumcision (VMMC) requires regular improvement and monitoring for a scale-up that ensures sustainability (Jennings et al., 2014).

An innovative method still under investigation is conditional cash transfers for STI prevention (Heise, Lutz, Ranganathan, & Watts, 2013). This has been demonstrated in rural Tanzania via the RESPECT study, in which randomly selected participants were compensated regularly with every negative test to *C. trachomatis*, *N. gonorrhoeae* and *T. vaginalis*. Other STIs tested were HIV, *Herpes simplex virus 2* and syphilis, but only at baseline and 12months after the start of the study (de Walque et al., 2012).

Table 3-5.1. Studies showing prevalence of sexually transmitted infections

Study Population	Results and etiological agents	Significance	Author and year
17,813 pregnant women attending 57 antenatal clinic (ANC) clinics in Tanzania.	HIV prevalence of 8.7% varying by region with 25 – 34 age groups being most affected (11%). 7.3 % prevalence of syphilis; 35–49 yrs (10.4%) was the most affected age group.	A need for greater HIV testing and counseling services at ANC clinics along with antiretroviral drugs	(R. O. Swai et al., 2006)
Data from antenatal clinic (ANC) collected retrospectively on syphilis and HIV, and prospectively from 105 HIV-positive and 100-negative women	Decline in syphilis prevalence over 3 study years (3.1%, 1.4%, and 1.3%, respectively) without accompanying decrease of HIV cases (6.1%, 6.4%, and 5.4%, respectively). HIV was associated with higher prevalence of trichomoniasis (18.8% versus 5.0%; $P < 0.003$) and candidiasis (16.5% versus 2.0%; $P < 0.001$). This was not seen for gonorrhoea, chlamydia and syphilis.		(Chiduo et al., 2012)
1296 women attending 6 ANC in rural Manyara and Singida regions in catchment area of Haydom Lutheran Hospital.	HSV2 antibodies prevalence: 20.7%. Low syphilis prevalence (1.6%) compared to an earlier study was attributed to syndromic management of STI since 1999. HIV prevalence: 2%.	Since HIV had such a low prevalence rate, possibility for more effective prevention measures via control of other STIs especially in pregnant women.	(Yahya-Malima, Evjen-Olsen, Matee, Fylkesnes, & Haarr, 2008)
1,418 blood and 1440 urine samples from women aged 20–44 in Moshi urban district	Prevalence of HSV-2 (45.8%), HIV (11.6%) and <i>Trichomonas</i> (10.8%). Other STIs studied were collectively below 5.0%. The CAGE score revealed 15% of the study participants to be alcohol abusers. Abusers were more likely to be women with a history of physical (OR=2.05; 95% CI: 1.06–3.98) and sexual violence (OR=1.63; 95% CI: 1.05–2.51). Additionally since alcohol abuse was associated with an increased number of sexual partners, it can be regarded to indirectly associate with STI acquisition.	Alcohol use can be a useful indicator for expanded STIs and HIV prevention programmes in women from sub-Saharan Africa.	(Ghebremichael, Páintsil, & Larsen Ulla, 2009)

Study Population	Results and etiological agents	Significance	Author and year
567 men gave blood samples and 588 men gave urine samples from Moshi municipality.	Prevalence of HSV-2, 39.2%; HIV, 6.5%.	Women are most affected by HIV in sub-Saharan Africa and this study found a high prevalence amongst the studied men. Programmes should therefore target young men for an overall benefit.	(Chebremichael & Painsil, 2011)
600 Female bar workers from Mbeya.	3-monthly information and education sessions on HIV/STI and reproductive health reduced prevalence of gonorrhoea (22.2% to 6.8%).		(Gabriele Riedner et al., 2006)
2654 3 rd trimester pregnant women attending ANC in Majengo and Pasua, Moshi urban district	Prevalence of HSV-2, 33.6%; HIV, 6.9%; active syphilis, 0.9%.	Comprehensive control measures for HIV can be instituted via control of other STIs particularly in pregnant women.	(Msuya et al., 2009)
448 people from fishing community of Mwanza region. Genital (vaginal and cervical) samples and venous blood.	Prevalence of syphilis, 14.3%; HIV, 9.8%; HBV, 9.2%; HCV, 5.6%. Regular alcohol usage was significantly associated with HIV.	Prevalence of STIs are higher among this community than the general population.	Kabamanya, Abade A and Aboud S (Muhimbili university of health and allied sciences (MUHAS), 2014)
1829 women from sub-Saharan Africa multisite study from Blantyre, Lilongwe, Dar es Salaam and Lusaka, included 1558 HIV-infected and 271 uninfected pregnant women.	No difference in morbidity or mortality by providing antibiotics prenatally and perinatally to both groups of women.	Chemoprophylaxis with antibiotics (metronidazole, erythromycin and ampicillin) does not offer added advantage over placebo to both HIV positive and negative pregnant women.	(Aboud et al., 2010)
958 women from Moshi and other areas in South Africa and Zambia at risk of STIs	Bacterial STI prevalence: chlamydia (5.8 PYAR), syphilis (4.7 PYAR), gonorrhoea (3.3 PYAR).	High prevalences calling for expanded STI prevention programmes	(Kapiga et al., 2009)
2270 (86%) HIV-infected and 366 (14%) HIV-uninfected women attending ANC in four sub-Saharan countries including Tanzania (Dar es Salaam).	7.3% of HIV-infected and 2.6% of HIV-uninfected women had syphilis.	Incorporate HIV and syphilis diagnosis and treatment plans with antenatal programmes.	(Potter et al., 2006)
1305 HSV-2 seropositive women working in STI high risk conditions (working in bars, guesthouses etc).	Prevalence of bacterial vaginosis among these women was 62.9%. Nugent scoring ⁸ of 9-10 was 16.1%.	Practices that change vaginal flora may be associated with the occurrence. Need for further exploration on the subject	(Baisley et al., 2009)

⁸ Nugent scoring is a method of diagnosing bacterial vaginosis by microscopic identification of Gram stained sample.

Table 3-5.2. Studies of sexually transmitted infections with relevance to antibiotic resistance

Study Population	Results and etiological agents	Significance	Author and year
320 women with genital discharge syndromes (GDS) who presented at the OPD or STI clinic in Mwanza	Prevalence of bacterial vaginosis (25.9%), vaginal candidiasis (25.6%), <i>N. gonorrhoeae</i> (8.4%). High resistance rate to ciprofloxacin.	International travel and drug selection pressure secondary to widespread use of ciprofloxacin may be responsible for high resistance rate.	(Buhalata et al., 2013)
570 female and 241 male patients from Sekou Toure hospital, Mwanza STD clinic; 249 females with vaginal discharge from women's centre in Mwanza city; 294 swabs from Rwandan males with urethral discharge, from refugee camp in Ngara.	Penicillinase production in 25-74% of gonococci species. Resistance to cotrimoxazole, 9-22%; to erythromycin, 5%.	Cotrimoxazole may be ineffective as syndromic treatment for genital discharge.	(Changalucha, West, Rwakatare, & Marealle, 2002)
328 participants with primary and latent syphilis in Mbeya.	Trial of azithromycin vs penicillin G benzathine. Cure rates similar: azithromycin, 97.7%; penicillin G, 95.0, 3 and 6 months after treatment.	A single dose azithromycin may be a good alternative antibiotic for treatment of Syphilis however resistances already reported in the US permit only a cautious use.	(G Riedner et al., 2005)

Abbreviations

ANC: Antenatal clinic

HBV: Hepatitis B virus

HCV: Hepatitis C virus

HIV: Human immunodeficiency virus

HSV: Herpes simplex virus

OPD: Outpatient department

PYAR: Person years at risk

STI/D: Sexually Transmitted Infection/Disease

Health Care Associated Infections (HAIs)

Prevalence

HAIs include health-care-associated urinary tract infections (UTIs), surgical site infections (SSI), hospital-acquired pneumonia or ventilator-associated pneumonia, and health-care-associated bloodstream infections. ESBL-producing Gram-negative bacteria are a major cause of HAIs. Given the difficulty in defining HAIs, the complex diagnostic processes, and limited surveillance, the prevalence of HAIs in Tanzania is difficult to estimate. The few studies that have estimated the burden of HAIs in Tanzania have reported that about one-quarter of hospital admissions result in HAIs, the most common pathogens being *S. aureus*, enterobacteriaceae species, particularly *E. coli*, and *Klebsiella* spp (see table 3-6).

In addition to the morbidity associated with HAIs, delayed recovery and lengthened hospital stay has economic costs. In extreme cases, patients die from these infections, many of which are caused by multi-resistant organisms that can be difficult to detect and treat. Studies outlined in the table below give a picture of the magnitude of the HAIs and susceptibility patterns in that setting.

Treatment

Pseudomonas aeruginosa is a hospital-associated infection that often requires carbapenems for treatment (Kanji&Kanafani, 2011). The table below shows studies that have been conducted in the country describing carbapenemase production by this pathogen and associated genes.

Prevention

The case for prevention of HAIs cannot be overemphasized and several studies call for greater infection prevention and control measures at hospitals. A nosocomial non-typhoidal meningitis outbreak among 24 children at a rural hospital in northern Tanzania abated after the hygienic practices were improved (Vaagland et al., 2004). One notable case was when the TFDA required, effective May 2010, the use of auto-disable syringes only—syringes that become unusable after a single use. A systematic review of cerebral malaria (degedege) found nosocomial bacteremia to explain 6-8 percent of fevers at MNH in Dar es Salaam. Bacteremia was seen to cause more deaths than malaria at this hospital highlighting the role of HAIs in accounting for negative outcomes (Reid, 2010) a traditional proscription of injections for the treatment of cerebral malaria (degedege).

Injections were also found to associate with incidences of HAIs and increased patient care costs in Temeke district hospital (now called Temeke regional referral hospital). Upon intervention with the auto-disable syringe, the chief medical officer reported savings of US \$280 off a seven-day course of antibiotics, as well as saved bed costs and intensive care for each patient (Taylor, 2005)

Other primary prevention methods include reduction of SSIs by use of pre-surgical antimicrobial prophylaxis in place of long courses of post-surgery antibiotics. It has, however, been found that 30 to 90 percent of antibiotics are prescribed inappropriately for surgical prophylaxis. Errors found were in timing of the antibiotic and prolonged duration given (Munckhof, 2005), possibly adding to the selection pressure for resistant bacteria (Al-Momany NH, Al-Bakri, Makahleh, & Wazaify, 2009). One study at MNH and Muhimbili Orthopedic Institute established that the duration and timing of prophylactic antibiotics did not follow guidelines. The authors attributed to these errors a high rate of antibiotic resistance (Manyahi, 2012). Two studies have compared pre-surgery prophylaxis with post-surgery antibiotics in Tanzania. One found a striking reduction in development of SSIs (from 21.6 percent to 4 percent) by applying preoperative antibiotic prophylaxis in a rural hospital (Saxer et al., 2009). The second study, in a Mwanza hospital (BMC), found that, although not statistically significant, occurrence of SSI among those who received pre-operative prophylaxis of antibiotics was 15 percent as opposed to 28 percent of patients who received them post operatively. Only 16 percent of the 941 patients who underwent major surgery received the appropriate preoperative antibiotic prophylaxis, and the authors recommended surgeons be informed of the best practices to reduce SSI rates (Mawalla, Mshana, Chalya, Imirzalioglu, & Mahalu, 2011). In view of the high rates of resistance to antibiotics commonly prescribed for infections in Tanzania, it is essential to review the prophylactic post surgical extended dose currently being practiced.

Table 3-6. Studies of health care associated infections with relevance to antibiotic resistance

Study Population and sample	Results and etiological agents	Significance	Author and year
<p>Samples from 50 patients in the MNH ICU suspected to have a nosocomial infection: 30 UTIs, 15 wound infections, 3 blood stream infections and 2 cases of pneumonia.</p>	<p>39 Gram-negative bacteria were isolated, of which 28.2% were ESBL producing.</p> <p>Both ESBL and non ESBL producing isolates were highly resistant to commonly used antibiotics.</p> <p>Genetically unrelated strains had similar SHV, TEM and CTX-M genes, suggesting horizontal transfer of these genes within the ICU. However, there was also evidence of clonal spread of the resistant bacteria.</p>	<p>A similar genetic relation between isolates from ICU patients and those from the paediatric ward (Blomberg et al., 2005) suggests dissemination of the ESBL gene within the hospital.</p> <p>Supports more stringent hospital IPC policies.</p>	<p>(Ndugulile, Jureen, Harthug, Urassa, & Langeland, 2005)</p>
<p>613 adult patients admitted for surgery at St Francis designated district hospital and sterile swabs from surgical site.</p>	<p>SSI prevalence was 23.5% and wound classification was not an independent predictor for SSI. Explained by unsatisfactory sterilization, little time between surgeries, few instrument sets for adequate sterilization and holes in surgical drapes.</p> <p><i>S. aureus</i> was the commonest isolated pathogen with prevalence of 37%; one strain was MRSA. <i>E. coli</i> and <i>Enterococcus</i> spp followed with prevalence of 11% and 5%, respectively. Of these, 18% were multiresistant ESBL-producing and 3 <i>Enterococcus</i> isolates were also resistant to vancomycin.</p>	<p>Factors contributing to low predictability for development of a SSI should be corrected for in the National Nosocomial Infections Surveillance system score to ensure reliability and usefulness of the tool.</p> <p>Worrisome evidence of multiresistant pathogens and genes in this rural population.</p>	<p>(Fehr et al., 2006)</p>
<p>Sterile swabs from surgical site of 941 patients who underwent major surgery at Bugando Medical Centre</p>	<p>26% prevalence of SSI; strong predictors identified.</p> <p>SSI rates for the 57 patients with co-morbidity, particularly HIV infection, were 70.2% compared to the 38.4% rate amongst those without.</p> <p>Cigarette smoking was another predictor; 84.8% of those who smoked developed SSI.</p> <p>Use of a drain and skin preparation with iodine alone prior to surgical manipulation also increased risk of SSI.</p> <p>Commonest isolated bacteria: <i>S. aureus</i> (28.6%), <i>E. coli</i> (25%), <i>K. pneumoniae</i> (17.9%).</p> <p>High rates of resistance to ciprofloxacin: 86%, 80% and 54% in <i>E. coli</i>, <i>K. pneumoniae</i> and <i>S. aureus</i>, respectively.</p> <p>ESBL production: <i>E. coli</i>, 65%; <i>K. pneumoniae</i>, 80%. This conferred resistance to first, second, third and fourth generation cephalosporins.</p> <p>MRSA: <i>S. aureus</i>, 19%.</p>	<p>Supports stronger prevention strategies to reduce SSI rate.</p>	<p>(Mavalla et al., 2011)</p>

Study Population and sample	Results and etiological agents	Significance	Author and year
<p>Gauging prevalence of clindamycin-inducible resistance of MRSA from 600 clinical specimens (pus, wound swabs, aspirates) in patients admitted at BMC surgical wards</p>	<p>26.6% of pathogens isolated were <i>S. aureus</i>, of which 16.3% were MRSA, which were resistant to cotrimoxazole (92%). Clindamycin-inducible resistance (iMLSB) was significantly higher in MRSA isolates (61%) versus MSSA isolates (22%).</p>	<p>Clindamycin is used to manage infections by both MSSA and MRSA therefore the high resistance values observed highlight the need for routine susceptibility tests of these isolates to it.</p>	<p>(S E Mshana et al., 2009)</p>
<p>160 <i>S. aureus</i> strains recovered from clinical specimens of wound swabs (428), pus (108), and nasal swabs (64) from wards at Bugando Medical Centre</p>	<p>MRSA: 15% of isolates. Most isolates of ST88 group, geographically similar to rest of the Africa, suggesting African reservoir. During this pioneering mapping of the molecular epidemiology of MRSA, the newest Tanzanian MRSA clone (ST1797/t7231) was also isolated.</p>	<p>Supports urgent improvements in general IPC measures in the hospital, including simple personal hygiene routines and regular staff screening.</p>	<p>(Moremi et al., 2012)</p>
<p>1260 routine clinical specimens from blood, wound swabs, urine and pus from 700 adults, 600 neonates and 60 children. Most isolates were from blood cultures in neonatal unit (64%) and its intensive care- units (36%).</p>	<p>ESBL producers: 50.3% of <i>K. pneumoniae</i> isolates BlaCTX-M-15 ESBL allele was predominant, in 76% of isolates.</p>	<p>This study calls for supports regular antibiotic resistance surveillance to map out the status of ESBL production among neonates where the infection is commonly found to be hospital associated.</p>	<p>(Stephen E. Mshana, Hain, Domann, Lyamuya, & Chakraborty, 2013)</p>
<p>Rectal swabs of 113 post-delivery women and their respective neonates (126) from the obstetrics wards, neonatal wards and ICU at BMC.</p>	<p>ESBL carriage: 15% among post-delivery women and 25.4% among neonates. ESBL isolates in mothers: <i>E. coli</i> (30%), <i>Enterobacter</i> spp (20%). ESBL isolates in neonates: <i>K. pneumoniae</i> (77.1%) <i>E. coli</i> (14.3%). Gastrointestinal ESBL strains among pregnant women were generally different phenotypically from strains in newborns, so were not considered source of infection.</p>	<p>Though these findings suggest an environmental component to the neonate acquisition of infection, further studies required to investigate this.</p>	<p>(Nelson et al., 2014)</p>

Study Population and sample	Results and etiological agents	Significance	Author and year
<p>Cross-sectional laboratory study on 227 Gram-negative bacteria from isolates of pus (112), urine (56), blood (55), aspirate (3) and sputum (1)</p>	<p>Cultured organisms: <i>K. pneumoniae</i> (33.5%), <i>E. coli</i> (24.7%), <i>P. aeruginosa</i> (18.1%). Multi drug resistant isolates were selected when organisms were resistant to at least three antibiotics. 78% were found to be ESBL producing.</p> <p>Urine (39.29%) and blood specimens (36.36%) had highest prevalence of carbapenemase genes.</p> <p><i>E. coli</i> (14%), <i>K. pneumoniae</i> (10.57%) and <i>P. aeruginosa</i> (10.13%) had highest rates of carbapenemase gene.</p> <p>35% with one or more carbapenemase genes, including a low prevalence of NDM-type metallo-beta-lactamase. Other genes were IMP-types (21.59%) and VIM (12%).</p>	<p>High prevalence of carbapenem resistance genes amongst multidrug resistance Gram- negative bacteria isolates supports routine testing of severe systemic infections.</p>	<p>(Mushi, Mshana, Imirzaioglu, & Bwanga, 2014)</p>
<p>Laboratory based study involving 172 multi- drug resistant <i>K. pneumoniae</i> and <i>P. aeruginosa</i> from clinical specimens: blood (76), pus (74), urine (20) and aspirates (2).</p>	<p>113 were ESBL <i>Klebsiella</i>, 39 were ESBL non producing <i>P. aeruginosa</i> and 20 (33.9%) were ESBL producing <i>P. aeruginosa</i>.</p> <p>48.7% of the ESBL producing <i>K. pneumoniae</i> isolates were susceptible to piperacillin; 54 of the 59 (92%) <i>P. aeruginosa</i> isolates were susceptible.</p>	<p>Authors recommended piperacillin-tazobactam for treatment of HAls as alternative to more expensive carbapenems, assuming access to susceptibility testing.</p>	<p>(Petro et al., 2014)</p>
<p>100 patients with suspected SSIs, from MNH and Mulhumbili Orthopedic Institute (MOI)</p>	<p>77.5% Gram-negative bacilli, 22.5% Gram-positive</p> <p>Common isolates: <i>P. aeruginosa</i> (16.3%), <i>S. aureus</i> (12.2%) and <i>K. pneumoniae</i> (10.8%).</p> <p>MRSA: <i>S. aureus</i> (44.4%)</p> <p>ESBL: <i>E. coli</i> (92.3%), <i>K. pneumoniae</i> (69%).</p> <p>Resistance to ceftriaxone was 100%, but most was sensitive to ciprofloxacin.</p>	<p>Ceftriaxone was the most commonly used agent for surgical antimicrobial prophylaxis at the two hospitals.</p> <p>There is a need for guideline review with possibility of adopting ciprofloxacin as first-line antibiotics for empirical treatment of SSIs.</p>	<p>(Manyahi, 2012)</p>
<p>Wound swabs from 100 patients with suspected SSIs from MNH</p>	<p>93 of the 147 pathogenic bacteria isolated were multiply resistant (MDR) with around 61% MDR rates amongst both the Gram- positive and Gram-negative isolates. MDR was amongst all <i>E. coli</i>, <i>A. baumannii</i> and <i>P. stuartii</i>.</p> <p>Most of the Gram-negative bacteria (90%) had resistance to over four antibiotics classes</p>	<p>A swift revision of antibiotic prescribing practices are at the national hospital is required.</p>	<p>(Manyahi et al., 2014)</p>

Study Population and sample	Results and etiological agents	Significance	Author and year
169 admitted patients and 47 healthcare workers at two Muhimbili ICUs.	MRSA colonization among patients and healthcare workers: 11.83% and 2.1%, respectively. 85.7% of isolates sensitive to vancomycin, all resistant to penicillin and erythromycin.	History of diabetes and a history of illicit drug use were risk factors for resistance.	(Geofrey, 2013)
Blood culture samples from 23 children and spinal fluid cultures from 16 children with suspected meningitis and/or septicemia at Haydom Lutheran Hospital, aged 1 day -6 years	Outbreak of <i>S. enteritidis</i> was only amongst neonates and most were ill before leaving hospital. Of first-line drugs, organism susceptible only to gentamicin; resistant to ampicillin and chloramphenicol. High mortality rates (100% with meningitis), despite use of gentamicin, which does not satisfactorily cross blood-brain barrier.	A clonal outbreak of <i>S. enteritidis</i> accounted for the bacteremia and meningitis infection. This information coupled with the genotype and resistance pattern favors a nosocomial source of the infection. The third generation cephalosporins are known to be effective against this pathogen but unattainable to most due to the cost.	(Vaagland et al., 2004)
90 blood and pus isolates from central pathology laboratory of the MNH	Carbapenem resistance was found amongst children aged 0-10 years in 8.9 percent of the isolates. All isolates also harbored blaVIM-2, conferring broad spectrum beta lactam resistance. This was the first observation of VIM-2 producing <i>Pseudomonas aeruginosa</i> associated with ST640.	This further cemented the evidence of aglobal distribution of blaVIM-2 and greater complexity of the mechanism of resistance of <i>P. aeruginosa</i> . This was cause for greater call for a global surveillance to understand these mechanisms.	(Sabrina Moyo et al., 2015)

Abbreviations

- ESBL: Extended spectrum beta-lactamase
 ICU: Intensive care unit
 IPC: Infection prevention and control
 MDR: Multidrug resistance
 MNH: Muhimbili national hospital
 MRSA: Methicillin-resistant *Staphylococcus Aureus*
 NDM-type metallo-beta-lactamases: New Delhi metallo-beta-lactamase
 SSI: Surgical site infection
 UTI: Urinary tract infection

BOX: Recent Initiatives in IPC

In the late 1990s, MOHSW initiated IPC activities through a variety of programs and development partners. In 2004, MOHSW issued National Infection Prevention and Control Guidelines for Health Care Services for all public and private health facilities. Since that first manual, the programme has continued to develop policy guidelines and standards along with building capacity of health care workers.

The programme was further supported by the U.S. President's Emergency Plan for AIDS Relief (PEPFAR) in 2003/2004, including an injection safety programme. Other stakeholders, e.g., TBS, TFDA and MSD were included in discussions.

The MOHSW has continued to develop guidelines, including: National Health Care Waste Management Policy Guidelines (2006), National Infection Prevention and Control Guidelines for Health Care Services in Tanzania (2007), Quality Improvement: Infection Prevention and Control Orientation, Guide for Participants (2008), and Health Care Waste Management Standards and Procedures (2012). Two additional documents are pending publication: the National Catalogue for Health Care Waste Management Equipment and Facility Options (2012) and Standard Operating Procedures for Waste Handlers.

Every health facility is required to have an infection control committee, according to a MOHSW directive. However, these committees, by and large, have not been active (and are the focus of a recommendation of this report).

IPC training was instituted in 2007 in the training curriculum of nurses and midwives, clinical officers and assistant medical officers. The Tanzania Nursing and Midwifery Council (TNMC) in 2012 had further reviewed the curriculum for the National Technical Award (NTA) level 4 -6 with the intention of strengthening contents of IPC and other quality improvement concepts.

There is still a need for curriculum revision to sensitize and inform all future health care providers prior their professional service, training on their role in preventing spread of diseases.

The MOHSW, in collaboration with Jhpiego (a non-profit research organization based in the United States), has convened a health-care associated infection technical working group, focused initially on post surgery HAIs, post caesarean section and post herniorrhaphy. A future goal is to reduce the risk of blood stream infections, which require more specialized and costly equipment (personal communication with Dr. Albert Komba Infection Prevention Project Director, Jhpiego, December 2013).

The Ministry of Health is dedicated to strengthening and supporting IPC practices, but has not yet been able to provide sufficient funds them. This is, however, a stated priority.

Surveillance for Bacterial Infections⁹

The IDSR system in Tanzania was introduced in 2011. The epidemiology unit of the MOHSW collects data on diseases and reports through IDSR. Laboratory surveillance of bacteria is performed at the regional, zonal and national laboratories, which have the capacity to diagnose bacterial infections. The IDSR has issued guidelines for specimen collection from all levels. The IDSR laboratory reports monthly on cholera, shigellosis, plague and meningococcal meningitis. National IDSR system links with National Health Laboratory Quality Assurance and Training Centre (NHLQATC) in all laboratory diagnostic and cases confirmations. All the isolates/samples of all reported cases in IDSR are sent to NHLQATC for

⁹ Information was provided by Dr. FaustaMoshia and Mr. Jacob Lusekelo on May 2014 from National Health Laboratory Quality Assurance and Training Centre (NHLQATC).

confirmation, antimicrobial susceptibility testing and strain storage.

The NHLQATC is in the diagnostic section of the MOHSW and is the first accredited laboratory in the country (with ISO 15189). It aims at supporting other labs to provide the community with quality services. It is a Public Health Laboratory that oversees external quality assurance of the 32 other laboratories for culture and susceptibility and techniques.

It engages in outbreak index case confirmation, surveillance and antimicrobial susceptibility testing of referred isolates. The microbiology unit has been involved in several bacterial surveillances such as African Cholera Surveillance Network (AFRICHOL), National Institute for Medical Research (NIMR), Mwanza gonococcal and ongoing enteric disease surveillance.

The laboratory has received assistance from various partners including important technical support from the American Society for microbiology, CDC, USA and the World Bank.

The Pediatric Bacterial Meningitis Surveillance Network began in 2002 with the goal of collecting data on laboratory confirmed cases of meningitis in children under five. Data collected from 2002-2008 across Africa revealed 69,208 suspected cases of meningitis, of which 4,844 were positive for *S. pneumoniae* (47 percent), *H. influenzae* (34 percent) and *N. meningitidis* (19 percent) (CDC, 2009).

In 2003, netSPEAR was established to collect and monitor data showing the number of pathogens detected in hospitals.

The Gonococcal Antimicrobial Surveillance Programme (GASP), a worldwide laboratory network started with regional focal points and in partnership with WHO regional office collected data on patterns of antimicrobial susceptibility in gonorrhoea in participating countries. After 2010, efforts to renew operations in Africa were made, including site visits to the National Reference Laboratory in Antananarivo, Madagascar and the National Institute for Medical Research in Mwanza, Tanzania (Lewis, 2011).

Other bacterial surveillance in the country includes the AFRICHOL Consortium that aims at bringing together key African and international cholera and surveillance experts to exchange information on existing cholera surveillance, share knowledge regarding disease burden, and assessing methods of cholera control in outbreak and endemic settings. AFRICHOL conducted a routine surveillance on cholera, collecting information on the existing types and individual susceptibility testing for 1 year in Temeke and Mwanza, Sekouture and Magu, which are areas with high cholera outbreak rates. Resistance to cotrimoxazole was noted in all diarrhea cases seen.

The overall East Africa Public Health Laboratory Networking Project (EAPHLNP) objectives are to support establishment of a network of efficient, high quality, accessible public health laboratories for the diagnosis and surveillance of enteric diseases among others. They are currently conducting an enteric research study in all the regions to study the pattern of bacterial causes and their susceptibility testing. The enteric pathogens include cholera and *Shigella*. Enteric disease surveillance (still ongoing) is conducted in all regions of Tanzania. There is a centralized system where data on these pathogens is collected from Zonal laboratories every month and is then analyzed. All regional laboratories are involved in the surveillance where labs with capacity to perform culture send isolates to NHLQATC for confirmation and antimicrobial susceptibility testing, and those labs without such capacity are sending direct stool/rectal swab to NHLQATC for testing and susceptibility testing.

A good system of communication is in place but is not well used, which causes delay in confirmation of outbreaks. Data should ideally be collected from zonal and regional labs but due to lack of supplies, culture and susceptibility testing, are not automated to routine workup and thus only few laboratories are reporting. Other challenges are unavailability of sample collection tools in the sites and which cause missing of samples that could be useful in surveillance.

CHAPTER 4:

Burden of Disease and antibiotic resistance in Food Animals

National Disease Burden

Tanzania produces a large number of livestock, but the high prevalence of bacterial disease in addition to the burden already posed by parasitic and viral diseases, is a barrier to improving productivity. This not only has financial implications, but also threatens food security. The social and economic costs of these diseases are most likely underestimated because they are poorly documented.

Even though the focus here is on bacterial diseases and their required antibiotic use, such diseases are only a part of the disease burden in Tanzania. Viral and parasitic diseases, such as tick-borne diseases (TBD), FMD, trypanosomiasis and helminthiasis are the most common diseases in large and small ruminants. ND, which is viral, is most prevalent in free-range chickens (Ministry of Health, 2012) and fowl typhoid in commercially raised chickens (Mtambo, FAO, 1999). The most common bacterial diseases are contagious bovine pleuropneumonia (CBPP) in cattle and contagious caprine pleuropneumonia (CCPP) in goats.

Little attention has historically been paid to the spread of disease between wildlife and livestock. However, several researchers have studied this phenomenon recently. Pastoralists have identified eight diseases as the most important diseases affecting cattle, sheep, and goats due to interaction with wildlife (Kideghesho, 2001): malignant catarrhal fever and lumpy skin disease, which are viral; CBPP, black quarter, anaplasmosis and anthrax, which are bacterial; and ECF and ormilo (turning sickness), which are parasitic. The spread of foot and mouth disease can also be attributed to the wildlife and livestock interactions, particularly through buffaloes, and in some cases of giraffe calves and impala at the Kenyan border.

Bacterial Disease in Farmed Animals

Large and small ruminants

TADs are a public health threat as these are highly infectious epidemics that spread across borders causing extreme morbidity and mortalities to animals with consequent human socioeconomic devastation. Bacterial TADs that are most common in cattle and goats include CBPP and CCPP.

CBPP

CBPP occurs in cattle and affects production through mortality and reduced productivity (Tambi, Maina, & Ndi, 2006). Antibiotic treatment may delay recognition of the disease, create chronic carriers and lead to emergence of resistant MmmSC strains (OIE-World Organization for Animal Health, 2009). This disease afflicts the lungs of some hooved animals such as cattle, buffalo, and yaks. Others such as sheep and goats are resistant to the disease. It has been reported in Asian yaks, American bison, and African cattle, but never in African buffaloes (Food and Agriculture Organization of the United Nations (FAO), 1997).

The most recent epidemics in Tanzania were in 1996 and 1999. However, the disease was reintroduced from Kenya in 1990 to the Arusha region after 25 years of no reports of the disease (Bölske, Johansson, Heinonen, Panvuga, & Twinamasiko, 1995; Tambi et al., 2006). Tanzania had the highest proportion (35.5 percent) of cases from 1995-2002 among member countries of the Pan African Programme for the Control of Epizootics (Tambi et al., 2006). The disease has emerged in 18 regions (52 districts).

CBPP spread to 54 out of 120 administrative districts of Tanzania (LJ Kusiluka & Sudi, 2003). This spread has amounted to an estimated loss of 350,000 cattle, valued at \$40 million, along with a compounded annual loss of USD 3 million nationally (Kitalyi & Njau, 2003).

The direct losses incurred from CBPP are animal mortality, vaccination campaign costs and disease surveillance in Tanzania. Indirect losses resulting from chronic disease are loss of weight and working ability, delayed marketing, reduced fertility and losses due to quarantine and the consequent reduced cattle trade (H M Msami, Ponela-Mlelwa, Mtei, & Kapaga, 2001).

CCPP

CCPP is a severe disease of goats characterized by respiratory distress, coughing and nasal discharge, with a high mortality rate. The disease is widespread in eastern Africa and the Middle East (Fao, 2011). It is caused by *Mycoplasma capricolum* subsp. *capripneumoniae*. Its symptoms include interstitial, fibrinous pleuropneumonia, interlobular edema and hepatization (consolidation of tissue into a liver-like solid mass) of the lung causing high mortality rates of up to 80 percent (FAO, 2012). Some antibiotics, such as tetracycline or tylosin can be used to treat it, if they are given early, but generally, other methods of control such as quarantine, slaughtering, and sometimes vaccination are most common.

The disease in Tanzania was first suspected in 1980 and officially confirmed in 1998 (H.M Msami, 1991; H.M Msami et al., 1998). In pastoral and non-pastoral areas of Tanzania, outbreaks were reported frequently, and conventional methods were not very effective in curbing their spread (L Kusiluka, Kimaryo, Nsengwa, Kazwala, & Kambarage, 2007).

TBDs

Cattle, goats and other grazing livestock also get TBDs, although little information is available on their prevalence and incidence. Of these, only anaplasmosis and cowdriosis (heart water) are bacterial. Anaplasmosis is caused by *Anaplasma phagocytophilum*. It occurs in both animals and humans, and is generally treated in early stages in these livestock by the antibiotic oxytetracycline (Whittier, Currin, & Currin, 2009). Cowdriosis is caused by the intracellular Gram-negative coccal bacterium *Ehrlichia ruminantium*. It is commonly treated with tetracycline in the early stages of the disease.

Other Bacterial Diseases

While the following bacterial diseases may not be as high in prevalence as the ones described above, their economic burden is still notable in cattle and other grazing livestock. These include mastitis, black quarter, and haemorrhagic septicemia.

Mastitis

Mastitis primarily affects cattle in Tanzania. Bovine mastitis is not caused by a single pathogen, but a variety, and can be accompanied by visible signs, such as changes in the milk and swollen udder (Kivaria, Noordhuizen, & Msami, 2006). Among all cattle, dairy cattle are most susceptible to the disease. Worldwide, 50 percent of dairy cattle have some form of mastitis (M. Shem, Malole, Machangu, Kurwijila, & Fujihara, 2001). Studies conducted in the lake zone of Tanzania showed that the average annual incidence of sub-clinical mastitis was between 40 to 71 percent (Msanga, Bryant, Rutam, Minja, & Zylstra, 2000; M. N. Shem et al., 2001). Mastitis transmission between cows is facilitated by poor hygiene and milking practices. Treatment for the disease generally varies by the stage of the disease, the type of disease-causing bacteria, and the mode of transmission. The following are types of treatments: Intramammary infusions with antibiotics, which typically employ the use of penicillin and systemic treatment through intramuscular and subcutaneous route.

Brucellosis, Bovine Tuberculosis and Anthrax

Other important bacterial diseases in large and small ruminants are brucellosis, bovine tuberculosis (BTB) and anthrax. However, though these diseases have potential zoonotic importance, the use of antibiotics to control them is minimal. To control the risk of transmission from animals to human of Brucellosis and TB, strict test and slaughter of positive reactants is recommended. Additionally, press upon proper control by vaccination of Brucellosis and Blanthrax for anthrax.

Poultry Diseases

Use of antibiotics to control diseases in poultry is a common practice in commercial farming system that falls under sector 2 and 3 of FAO classification¹⁰. The most common diseases for which farmers use antibiotics are fowl typhoid, salmonellosis, colibacillosis (coliform infections), mycoplasmosis such as infectious coryza and coccidiosis. In commercial chickens under intensive management fowl typhoid is responsible for the greatest morbidity and mortality (Food and Agriculture Organization of the United Nations (FAO), 1999).

Salmonellosis and Fowl Typhoid

In chickens, the most prevalent *Salmonella* belongs to *Salmonella enterica* serovar GallinarumbiovarGallinarum (denoted *Salmonella gallinarum*), a causative agent of fowl typhoid. Studies confirm higher serological prevalence of *Salmonella gallinarum*, in commercially based chickens. Fowl typhoid is generally treated with the following antibiotics: amoxicillin, potentiated sulphonamide, tetracyclines, and fluoroquinolones (The Poultry Site, 2012). One study found that the risk of infection in flocks of scavenging local chickens kept in contact with commercial chickens was six times greater than the risk of infection in flocks that had no contact (R. Mdegela, Yongolo, Minga, & Olsen, 2000). Subsequent studies in Tanzania add to this finding. For instance, a study found severe and long-lasting clinical signs (i.e., marked decrease in feed intake and reluctance to move) in commercial layer chickens. The study included 105 chickens of six indigenous local chicken ecotypes, of which two were commercial layers, the Mbeya and N'zenzegere ecotypes (Msoffe, Minga, Mtambo, Gwakisa, & Olsen, 2006).

Colibacillosis

Avian pathogenic *Escherichia coli* can cause localized and systemic forms of colibacillosis. The localized form of the disease can present as yolk sac infection (omphalitis), cellulitis, swollen head syndrome, scour (diarrhea), salpingitis and peritonitis, orchitis and other related conditions. Colisepticaemia (the systemic infection) takes several forms: neonatal, respiratory, enteric, in laying birds and ducks. When the disease is suspected, early initiation of antibiotics is the treatment of choice.

Infectious Coryza

Infectious coryza has significant global economic losses with high culling rates and reduced production of eggs (approaching 40 percent reduction) Mouahidet *al.* (1989) and high mortality rates (48 percent) (Bland *et al.*, 2002). Almost half of 56 samples from different regions in Tanzania found pathogenic and non-pathogenic *Avibacterium* spp., amongst which 59 percent were *Avibacterium paragallinarum*. There are virtually no studies in infectious coryza in poultry, although a study in Uganda suggests high levels of resistance (Byarugaba *et al.*, 2011). Adoption of a vaccine could have the positive financial implications and added benefit of controlling for antibiotic overuse and resistance. Several vaccines have been studied for use amongst the various strains of the bacterium (Blackall, 1995). There is optimism with use of the local strain Tan 1-05 of *Av. Paragallinarum* for this purpose (Wambura, 2010).

¹⁰ This is a commercial poultry production system. See chapter 2 for a full explanation.

Coccidiosis

Coccidiosis is caused by a protozoan parasite, the most pathogenic species of which are *Eimeria tenella* and *Eimeria necatrix* (FAO Corporate Document Repository, n.d.). It is a relatively common infection in poultry particularly the younger population and more so in urban than rural settings. It causes a range of signs and symptoms, the most characteristic of which are emaciation, thirst, listlessness, ruffled plumage, bloodstained faeces and huddling of birds together. East African surveys, last conducted more than 20 years ago, showed fecal rates of 47 percent for *Eimeriaspp* (Eissa, 1987). More recently, a prevalence of 54 percent was found in Morogoro (H E Nonga, Simon, Karimuribo, & Mdegela, 2010) and in another study, it accounted for 46 percent of poultry deaths in Arusha (E. S. Swai, Sanka, & Kaaya, 2013).

In view of the magnitude of potential losses due to these diseases, antibiotics are commonly included in manufactured feeds. The Grazing-Land And Animal Feed Resources Act No. 13 was enacted by the parliament in 2010. The Act established the Grazing-Land And Animal Feed Resources Advisory Council, which is a collaborative effort with representation from various bodies responsible for regulation. The document mentions antibiotics as substances not occurring naturally as ingredients in animal feeds. The labeling must declare the antibiotic and amount added. No limits have been specified for how much can be added (Parliament of Tanzania, 2010).

One study has found that farmers (65 percent) generally treat their commercial chicken themselves and that 85percent of these drugs are antibiotics. The common chicken diseases treated include infectious coryza (65 percent), colibacillosis (55 percent), coccidiosis (54 percent) and fowl typhoid (85 percent). Although most of these farmers (80 percent) were aware of withdrawal period to be exercised before selling eggs, this was not adhered to and all studied eggs (70 in total) had traces of antimicrobial residues (H E Nonga et al., 2010). This practice however, contributes significantly to the emergence of antibiotic resistance, which is subsequently transferred to humans through consumption of meat, eggs and other products.

Aquaculture

Aquaculture is expected to both satisfy the country's demand for fish and protect fish stocks. It is viewed as a desirable alternative to over-fishing. There are more than 20,000 mostly small earthen ponds, which are on average 150 square meters, for farmed fishing in the country. Common aquaculture settings for bacterial diseases to occur include seaweed farms, fish farms and shrimp farms. Shrimp farming is relatively new in Tanzania, and thus far, only viral diseases have so far been reported to occur in shrimp. There is limited literature on aquatic disease outbreaks and on antibiotic use in the sector.

The bacteria of greatest importance to aquaculture are *Aeromonas*, *Acinetobacter*, *Kluyvera*, *Vibrio* and *Yersinia*. Researchers have found *Aeromonas* and *Pseudomonas* spp. in areas where tilapia is found. These microorganisms are responsible for ulcerative syndrome, bacterial hemorrhagic septicemia, tail and fin rot, bacterial gill rot and dropsy.

Wild tilapia was studied at the Mtera Hydropower Dam in central Tanzania, at the confluence of the Great Ruaha and Kisigo Rivers. The study isolated pathogenic bacteria from tilapia in response to earlier outbreaks of an ulcerative disease that killed fish in the dam in 2006 and 2009. It concluded that *Aeromonas hydrophila* and other motile *Aeromonas* were the causative agents (Shayo et al 2012). While the study does not look at an aquaculture setting, it captures the types of bacteria responsible for the diseases that can occur in aquaculture settings. Shah and colleagues found evidence of similar bacteria in Pakistan and Tanzania. The Shah study focused specifically on the prevalence of antibiotic resistance genes in aquatic and sedimental environmental bacteria. Since Pakistan and Tanzania are two more recently emerging countries for aquaculture production, it was easier to study these resistance genes prior to a potential increase in intensive aquaculture and use of antimicrobials. It found that there were more resistant bacteria than expected (Shah et al., 2012).

Animal Disease Surveillance

The main objective of Tanzania's surveillance network is to produce information to support the livestock industry. The network includes a livestock information management system that backs up policy and strategy development, and risk assessment and management. The epidemiologic surveillance system includes the Epidemiology Unit in the Directorate of Veterinary Services, The National Veterinary Laboratory System (Animal Disease Research Institute, Tanzania Veterinary Laboratory Agency), Sokoine University of Agriculture, veterinary service providers, and wildlife research institutes.

The Epidemiology Unit aims to:

- Strengthen the national epidemiological system,
- Improve animal disease surveillance monitoring and diagnosis,
- Analyze animal disease and other related data and
- Provide information for early warning, rapid response, and planning and implementation of programs to deal with animal diseases.

The disease surveillance system includes both passive and active (targeted) disease surveillance. The former involves the secondary use of data collected for some other purpose. Active (targeted) surveillance is used to collect information for the specific disease or condition to substantiate its presence or absence. Traditionally, there has been a lack of communication and coordination in the surveillance in human and animal sector. This weakness is now overcome through the adoption of One Health concept.

The One Health concept offers a promising model for disease surveillance and tracking as well as control of emergence of antibiotic resistance in Tanzania. This approach is currently advocated by a number of consortia and networks, including SACIDS, OHCEA, Afrique One, CGWESA, NRN-Biomed. The need to unite efforts to improve the surveillance and manage the diseases more effectively was realized during the launch of One Health Tanzania by his excellence, the vice president of Tanzania, Dr. Gharib Bilal (Tanzania OHCEA report 2013). Plans to further strengthen disease surveillance in human and animals are further stipulated in Tanzania One Health Forum and Tanzania One Health road map.

Resistance rates

Antibiotics are commonly used to treat animals, just as they are in humans. In Tanzania, the animal diseases in which antibiotics are highly used are mastitis, tick borne diseases, fowl typhoid, salmonellosis, colibacillosis, coccidiosis and other causes of diarrheal disease. The available studies show a number of multidrug resistant bacteria (Mdegela et al., 2004; Nonga and Muhairwa, 2010; Shah et al., 2012).

A study done in Kibaha (Table 4-1) isolated nine different species of bacteria known to cause mastitis in lactating animals. Antibiotic susceptibility tests of the isolates to seven types of antibiotics indicated high resistance to penicillin G, chloramphenicol, streptomycin and oxytetracycline among *Arcanobacter pyogenes*, *Staphylococcus hyicus*, *S. intermedius* and *S. aureus* from cattle with mastitis (Mdegela et al., 2004).

Table 4-1. Prevalence (percent) of antimicrobial resistance in isolates from cattle with mastitis in Kibaha district, Tanzania

Bacterial isolates tested	Percent resistant to antimicrobial				
	Oxytetracycline	Penicillin G	Chloramphenicol	Streptomycin	Oxytetracycline
<i>Staphylococcus aureus</i>	43.7	37.5	43.6	37.5	25
<i>S.intermedius</i>	50	50	40	30	20
<i>S.agalactiae</i>	63.3	45.5	18.2	54.5	45.5
<i>S. epidermis</i>	50	15.6	30.8	30.8	19.2
<i>S.saprophyticus</i>	66.3	66.3	0	33.3	33.7
<i>Arcobacterpyogenes</i>	0	100	100	50	50
<i>Micrococcus</i> spp.	66.3	66.3	66.3	50	50
<i>S.hyicus</i>	100	0	0	100	100

SOURCE: Mdegela et al., 2004

Studies on antibiotic resistance in poultry have focused on *Campylobacter* and *E. coli*. Nonga and colleagues examined bacterial resistance in Muscovy ducks, which represent an estimated 5 percent of the country's poultry and are a source of both meat and income. The authors were particularly interested in ducks infected with thermophilic *Campylobacter*, and in particular *C. jejuni*, which is among the leading causes of bacterial gastroenteritis in humans. According to the WHO, the incidence of *Campylobacter* infections worldwide has recently surpassed those of salmonellosis and shigellosis. Domestic birds such as ducks are carriers of *Campylobacter* spp. and serve as major sources of infection to humans. The authors tested 50 *C. jejuni* isolates and found that they were susceptible to streptomycin, nitrofurantoin, and amikacin, while they showed some resistance to cefuroxime (48 percent), tetracycline (74 percent), and ampicillin (82 percent) (Hezron Emmanuel Nonga & Muhairwa, 2010).

E. coli can cause colisepticaemia, egg peritonitis, yolk sac infection and coligranuloma are being reported to occur under unhygienic conditions. A study conducted in Morogoro municipality examined the intestinal contents of 120 chickens slaughtered for restaurants. The authors examined 11 isolates out of a total of 78 chickens that were found to have *E. coli* (65 percent), and found them resistant to amoxicillin-clavulanate (82 percent), sulphamethoxazole (36 percent) and neomycin (54 percent) (H E Nonga et al., 2010).

Further investigations on resistance to antibiotics were conducted on commensal microorganisms by Katakweba and colleagues who took nasal swabs in humans, pigs and dogs in Tanzania. The *S. aureus* isolates were all resistant to penicillin and had relatively high levels of resistance to sulphamethoxazole/trimethoprim (8 percent), rifampicin (5 percent), amoxicillin-clavulanic acid (3 percent), oxacillin (11 percent) chloramphenicol (8 percent) and gentamicin (8 percent). Similarly, *E. coli* and *Enterococcus* spp. isolates were collected from humans, pigs, beef and dairy cattle, exotic and indigenous chickens. The bacteria were tested for antibiotic resistance to six types of antibiotics and the results reported high resistance to tetracycline (79 percent), sulphamethoxazole/trimethoprim (77 percent) and ampicillin (74 percent), with lower levels of resistance observed in cefotaxime (40 percent) (Katakweba, unpublished data).

In Tanzania, antibiotics are also commonly used for treatment of tick borne diseases, in particular anaplasmosis and heart water in cattle; fowl typhoid in poultry; and salmonellosis and coccidiosis and other causes of diarrheal conditions in different animal species. Despite high usage, no studies have been conducted to establish the existence of antibiotic resistance.

There is little research on antimicrobial resistance in the aquaculture system in Tanzania. The available research conducted in Morogoro (rural and urban), Mvomero, Songea and Masasi indicates a number of bacterial pathogens known to cause diseases in fish with resistance to antibiotics. Shah and colleagues isolated 126 bacteria samples from fishponds (water, sediments, healthy fish and diseased fish), which included *Aeromonas hydrophila*, *Vibrio anguillarum*, *Staphylococcus* spp., *Streptococcus* spp. and *Pseudomonas fluorescens*. The bacteria were tested for resistance to nine commonly used antibiotics in veterinary practice and resistance was found to tetracycline (62 percent), trimethoprim (86 percent), sulfonamides (84 percent), amoxicillin (89 percent), oxolinic acid (87 percent), streptomycin (58 percent), chloramphenicol (59 percent), florfenicol (81 percent) and erythromycin (91 percent) (Shah, Colquhoun, Nikuli, & Sørum, 2012). Of the 126 bacterial isolates in the study only 2 percent were susceptible to all nine antibiotics, and 10 percent were resistant to all nine.

Role of Environmental contamination in promotion of antibiotic resistance

Antibiotic resistant bacteria are found in animals that have traditionally not been given antibiotics, such as wild-caught fish, and bacteria in the environment may carry resistance genes. Some may be natural resistance present because of genetic diversity, but some may be from contamination with antibiotic residues that are washed as effluent into water bodies through rain (Jiang, Zhang, Xiao, Geng, & Zhang, 2013).

Antibiotics may be released into the environment from both human and animal sources, through excretion, disposal of unused or expired compounds, medical wastes, effluents from pharmaceutical industries, discharge from wastewater treatment facilities, leakage from septic systems and agricultural waste storage structures. Other pathways for dissemination are via land application of human and animal wastes, surface runoff and unsaturated zone transport¹¹. Once in the environment, like any other organic chemicals, their efficacy depends on their physio-chemical properties, prevailing climatic conditions, soil types and variety of other environmental factors. If antibiotics in the environment are not efficiently degraded, the residues may contribute in development of antibiotic resistant in microbial populations (Witte, 1998).

Of the sewage generated globally, over 80 percent is discharged untreated into the environment (Dreschel, Alexandra, & Evans, 2010). In Africa, more than 95 percent of the sewage produced is untreated (Nyenje, Foppen, Uhlenbrook, Kulabako, & Muwanga, 2010). Nonetheless, even the available sewage treatment plants are not effective at removing most of the antibiotic residues (Hendricks & Pool, 2012; Nakata, Kannan, Jones, & Giesy, 2005).

In Africa, tetracyclines are the predominantly prescribed antibiotics and they account for 41 percent of all antibiotic-associated residues, followed by beta-lactams (18 percent) (Darwish et al., 2013).

Antibiotic residues in the environment have the potential to induce the occurrence of resistant bacteria (Barnes et al., 2008; Soto-Chinchilla, García-Campana, & Gámiz-Gracia, 2007) and consequently enhance the transfer of resistant genes (Davidson, 1999).

Studies on antibiotic residues in the environment have been conducted mostly in high-income countries. A recent study on antibiotic residues in sewage in Kenya revealed high levels of sulfamethoxazole (90 ng/L) and trimethoprim (30 ng/L) and similarly in vegetables irrigated with same sewage. Sulfamethoxazole residues were detected at 23 ng/kg while trimethoprim was detected at 15 ng/kg (Mathenge, 2014). A recent study by Katakweba (2014) isolated multidrug resistant *E. coli* and *Enterococcus* spp in wildlife which suggests environmental contamination as a source. Another study (Shah et al., 2012) isolated a number of bacteria from farmed fish, in particular the Nile perch, of which more than 70 percent had multidrug resistant bacteria.

¹¹ The unsaturated zone, also known as the vadose zone, is between the ground surface and the water table. Movement of water through this zone is contributes to water contamination.

CHAPTER 5: Antibiotic Use and Supply Chain Management

HUMANS

Antibiotic Use in Human Health

Antibiotics are widely available across Tanzania and can be obtained from authorized pharmacies, unauthorized drug shops, and hospitals.

Antibiotic outlets and use in the community

Tanzanian drugstore outlets are divided into part I pharmacies, which by law are allowed to sell prescription-only medicines and part 2 drugs (over-the-counter). Part 2 poison shops DLDB are allowed to sell over-the-counter non-prescription medicines, and ADDOs are allowed to dispense selected prescription-only medicines. Despite strict regulations formulated by the Tanzania Pharmacy Council concerning which types of store are legally allowed to sell antibiotics and which require prescriptions, in practice, antibiotics can commonly be purchased without prescriptions from both authorized and unauthorized drug stores.

In a 2010 study in Moshi (Van Den Boogaard et al., 2010), antibiotics such as ciprofloxacin could be purchased easily without a prescription from both part I and part II shops. A study by Viberg and colleagues that sought to determine patient and drug seller attitudes and behaviors towards antibiotics and resistance found that 24 percent of patients were sold antibiotics for ailments such as cough, stomachache, and diarrhea. In-depth interviews with patients who were sold antibiotics by medical officers found that 49 percent of those prescriptions were inappropriate (Viberg, Kalala, Mujinja, Tomson, & Lundborg, 2010).

In addition to selling antibiotics without a prescription at a client's request, drug sellers also promote inappropriate regimens. A cross-sectional study conducted in ADDOs and DLDB in coastal and Morogoro regions used a simulated client method ("mystery shopper") for data collection (Minzi and Manyilizu, 2013). The researchers found that 30 percent of DLDB and 35 percent of ADDOs dispensed incomplete doses of antibiotics. Additionally, this study found that both ADDOs and DLDB dispensed fortified procaine penicillin powder (an injectable) as topical application for injuries.

A study was conducted to explore mothers' knowledge of fever and its management. Mothers of children less than 10 years old with fever brought to the outpatient departments of two municipal hospitals were asked about main sources of the drugs administered by mothers (Mwambete & Andrew, 2010) treatment given before coming to the hospital. Most (88.4 percent) of the respondents had treated the children, and of those, 24 percent used antimalarials and antipyretics, and 7.6 percent used antipyretics and antibiotics. Pharmacies (90.4 percent) were the.

The studies above suggest that irrational antibiotic use in the community may contribute to the development of antibiotic resistance in the community.

Irrational hospital use of antibiotics

Antibiotics are still used empirically in hospitals, illustrated by a study conducted in the Bugando Medical Centre medical adult ward. About half of the patients were given ceftriaxone for an average of 7 days, without laboratory tests.

Several studies in Tanzania have confirmed irrational prescription of antibiotics in hospitals. A study in Moshi hospitals found that 83 percent of children under 5 years old presenting with diarrhea and cough received antibiotics. The most commonly prescribed antibiotics were penicillins, sulphonamides, aminoglycosides and macrolides. Clinical officers and assistant medical officers were the providers most likely to prescribe antibiotics and diarrhea was the condition most likely to trigger an antibiotic prescription (Gwimile et al., 2012).

A study by Kahabuka and colleagues (Kahabuka et al., 2013) on care-seeking and management of common childhood illnesses in Tanzania found that the most common first option for child care was primary health facilities (54.8 percent), followed by private pharmacies (23.4 percent). It was also observed that in public health facilities and pharmacies antibiotics use for diarrhea treatment was high (49.0 percent) even if it was not warranted.

A study by Gouws and colleagues (Gouws et al., 2004) on the impact of antibiotic training in first-level facilities in Tanzania, Brazil, and Uganda found that 18 percent of caregivers of children who received an antibiotic from an IMCI-trained worker were advised incorrectly on how to administer the drug.

Between September 2010 and March 2011, a cross-sectional study from pediatric wards in two Moshi municipality hospitals included 384 children under 5 years with diarrhea and cough. Altogether, 326 (82.4 percent) of these children were prescribed antibiotics. By symptom (Table 5-1), antibiotics were prescribed inappropriately for all symptoms, but the pattern differed by symptom. It was much more likely for nausea/vomiting, watery diarrhea, and abdominal pain than for other symptoms (Gwimile et al., 2012).

Table 5-1. Antibiotic prescribing and patient complaints

Presenting symptoms	Total (n=384)	Prescription status	
		Inappropriate	Appropriate
		No. (%)	No. (%)
Fever	233 (60.7)	51 (21.9)	182 (78.1)
Cough	271 (56.5)	52 (24.0)	165 (76.0)
Nausea/vomiting	197 (50.8)	105 (53.3)	92 (46.7)
Watery diarrhea	195 (50.8)	106 (54.4)	89 (45.6)
Bloody diarrhea	9 (2.3)	2 (22.2)	7 (77.8)
Difficulty in breathing	58 (15.1)	4 (6.9)	54 (93.1)
Abdominal pain	3 (0.8)	2 (66.7)	1 (33.3)
Other	32 (8.3)	11 (34.4)	21 (65.6)

Patient could have more than one clinical complain, Test used χ^2

SOURCE: (Gwimile et al., 2012)

Antibiotic Supply Chain

Antibiotic sources: imports and local manufacture

Local Manufacture

The pharmaceutical industry in Tanzania is all secondary¹² and tertiary¹³. Active ingredients are imported mainly from India and China and the finished products are made in Tanzania. Most drug production is focused on basic drugs such as antibiotics, antimalarials, antihelminthics and sedatives. Cephalosporins and other third-line antibiotics are imported in a finished state and are not locally manufactured or packaged, with the exception of quinolones, which are manufactured locally (Mhamba & Mbirigenda, 2010); Mary Masanja, personal communication, June 1, 2013).

Three of Tanzania's seven pharmaceutical manufacturers produce antibiotics (Mhamba and Mbirigenda, 2010; Mary Masanja, personal communication, June 1, 2013). These are Shelys, Keko Pharmaceuticals, and Zenufa. Tanzania Pharmaceutical Industries also produced antibiotics, but production was suspended by the TFDA after it was found that TPI sold counterfeit antiretroviral (ARV) drugs to the MSD.

Shelys, run by the Aspen Group, is the largest pharmaceutical company with branches all over East Africa, and caters to both a domestic and international market (41 percent of drugs are for export) (Mhamba & Mbirigenda, 2010). Zenufa, with branches in the Democratic Republic of Congo and Tanzania produces 12 antibiotics. Keko Pharmaceutical Industries, established in 1997 manufacture nine antibiotics (Mary Masanja, personal communication, June 1, 2013).

Imports

About 10 percent of the national drug requirements are met by drugs produced in Tanzania. Sixty percent imported from India, 15 percent from Kenya, 10 percent from China and 5 percent from other countries (Mary Masanja, personal communication, June 1, 2013). There are currently 230 registered wholesalers that serve the retail sector (Mary Masanja, personal communication, August 15, 2014).

Procurement

Public

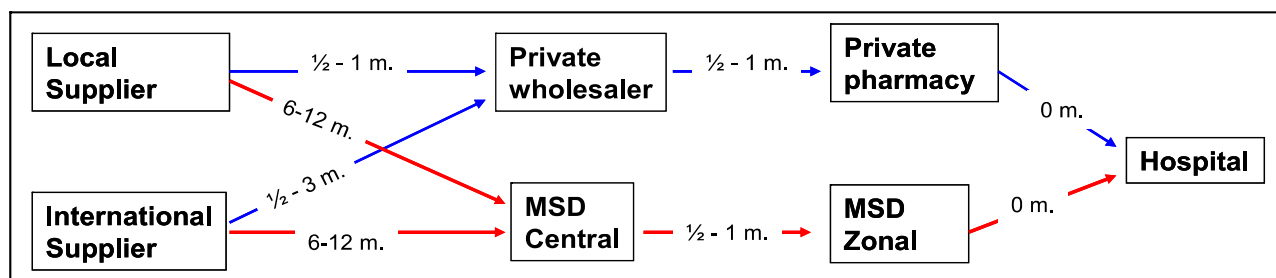
Nearly all drugs in public health facilities (an estimated 98 percent, according to MSH [2001]) are supplied through the MSD, the national wholesaler, and many drugs in private and mission facilities are also sourced there. As MSD is government-run, they are able to supply drugs at subsidized costs. The Ministry of Health and Social Welfare allocates specific funds for each public facility based on use and budgetary restrictions. Government-run health facilities have access to these funds, and are required to order medicines from MSD (unless they are under the Global Fund or GAVI). Every quarter, public health facilities are required to complete a stock check and place an order for projected use. Selection of medicines is done at the dispensary or health center, the hospital, regional stores, and at the national level (Ministry of Health and Social Welfare, 2008b). Because stock-outs are frequent, MSD usually informs the facility after the order has been placed. The facility is then permitted to contract with private vendors using its own funds (interview with MSH, 2013).

MSD is legally obligated to use a tender method to procure medication, which takes between 9 and 12 months, severely limiting their ability to deal with unexpected demand. Overall stocking times are shown in figure 5-1 below, taken from a 2007 report by the Euro Health Group. As the figure shows, procurement times from supplier to hospital, through the MSD, can take over a year, and rarely take less than a month. When the middleman is a private wholesaler, not the MSD, delivery times are much faster (Euro Health Group, 2007).

¹² Secondary manufacturing involves producing finished doses.

¹³ Labelling and packaging of finished products is considered tertiary manufacturing.

Figure 5-1. Time taken by MSD and private wholesalers for the processes of procurement and supply of essential drugs.



SOURCE: Euro Health Group, 2007

Private tenders result in shorter delivery times, but also higher prices. The Euro Health Group study concluded that private wholesalers have an easier time maintaining relationships with suppliers and obtaining medications on short notice (Euro Health Group, 2007). Once an order is made, the challenges continue as IT systems are rarely used to monitor supplier performance. Interviews and data analysis suggest that only 50 percent of procured items arrive on time (Euro Health Group, 2007). It is unclear how many procured items reach hospitals and patients, as systems for monitoring and recording stock are weak (Mhamba & Mbirigenda, 2010).

Faith-based facilities

Faith-based facilities, which comprise of 42 percent of health facilities in the country, have slightly more flexibility. While they, too, have an allocated budget at MSD, they are permitted to contract with private vendors at will. Furthermore, faith-based facilities also have access to MEMS, which supplies medicines that are stocked out and not available at MSD, in addition to drugs that MSD does not carry (Jafary Liana, personal communication, 2013).

Private Sector

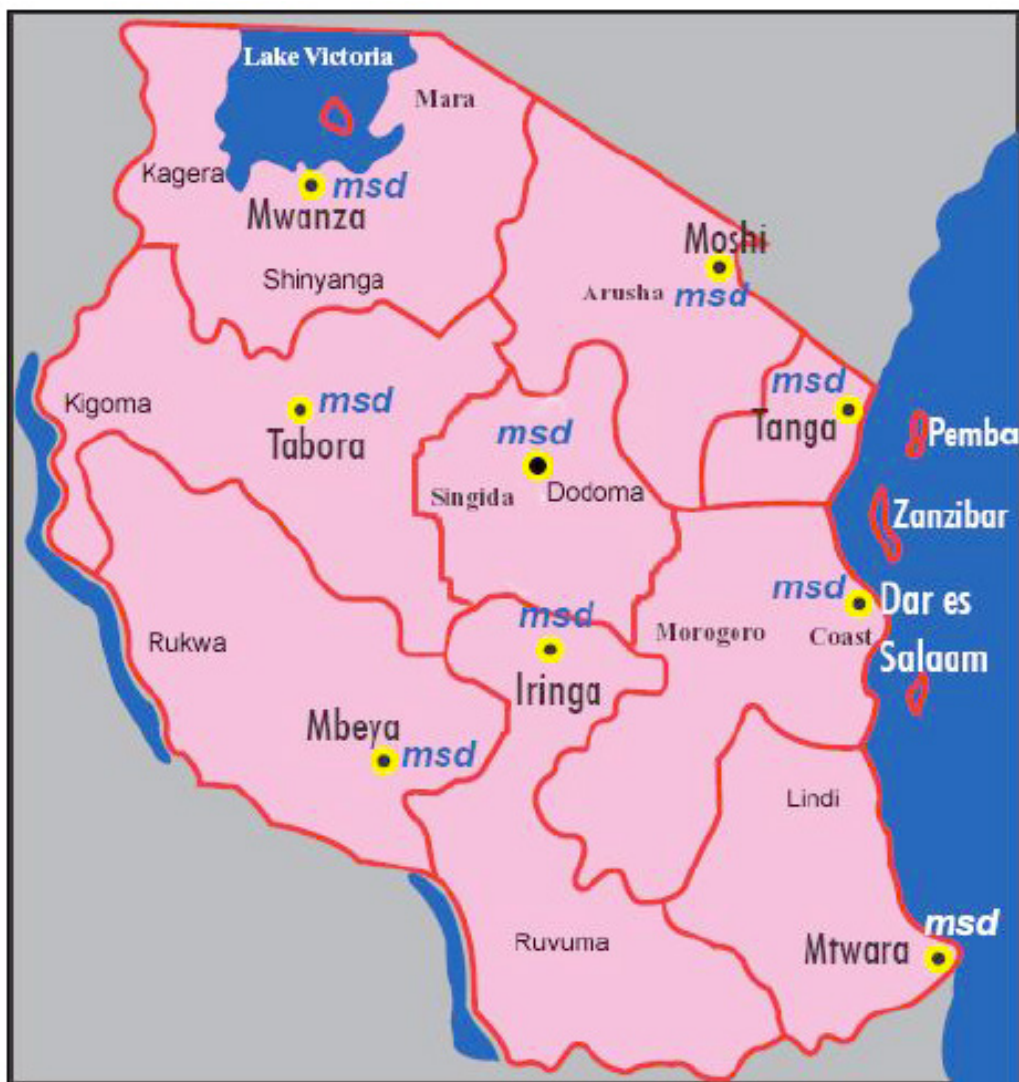
In order to import any medicine, companies must first obtain approval from TFDA. Registration of a new drug involves composition analyses, visits to the manufacturer to assess GMP compliance, quality and toxicology testing, and can take up to two years to complete. Approvals are granted for periods of five years. Renewals are granted within six months of filing an application. In addition, all companies are required to submit an invoice prior to importation to seek approval from TFDA. Once medicines reach a port of entry, samples are inspected using mini lab kits and some medicines are taken to the central laboratory for further testing. Drugs are recalled if they do not adhere to quality checks (Mary Masanja, personal communication, June 1, 2013). As a final step, TFDA also undertakes post marketing surveillance testing. Samples from pharmacies are collected and quality checks are performed. TFDA also monitors adverse drug reactions (TFDA, 2012).

There are several problems with the importation of medicines and medical devices, including the submission of fake invoices, the use of unofficial ports of entry for importation, and the false declaration of goods, which prevents proper inspection. To improve this, TFDA is currently evaluating their inspection procedures (TFDA, 2012).

Distribution

In a 2008 study, medicines from MSD were reported to reach Tanzania's 10 zonal medical stores (figure 5-2) in a timely fashion, but adequate transport to reach health facilities was met in only Mbeya, Tabora and Moshi.¹⁴ Delivery challenges included weather, a fragmented transportation network, the poor condition of vehicles and theft (Ministry of Health and Social Welfare, 2008c). Most health facilities cited the lack of vehicles and high cost of transportation as the major causes of delivery problems (Ministry of Health and Social Welfare, 2008c). To address these issues, MSD is in the process of streamlining their procedures with the goal of delivering directly to health facilities (interview with MSH, 2013).

Figure 5-2. Map of MSD Zonal Medical Stores



SOURCE: (Management Sciences for Health (MSH), 2011)

¹⁴ The nine zonal medical stores are located in Mwanza, Tabora, Dodoma, Moshi, Tanga, Dar es Salaam, Mtwara, Mbeya and Iringa (mainland) and one in Zanzibar

Quality

Prequalified by the WHO, the National Quality Control Laboratory (under TFDA) is responsible for all quality control, and sometimes may contract with external laboratories to perform these tests. In a Ministry of Health and Social Welfare report assessing supply management, MSD met all quality assurance criteria (MOHSW, 2008).

A review of pharmaceuticals produced in Tanzania found that only two companies meet international manufacturing standards – Shelys and Tanzania Pharmaceutical Industries Limited, the latter of which was suspended in 2012 due to the counterfeit supply of antiretroviral medication (Mhamba & Mbirigenda, 2010).

Table 5-2. Antibiotics manufactured locally

Antibiotics	Zenufa	Shellys	Keko Pharmaceutical Industries
Sulfamethoxazole + trimethoprim (cotrimoxazole) tablets	✓	✓	✓
Procaine penicillin	✓		
Erythromycin tablets	✓	✓	✓
Chloramphenicol capsules	✓	✓	
Ampicillin + cloxacillin capsules	✓	✓	✓
Ampicillin capsules	✓	✓	✓
Cloxacillin capsules	✓	✓	✓
Amoxicillin capsules	✓	✓	✓
Ciprofloxacin tablets	✓	✓	✓
Phenoxymethyl penicillin tablets	✓	✓	✓
Doxycycline capsules	✓	✓	✓
Azithromycin tablets	✓	✓	

SOURCE: Mary Masanja, personal communication, June 1, 2013

Counterfeit medication, however, is largely a problem amongst imported medicines. In addition, the government has a poor system to withdraw harmful and counterfeit drugs from the market (Mhamba & Mbirigenda, 2010).

Adequacy of Supply

As noted above, MSD has frequent stock-outs and is often unable to fill orders. In interviews in Dar es Salaam, MSD workers noted that weak forecasting of needs by major clients, long and complicated tendering procedures, delivery delays by local wholesalers and manufacturers, and poor internal coordination all contribute to these stock-outs (Euro Health Group 2007). The average length of MSD stock-outs varies greatly, ranging from 1.6 days on average in Dar es Salaam to 81.2 days in the Mwanza zonal store. MSD's stocking troubles are further exacerbated by the limitation that they are allowed to contract only for one-time procurements and cannot ensure future contracts, making them a low priority for suppliers compared to private wholesalers (Euro Health Group, 2007).

MSD operates with a fixed price list that is adjusted yearly. MSD is able to procure drugs at extremely favorable prices compared to international prices and those in the private pharmacies (Health research for action (HERA), 2006). The view of all health workers, whether from the public or mission based hospitals, is that MSD is an institution selling quality medicines at the best prices.

The fixed low prices are mainly obtained from its method of procurement and its ability to purchase in bulk. MSD is allowed to charge a 17.4 percent mark-up, which should be enough to fund its operations (Euro Health, 2007).

Table 5-3. Percentage of Time Tracer Items Out of Stock for FY 2000-2001 (N=27)

Item	All	Dispensaries	Health Centers	NGO Hospitals	MSD Zonal Stores	MSD Dar es Salaam	Regional Hospitals	Mission Clinic/Hospitals
Amoxicillin 250 mg tablets	21	28	31	8	0	0	23	1
Benzylpeni-cillin sodium 5 MU vial	13	16	23	2	2	0	7	2
Ciprofloxacin 500 mg tablets	46	80	98	1	45	0	30	0
Co-trimoxazole 480 mg tablets	25	37	33	5	23	0	13	7
Doxycycline 100 mg tablets	13	16	22	0	14	4	1	0
Erythromycin 250 mg tablets	39	67	97	1	1	0	9	100
Gentamicin 40 mg/ml ampoule	41	80	100	6	23	0	2	0
Metronidazole 200/250 mg tablets	15	21	28	4	0	0	6	0

SOURCE: Management Sciences for Health, 2003

In an assessment of procurement and supply management in Tanzania, zonal medical stores and health facilities were found to have over 80 percent availability of the 20 tracer medicines (medicines that are frequently used) (Table 5-3). Despite this, health facilities reported large numbers of stock-out days. Some medicines were unavailable for 4 months, and the median number of stock-out days for the 20 tracer medicines was reported to be 136. Major reasons for this were due to the lack of funding (41 percent) and to MSD shipping smaller quantities than ordered (41 percent). Zonal medical stores reported similar reasons for stock-outs, with delivery delays (75 percent) and small than ordered quantities (75 percent) as the major reasons (Ministry of Health and Social Welfare, 2008b). A 2010 survey reported 27 of 50 pediatric medicines surveyed in stock at MSD. In addition, only 32 percent of all pediatric medicines and 45 percent of pediatric essential medicines were available at public facilities. Low availability of medicines in the public sector increases out-of-pocket expenditures, as children under 5 years are supposed to receive free medication (Ministry of Health and Social Welfare, 2010).

Expiry of medicines and supplies was reported to be 4 percent (2006) of annual sales at the central medical store and 0.02 to 6 percent at three zonal medical stores. Reasons for this were due to short expiry time periods, errors in forecasting and lack of adherence to the 'first expired, first out' rule (Ministry of Health and Social Welfare, 2008b).

Drug Prices

MSD operates with a fixed price list that is adjusted annually. The Euro Health report concluded that pricing in 2007 allowed a 17.4 percent mark-up, which is lower than the mark-up of the government medical wholesalers in Uganda and similar to that in Democratic Republic of Congo, Lesotho, and Zambia. A number of studies have examined the retail mark-up, and the results are varied, ranging from 12 to 33 percent (Management Sciences for Health, 2003). The variability is largely due to the wide range of operating costs and differential pricing by the volume of medicines sold. Table 5-4 shows the average lowest selling price for medications by type of outlet.

Table 5-4. Lowest Cost Price

Generic Name	Duka la Dawa Baridi	Private Dispensaries	Private Health Centers	Private Hospitals	Private Pharmacies	District Hospitals	Public Health Centers	Regional Hospitals	NGO Hospitals
Amoxicillin 250mg capsule/tablet	19.70	19.15	16.75	17.00	15.83	17.00	20.84	17.00	18.17
Benzylpenicillin sodium 5 MU vial	300.00	330.18	392.50	285.00	274.50	285.00	182.83	285.00	274.17
Chloroquine 300mg tablet	5.52	17.75	3.50	5.75	5.07	5.00	3.50	5.00	5.10
Ciprofloxacin 500mg tablet/capsule	106.67	49.29	35.00	300.00	41.25	18.50	19.60	30.00	22.13
Condoms piece	29.07	36.48	N/A	N/A	71.03	N/A	N/A	N/A	N/A
Co-trimoxazole 480 mg tablet	7.50	8.87	7.70	6.45	6.99	6.40	6.20	6.40	5.75
Depo-Provera vial/vaccine	250.00	858.33	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dextrose 5% 500 ml bottles	311.10	430.00	180.00	350.00	409.81	330.00	403.33	330.00	335.00
Doxycycline 100 mg tablet/capsule	26.75	16.58	29.25	12.32	27.84	8.50	11.07	8.50	14.20
Erythromycin 250 mg tablet/capsule	34.50	26.00	32.00	28.60	27.13	32.00	32.44	32.00	30.98
Examination glove size 7.5 pair	177.26	180.73	185.00	1217.50	124.44	170.00	119.00	170.00	86.00
Ferrous sulfate 200mg/ folic acid 0.25 mg tablet	2.77	2.82	1.90	N/A	25.67	1.90	1.60	1.90	1.45
Gentamicin 40 mg/ml ampoule	77.50	148.75	42.50	115.00	112.50	70.00	70.00	70.00	68.33
Hydrochlorothiazide 25 mg/50 mg tablet	N/A	N/A	N/A	N/A	N/A	N/A	2.89	4.60	1.00
Ketamine 10 mg/ml vial		950.00			900.00	480.00	660.00	66.00	658.00
Mebendazole 100 mg tablet	7.03	4.57	2.55	3.11	8.57	2.55	2.49	14.03	3.25
Metromidazole 200 mg/250 mg tablet	4.48	5.24	3.20	4.00	3.24	2.80	2.53	2.80	2.90
Needle 22 G+ syringe 2 ml pair	38.10	54.73	32.00	40.00	33.30	30.00	30.00	30.00	33.00
ORS sachet	95.00	104.70	60.00	80.00	88.33	60.00	55.00	60.00	65.00
Oxytetracycline eye ointment 0.1% 5g tube	148.54	198.33	110.00	220.00	180.00	110.00	105.00	110.00	130.00
Paracetamol 500 mg tablet	5.70	3.25	2.18	2.31	2.21	2.36	2.36	2.36	2.36
Polio vaccine vial/vaccine	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Praziquantel 600 mg tablet	211.43	269.00	92.00	N/A	135.36	92.00	92.00	92.00	78.87
Propranolol 40 mg tablet	N/A	24.40	N/A	N/A	19.25	2.80	3.04	2.80	3.90
Quinine dihydrochloride 300 mg/ml ampoule	170.00	217.08	30.10	220.00	169.40	130.00	140.00	76.10	130.37
Rifampicin 150 mg+ isoniazid 100 mg capsules/tablets	N/A	40.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sulfadoxine 500 mg+ pyramethamine 25 mg tablet	65.46	35.79	19.00	60.00	69.15	18.00	19.00	11.00	19.67

Tanzania has no maximum retail price for medicines, and the majority of the population cannot afford out-of-pocket purchases. In the 2004 general drug assessment and the 2010 pediatric drug assessment, procurement prices in the public sector were found to be 31 percent and 20 percent less than international market prices¹⁵, with the exception of a few medicines. Procuring gentamycin was 11.38 times the international market price in 2004, compared to 3.14 in 2010, indicating a large price drop (Ministry of Health and Social Welfare, 2011a; World Health Organization, 2004).

Affordability of medicines has improved, however, a review of the pharmaceutical sector and access to essential medicines found stock-outs were common at public facilities, most often due to supply delays from MSD. This leads to out of pocket payments at retail pharmacies, which are more expensive than public facilities (Mhamba & Mbirigenda, 2010). Patients paid a median of 1.33, 2.67 and 2.90 times the international reference price for low-cost generic medicines in the public, private and non-governmental sectors, respectively, although prices were found to vary between facilities (WHO, 2004). Lower median prices were found in a 2010 pediatric drug assessment, which reported 0.96, 2.22 and 2.41 median price ratios¹⁶ for public, private and non-governmental sectors, respectively (MOHSW, 2011). Patients paid roughly twice the amount at private or non-governmental pharmacies compared to public facilities in 2004 and 1.5 times for pediatric medicines in 2010 (MOHSW, 2011; WHO, 2004). In addition, price controls are rarely enforced, leading to a wide distribution of prices for identical products across the country (Mhamba & Mbirigenda, 2010).

ANIMALS

Antibiotic Use in Animals

Although there is a lot of anecdotal evidence of antibiotic use in animals, very few studies have documented the specific formulations and quantities. A few studies have reported drug residues in beef, eggs and milk, which validate the fact that antibiotics are used (Z. I. Kimera, 2013; H. R. Mdegela et al., 2004; Mmbando, 2004; H. E Nonga, Mariki, Karimuribo, & Mdegela, 2009).

Veterinary use of antibiotic may be grouped into therapeutic, metaphylactic (timely mass medication), prophylactic and for growth promotion. Farmers may use antibiotics in animals to compensate for poor management due to lack of formal veterinary services and because of the prevalence animal diseases. It is likely that farmers are unaware of potential negative effects of antibiotic overuse in animals.

Poultry

Commercial chicken (layers and broilers) production accounts for most veterinary drug use in Tanzania, including antibiotics. The most common antibiotics/antimicrobials used are oxytetracycline, amprolium, sulphonamides, chlortetracyclines, chloramphenicol, doxycycline, flumequine, penicillins, neoxyvital, trimazine and tylosin. Reasons for high levels of use include the ease of purchasing antibiotics in agro veterinary shops, no requirement for prescriptions, and the high burden of poultry diseases in Tanzania (H. E Nonga et al., 2009; Sungura, 2010).

Nonga and colleagues (Nonga et al., 2009) interviewed 20 randomly selected farmers from suburbs of Morogoro on the use of antibiotics in broiler chickens. All the farmers interviewed reported using antibiotics to treat their chickens, 90 percent reporting frequent use. Most farmers buy antimicrobials from veterinary shops and treat their birds themselves, largely because of limited availability of veterinary services. The majority of antibiotics used were tetracyclines (used by 90 percent of farmers) and sulphonamides (used by 85 percent). Although 90 percent of farmers admitted to know about antimicrobial withdrawal periods, only one actually observed the guidelines, as the rest stated they feared economic loss. The authors conducted tests on liver samples from 70 slaughtered broiler chickens in the farms visited (20) and found that meat from 70 percent of the farms tested positive for antibiotic residues (Hezron Emmanuel Nonga, Mariki, Karimuribo, & Mdegela, 2009).

¹⁵ The comparison was made with non-profit international generic medicine suppliers.

¹⁶ Median price ratios are median prices with reference to MSH's international reference price 2009.

A similar study was conducted in Urban district, Zanzibar (Sungura, 2010). In that study, a total of 55 smallholder broiler chicken farmers were interviewed in 15 wards in Urban district. The majority of the respondents (80 percent) reported diagnosing and treating chickens themselves with minimal help from veterinary drug sellers. Chicken antimicrobials were dispensed over the counter from agro vet shops without prescription. All the farmers interviewed reported using antibiotics to treat or prevent diseases in their birds. The most commonly used antibiotics were oxytetracycline (used by 100 percent of farmers), sulphonamides (used by 82 percent) and penicillins (used by 50percent). Less common were flumequine (used by 38 percent), piperazine citrate (used by 32 percent), tylosin (used by 23 percent) and neomycin (used by 10 percent). Up to 66 percent of the respondents were aware of drug withdrawal period; however, only 45.5 percent of them complied. Laboratory analysis of antibiotic residues in 70 broiler chicken meat samples showed that 76.4 percent of the meat samples contained antimicrobial residues.

Nonga and colleagues (H E Nonga et al., 2010) also studied antibiotic use and residues in commercial layer chicken eggs. The study involved 20 farmers selected randomly from different locations in Morogoro municipality. The study established that up to 65 percent of the farmers reported treating their chickens themselves after getting advice from drug sellers. The most commonly used antibiotics were sulphonamides (used by 100 percent of farmers) and tetracycline (used by 75 percent). Others were chloramphenicol (used by 10 percent) and flumequine (used by 10 percent). All the respondents reported that they did not observe withdrawal periods while selling eggs because they were afraid of economic losses. A total of 70 egg samples randomly selected from the 20 farms were analyzed for antibiotic residues and all were positive for antimicrobial residues.

A recent study by Mubito of chicken eggs in Dar es Salaam had similar results as in Morogoro. A questionnaire was administered to 100 commercial chicken farmers and pharmaceutical outlets to obtain information on antibiotic usage, awareness of withdrawal periods and public health concerns. The most frequently used antibiotics were tetracycline (32.2 percent) and sulfonamides (20.8 percent). Others were fluoroquinolones (9.8 percent), macrolides (9.4 percent), polypeptides (8.0 percent), amprolium (6.5 percent), aminoglycosides (6.4 percent), trimethoprim (5.5 percent), furazolidone (0.8 percent) and quinoxalines (0.4 percent). All the farmers reported not observing withdrawal periods, for fears of capital loss (Mubito, Shahada, Kimanya, & Buza, 2014a). Ninety-six eggs were analyzed for sulfadiazine and sulfamethazine residues. All the eggs contained sulfadiazine at level ranging from 22 to 230 ng/g (mean, 94.3 ng/g) and 59.4 percent of samples contained sulfamethazine residues ranging up to 94 ng/g (mean, 28.8 ng/g) (Mubito, Shahada, Kimanya, & Buza, 2014b).

Cattle

Karimuribo and colleagues (2005) studied antibiotic use by 60 dairy farmers in Morogoro municipality. Antibiotics accounted for 54.2 percent of the veterinary drugs they used in cattle. The most commonly used antibiotics were penicillin-streptomycin (used by 84 percent of farmers), oxytetracycline (used by 60 percent) and gentamicin (used by 12 percent). Of 59 milk samples tested for antibiotic residues, a small percentage (1.7 percent) was positive. The study concluded that readily available antibiotics over the counter in agro veterinary shops without any restrictions contributed to the widespread use.

A 2006 study examined the presence of antibiotic residues in unpasteurized milk. The study examined 986 milk samples in Dar es Salaam and Mwanza, and detected residues in 36 percent of samples (L. R Kurwijila, Omore, Staal, & Mdoe, 2006).

Screening for antibiotic residues in milk was also done in Njombe and Mvomero districts (R. H. Mdegela et al., 2009). A total of 69 smallholder dairy farms with lactating cows participated in the study and involved 91 dairy cattle. Antimicrobial residues were found in 4.5 percent of samples. A study of oxytetracycline residues in milk in Dar es Salaam city involved a total of 100 samples (40 from packed milk in shops, 30 from milk centers and 30 from farmers) (Kaale, Chambuso, & Kitwala, 2008). Oxytetracycline was found in just two samples from the farmers (6.7 percent) at <100 mg/ml. All samples from local milk centers and milk industries (packed) tested negative.

Midenge (2010) interviewed 187 small scale dairy cattle farmers in Kinondoni Municipality on the type of antibiotics used, awareness about withdrawal periods, awareness on drug residues related health hazards. It was established that 72 percent of veterinary drugs used in dairy cattle in the Kinondoni municipality were antibiotics. Tetracycline (used by 79.5 percent of farmers), penicillin-streptomycin (used by 55 percent), sulfadimidine (used by 18 percent), gentamycin (used by 10 percent) and kanamycin (used by 8 percent) were the most common antibiotics used by Kinondoni farmers (Midenge, 2010).

A recent study by Katakweba et al. (2012) conducted in Kinondoni and Morogoro, involved 160 livestock keepers and assessed awareness of human health threats from the use of antimicrobials in livestock and factors that promote selection pressure for resistance. For 30 percent of the livestock farmers it was the first mention they have ever heard of the concept of antibiotic resistance. 52 percent were unaware of the type of disease that required use of antibiotics. Withdrawal period to be taken after an animal had been given antibiotic was unknown to 22 percent of farmers and 40 percent of them did not know of the potential risk antibiotic use in animals may have on humans. Only fifty-four percent of respondents obtained their antibiotics through prescription by veterinarians. The most commonly used antibiotics were oxytetracycline (used by 62.9 percent of farmers), sulphadimidine (used by 23.2 percent), penicillin-streptomycin (used by 13.4 percent) and gentamycin (used by 1 percent). Livestock management systems, antibiotics handling and types of antibiotics used in the study areas were identified as potential risk factors for the development of antimicrobial resistance (Katakweba, Mtambo, Olsen, & Muhairwa, 2012).

Rwehumbiza and colleagues (2013) studied the uses of antibiotics and drug withdrawal periods in Kisarawe and Bagamoyo districts, Pwani region. It was established that all farmers use antibiotics to treat animal diseases and most farmers and milk suppliers (81.7 percent) were aware of the importance of observing withdrawal periods following treatment of sick cows. Twenty-one percent of 186 milk samples from different farmers in the districts that were analyzed for antibiotic residues were positive (Rwehumbiza, Ryoba, & Karimuribo, 2012).

In Arumeru district and Arusha municipality, Bukuku (2013) interviewed 35 farmers and analyzed milk samples from their farms for antibiotic residue analysis. Seventy-five percent used antibiotics, mostly to treat mastitis in dairy cattle. All farmer respondents were aware of withdrawal periods and almost all (97.1 percent) reported that they complied. Antibiotic residues analysis revealed no positive samples (Bukuku, 2013).

Oxytetracycline residues in beef from indigenous cattle was recently studied in a cross-sectional study in Kilosa district (Z. Kimera, 2013). A total of 60 samples of fillet, liver and kidney were collected from different beef carcasses slaughtered in slaughter slabs and cattle markets. Just over 70 percent had oxytetracycline residues, and of these, 68.3 percent had levels above the recommended value (Z. Kimera, 2013).

Antibiotic Supply Chain

Antibiotic sources

Local manufacture

Local manufacturers/formulators of antibiotics include Farmers Center and the MLFD's Vaccine unit. Antibiotics are also imported, but primarily by the private sector.

Imports

Veterinary antibiotics are primarily imported from Europe, mainly Belgium, Netherlands, and France. Asian countries such as China, India, and Indonesia (plus Turkey in Europe) have recently begun to dominate the market. Veterinary antibiotics, like antibiotics used in humans are regulated by TFDA. From 2009 – 2011, the major companies importing veterinary medicines were Twiga Chemical Industries, Bytrade Veterinary, Norbrook, Farmers Centre, Farm Base, Anicrop Services, Tan Veterinrina, Ultravetis, and Cooper Tanzania (TFDA excel document, May 2013). Once imported, they are distributed to agro vets and small grocery-like shops that sell antibiotics. The government occasionally procures vaccines in cases of outbreaks.

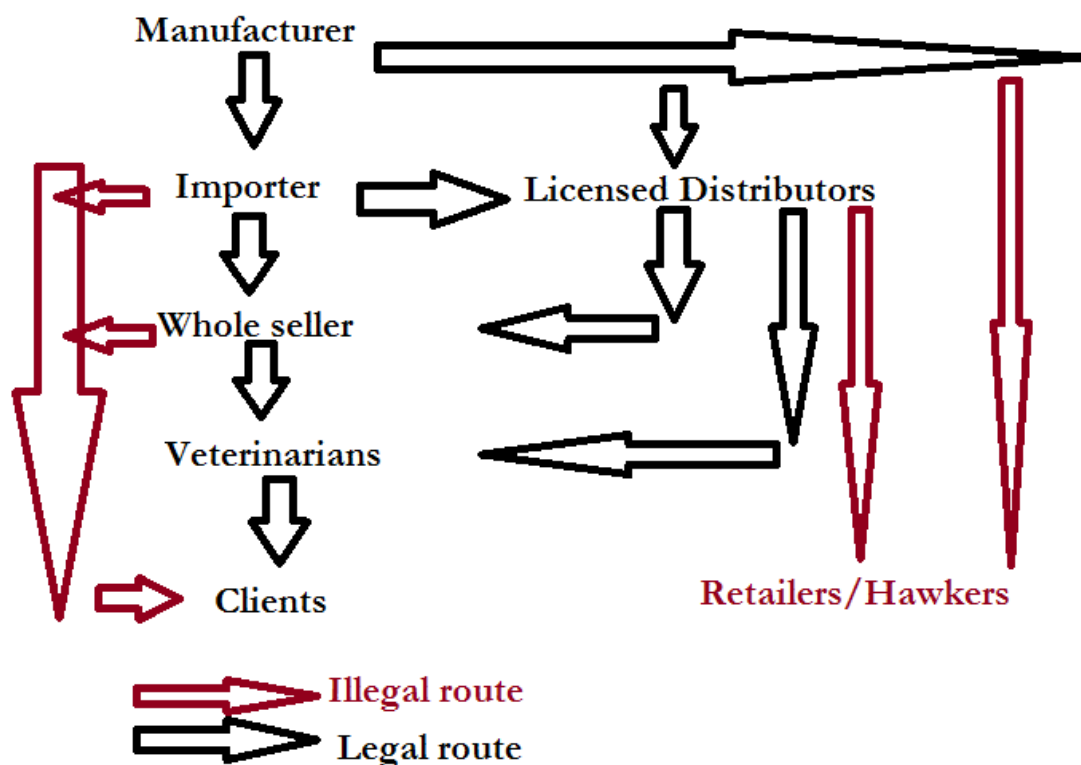
Procurement

Similar to the procurement of antibiotics for humans in the private sector, TFDA must grant approval to any importing company. Individual medicines are subject to composition analysis, and the exporting company is also inspected. An invoice prior to each order must be submitted to TFDA, and medicines once arrived at the port of entry undergo quality checks by TFDA. Post-market surveillance for veterinary medicines is limited (TFDA, 2012).

Distribution

The country's distribution of veterinary antibiotics can be briefly explained through the following chart. The client can receive the antibiotics easily through both formal and informal means dubbed "legal and illegal" routes respectively. This leads to a myriad of effects of which relevant to this report; the perpetuation of development and spread of antibiotic resistance to animals and consequently humans.

Figure 5-3. Veterinary antibiotics supply chain



SOURCE: Ministry of Livestock and Fisheries Development (from presentation by Dr. Pastory Dulla, 2014).

Quality

Both the quality and quantity of veterinary antibiotics in Tanzania are difficult to assess. While quality assessments are performed on imported drugs at the port of entry, there is very weak post-market surveillance on veterinary medicines (Cliffson Maro, personal communication, May 8, 2013).

Antibiotics included in feed are not controlled by the government. Informal feed manufacturers that are found in small kiosks do not regulate the quantity of antibiotics included, leading to unnecessary exposure to antibiotics. The quantity of antibiotics included in feed remains to be assessed (Pastory Dulla, personal communication, March 9, 2013).

It has been observed frequently that drug importers, distributors and wholesalers supply drugs direct to consumers. Antibiotics are commonly sold during cattle auction days by informal vendors, such as petty traders and livestock keepers. Antibiotics found in markets like these are often unregistered, and therefore sold at very cheap prices (Abdu Hayghaimo, personal communication, April 1, 2013). The quality of these medicines is undetermined.

Adequacy of supply (stock out)

It has been noted that stock outs are not a persistent problem in Tanzania. Shortages are intermittent and depend on importer competition as well as government regulations and policies (Cliffson Maro, personal communication, May 8, 2013).

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ABOUT CDDEP

The Center for Disease Dynamics, Economics & Policy (CDDEP) was founded with the objective of using research to support better decision-making in health policy. The CDDEP team employs a range of expertise—including economics, epidemiology, disease modeling, risk analysis, and statistics—to produce actionable, policy-oriented studies on malaria, antibiotic resistance, disease control priorities, environmental health, alcohol and tobacco, and various other diseases.

Many CDDEP projects are global in scope, spanning Africa, Asia, and North America. The strength of CDDEP derives from its researchers' experience in addressing country and region-specific health problems, as well as truly global challenges, while recognizing the circumstances in which the answers must fit. The outcomes of individual projects go beyond the usual models to inspire new strategies for analysis, and innovative approaches are shared through publications and presentations focusing specifically on methodology.

Founded in 2009 as a center of Resources for the Future, CDDEP is an independent non-profit organization. With headquarters in Washington D.C. and New Delhi, CDDEP currently employs full-time staff members in India and the United States, and relies on a distinguished team of academics and policy analysts around the world.

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