

Review Article



Factors Affecting HIV Clients' Exposures and Adherence to Toxoplasmosis Preventive Measures at the Individual, Interpersonal, Community and Institutional Levels: A Literature Review

Anita Owusu², Jacob K. Abebrese²

¹Presbyterian University Ghana, P. O. Box 59, Kwahu, Abetefi

²Bono Regional Hospital, Sunyani

Corresponding author: Anita Owusu. E-mail: owusuanita98@yahoo.com

Corresponding author:

Anita Owusu.

E-mail: owusuanita98@yahoo.com

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Anita Owusu.

Abstract: This study deals with the review of various literature relating to the topic under study, and has been sub-sectioned in accordance as follow key concepts of cerebral toxoplasmosis in HIV, risk factors of cerebral toxoplasmosis, preventive measures against cerebral toxoplasmosis, challenges of HIV patients with adherence to preventive measures, pitfalls in health care affecting the implementation of preventive measures, and theoretical framework. However, Factors affecting HIV clients' exposures and adherence to toxoplasmosis preventive measures can be categorized into individual, interpersonal, community, and institutional levels. These factors influence the extent to which HIV clients are exposed to toxoplasmosis and their willingness and ability to follow preventive measures. Based on research works on resistance patterns done in various parts of the West African sub-region, there has been an increasing worry over how effective co-trimoxazole is as a prophylactic medication against bacterial and parasitic opportunistic infections in HIV patients. CNS manifestations are often the primary feature of HIV/AIDS that leads to its diagnosis in an estimated 1 in 10 patients presenting with neurologic disorders. In late-stage HIV disease, CNS disorders are often associated with poorer outcomes.

Keywords: preventive measures, interpersonal, community and institutional levels

Introduction

Early initiation of highly active antiretroviral therapy (HAART) leads to better outcomes in persons in whom HIV is diagnosed as a result of the occurrence of cerebral toxoplasmosis (Smurzynski et al., 2010a). The standard medical treatment is with a six-week course of

sulphadiazine and pyrimethamine, with sulphadiazine being replaced with clindamycin in patients allergic to or in whom sulphur-based medications are contraindicated. It is particularly important to include folic acid in the regimen "to prevent drug-induced haematologic toxicity" (Lee et al., 2009). In situations of allergy to

pyrimethamine or in low resource settings where the above regimen (owing to the unavailability or high cost of pyrimethamine) cannot be obtained, trimethoprim with sulphamethoxazole is a useful alternative (Lee et al., 2009; Kongsangdao et al., 2008).

In patients with clinical and/or radiologic evidence of increased intracranial pressure or mass effect, mannitol, a medication that works on the principle of osmosis to increase fluid excretion from the body and increases urine output, or dexamethasone, a corticosteroid which combats inflammation, the underlying mechanism causing the swelling, may be used (Lee et al., 2009). The downside of using dexamethasone is that it makes it masks the telltale signs of the severity of the condition and thereby make it difficult to radiologically assess the patient's response to the antibiotics being administered (Lee et al., 2009).

Medications for epilepsy may also be used in patients with seizures but they are not recommended to be given for prophylaxis against seizures in cerebral toxoplasmosis. (Kongsangdao et al., 2008; Lee et al., 2009). It is extremely important that cerebral toxoplasmosis is optimally treated in AIDS patients to prevent the occurrence of immune reconstitution syndrome cerebral toxoplasmosis; this is a serious inflammatory illness that flares up after HAART is initiated (in patients in whom the initial toxoplasmosis led to the diagnosis of HIV) or re-introduction in those who had the initial disease even while they were already on antiretroviral medications (Lee et al., 2009). In such patients who develop this immune reconstitution syndrome cerebral toxoplasmosis the chances of fruitful results with HAART is significantly diminished (Kongsangdao et al., 2008).

To see changes on the radiographic images, it often takes longer time as compared to seeing clinical recovery; hence, it is best to delay radiographic re-assessment until about 2 to 3 weeks after commencement of treatment. However, if the patient fails to respond or even deteriorates, then it is advisable to reassess radiographically and if possible to look for another possible explanation for their presentation other than cerebral toxoplasmosis (Lee et al., 2009). Some conditions that have similar features as cerebral toxoplasmosis that need to be considered and also sought for are primary lymphoma of the central nervous system, progressive multifocal leukoencephalopathy, tuberculous meningitis (also an important consideration

in HIV patients, cerebral abscess and Cryptococcal meningitis (Lee et al., 2009).

In cases of severe intracranial hypertension where medications have proven ineffective at reducing the intracranial pressure, surgery, the only available option, has been tried with some success. Decompressive craniectomy is the surgical operation performed in such cases and it involves excision of part of the brain tissue to reduce the brain mass to bring down the intracranial pressure (Agrawal & Hussain, 2005).

Key Concepts of Cerebral Toxoplasmosis in HIV

Cerebral toxoplasmosis is a parasitic infection of the brain caused by the ubiquitous parasite known as *Toxoplasma gondii* which can be found in many mammals and birds. *T. gondii* is an opportunistic intracellular parasite with the ability to infest and cause destruction to nucleated cells. It is found worldwide, mostly in Asia and South America (Pappoe et al., 2017). The causative parasite *Toxoplasma gondii* has attracted an international attention because of its "public health and socioeconomic impacts" (Elsheikha et al., 2020b).

Toxoplasmosis as a single disease entity, has a considerable effect "on health care services, individual health care costs, and health insurance companies" (Prevention, 2019). It was estimated that toxoplasmosis was responsible for almost 3 billion US dollars in expenses resulting from ill health, and about 11,000 quality-adjusted life years missed every year. In the United States of America only, the total incidence of toxoplasmosis per year was approximated to be 9,832 out of which eye disease and brain disease (cerebral toxoplasmosis) were the most predominant types of the disease (Prevention, 2019). Another study done from 2000 to 2010 over a period of 11 years also in the United States found 789 toxoplasmosis deaths, mostly in Blacks and Hispanics, leading to about 815 million US dollars expended (Prevention, 2019).

The prevalence of infestation with *T. gondii* differs considerably from country to country and spans from about 11% in the United States of America to greater than 80% in some countries in Europe, Latin America, and the African continent. In USA, it is calculated that about 11% of the people who are at least 6 years of age have been infested with the causative parasite *Toxoplasma gondii* at some point in their lives (Elsheikha et al., 2020). Infestation with *T. gondii* is mostly prevalent in parts of the world having "hot, humid

climates and lower altitudes”, the reason being that the oocysts tend to have higher survival rates in such places (Prevention, 2019). Broadly speaking, the occurrence of antibodies to *T. gondii* in serum among people living with HIV tends to reflect a similar rate of serum positivity prevailing among the general populace, and often has no relationship with having cats. That notwithstanding, the prevalence could likely be related to age. For instance, in one study conducted in the United States among women living with HIV, those whose ages were more than 50 years old were more likely to be seropositive as opposed to their younger counterparts (Prevention, 2019).

Humans and other warm-blooded animals are the intermediate hosts whereas animals of the feline family are the definitive hosts for *T. gondii* (Pappoe et al., 2017). Cats (both domestic ones and their relatives in the wild) play a vital role in the transmission of the parasite; they are infected when they eat “rodents, birds, or other small animals” that harbour the parasites. The parasite is then shed in the faeces of the felines in the form of oocysts, which cannot be seen with the naked eyes (Dunay et al., 2018).

These cats are infested by eating meat laden with tissue cysts containing the slow-growing bradyzoites. In the small intestines, they undergo sexual development with resultant production of gametes. Fusion of the gametes leads to the formation of oocysts, which are then shed in faeces. The cats then release millions of *T. gondii* oocysts into the soil where they are mostly resistant to harsh environmental conditions; they remain viable for several months, making them very successful in their propagation (Pappoe et al., 2017). At any given time, however, only an approximate 1% of felines are passing oocysts in their excreta (Dubey 2004). Both adult cats and their young ones can pass many millions of oocysts through their excreta for a period of about 3 weeks following infection. The likelihood of shedding oocysts reduces as a cat ages; hence-adult cats tend to shed less *Toxoplasma* as compared to the younger kittens. This is because as they age they have higher chances of having been exposed to the parasite, and this prior exposure is associated with less shedding of oocysts. As such infected cats “can contaminate the soil or water in the environment as well” (Prevention, 2019).

The life cycle of *T. gondii* in both the definitive and intermediary hosts has been depicted in pictorial form in Fig. 1 below.

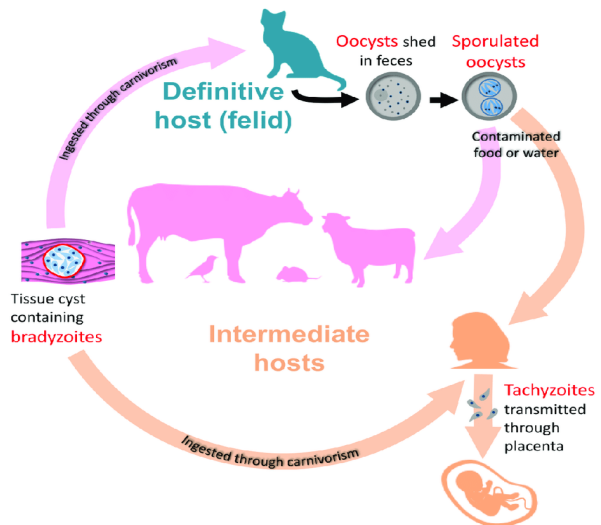


Fig. 1: Life cycle of *Toxoplasma gondii*

Image_source:

<https://www.researchgate.net/figure/The-life-cycle-of-Toxoplasma-gondii>

Acute infection in man is by the fast-growing tachyzoites, which have the ability to enter nuclear cells, leading to destruction and further infestation of more cells. In immunocompetent persons, the infection normally goes into latency as the tachyzoites transform into slow-growing bradyzoites and lie dormant within cysts in tissues such as heart and skeletal muscles, retina and brain parenchyma. Approximately 90% of such individuals show no symptoms (Dubey 2004). Less commonly, however, “cervical lymphadenopathy” or ophthalmic signs could manifest in primary infection among immunocompetent hosts. Infection with highly virulent strains of the parasite, especially rampant in Latin America, oftentimes leads to more serious lung infections and spread to most parts of the body, even among the immunocompetent, and is often fatal (Dunay et al., 2018).

The illness enters latency after acute infection, and a person might live their entire lifetime with the infection in this chronic condition. However, under a condition of immunosuppression, the slowly replicating bradyzoites resurrect and transform into swiftly reproducing tachyzoites that produce serious, life-threatening infections such cerebral toxoplasmosis that, if left untreated, result in significant morbidity and absolute death (Dunay et al., 2018). For them to cause brain infection, they use “complex strategies” to enable them bypass the formidable blood-brain barrier (Elsheikha et al., 2020). Additionally, foetuses could also be infected

in pregnancy. (Pereira-Chioccola et al., 2009). Cellular immunity plays a key role in keeping the infection under control. In the presence of high CD4+ T lymphocyte count there is usually no chance for reactivation of the dormant bradyzoites into tachyzoites for active infection to take place (Pereira-Chioccola et al., 2009; Vidal et al., 2005; Yohanes et al., 2014).

Cerebral toxoplasmosis occurs more frequently in advanced HIV disease when immunologic status is depressed (Luma et al., 2013). Many people have *T. gondii* antibodies present in their sera, including both HIV-infected and HIV-uninfected. For instance, in one study there was a serologic prevalence of 34.78% among HIV patients and 28.95% among those uninfected with HIV (Basavaraju, 2016). Elevated HIV viral load and low CD4 count that result in lowered immune status increase the risk of developing cerebral toxoplasmosis and other AIDS-defining events. Among HIV patients, toxoplasmosis often exhibits in the form of cerebral disease when the CD4+ T lymphocyte count falls below 100 cells/mm³, and alternative presentations occur less frequently (Dunay et al., 2018).

Clinical features of cerebral toxoplasmosis include influenza-like symptoms, body pains, headache, fever, focal weakness, cognitive impairment, seizures, speech disturbances and altered consciousness (Azovtseva et al., 2020; Bedu-Addo, 2006).

Diagnosis is usually by taking into consideration the clinical features, neurological imaging (such as MRI or CT scan), laboratory tests, and less often immunological assays and molecular genetic tests. MRI of the brain is the main diagnostic tool and may show multiple hypointense lesions or a single lesion with hyperintense peripheries (Lee et al., 2009). Common brain CT scan findings include multiple, well-defined lesions with perilesional oedema and mass effect. Single lesions also occur. On contrast enhancement, the toxoplasmosis lesions are often rim-enhancing. *T. gondii* specific immunoglobulins may also be assayed from blood or CSF. *T. gondii* DNA may also be detectable in CSF. (Azovtseva et al., 2020; Dai et al., 2014; Lee et al., 2009; Navia et al., 1986; Vidal et al., 2005).

Risk Factors of Cerebral Toxoplasmosis

Latent infection in the presence of HIV is known to predispose an individual to cerebral toxoplasmosis, especially in the setting of low CD4 counts (often below 100 cells per microliter) and HIV viral loads above 50

copies per milliliter (Pereira et al., 2010a). Lowered immunity is essential for the reactivation of *Toxoplasma* spores that lie dormant in the host awaiting an opportunity to flare up and cause disease, and this is so not only among HIV patients but also among all other patients with any form of immunosuppression (J. Dubey, 2004). Factors that have the potential to increase the chances of a person to risk of primary and latent infection with toxoplasmosis include “age, gender, race, educational level, socioeconomic status, cultural background, level of health literacy, lifestyle, living in rural areas, proximity to cats, contact with soil, scooping cat litter, pregnancy, number of births, frequent travel to areas where *T. gondii* is endemic, immigration, quality and source of drinking water, and *T. gondii* strain genotype/ virulence”. Luckily all these risk factors are easily alterable; thus a reduction in their influence has the prospect of decreasing the occurrence of *T. gondii* infection. Health care systems as well as current health management practices must therefore take all these into consideration so as to curtail the burden of toxoplasmosis, paying more attention to some “vulnerable groups or populations” (Elsheikha et al., 2020b).

Humans are mainly infected by accidentally ingesting the *T. gondii* oocysts via food (e.g. undercooked or raw meat) or water, but vertical (mother-to-child) transmission, transmission via blood transfusion, infection via organ transplantation as well “accidental ingestion or inoculation” of the parasite while working in the laboratory can rarely occur (Dunay et al., 2018; Pappoe et al., 2017). Similarly, transmission via unwashed or improperly washed hands after handling contaminated soil can also lead to infection (J. Dubey, 2004; Pereira et al., 2010b; Pereira-Chioccola et al., 2009). Rarely, infection via the pulmonary route has also been described. *Toxoplasma* does not transmit directly from person to the other; the only known exceptions are when pregnant mothers transmit the infection directly to their children in utero (vertical or congenital transmission) as well as blood transfusion and organ transplantation (Prevention, 2019).

Eating meat which is either raw or cooked to an intrinsic temperature less than 66 degrees Celsius (about 150.8 degrees Fahrenheit) poses a risk of acquiring latent toxoplasmosis, particularly in expectant mothers (J. P. Dubey et al., 2005b). The use of heat is the most effective way to kill the tough spores and oocysts of *T.*

gondii that are often hidden deep within the tissues of meat (Kijlstra & Jongert, 2008b). It is thus of utmost importance to be able to adequately and objectively determine the internal temperature of meat to be eaten, and this can only be done by using food thermometers to test them (Cook to a Safe Minimum Internal Temperature | FoodSafety.Gov, 2019). Additionally, consumption of improperly washed or unwashed and uncooked vegetables and fruits is another predisposing factor (Pereira et al., 2010a).

Inadequate handwashing after farming and gardening in contaminated soil is also a risk factor for infection. (J. Dubey, 2004; Pereira et al., 2010b; Pereira-Chiocola et al., 2009). A conscious effort at good and regular hand hygiene must indeed be the norm for gardeners and farmers since it is nearly impossible to tell which soil is or is not exposed to *Toxoplasma* spores. A study conducted in South Ethiopia found a high serologic prevalence of *T. gondii* among people living with HIV/AIDS, and similar findings have been replicated in other parts of the world (Yohanes et al., 2014). Feeding cats with uncooked internal organs of meat poses a risk to the felines themselves and to people living in the "immediate environment" of these cats (Ogendi et al., 2013a).

Preventive Measures against Cerebral Toxoplasmosis

For primary prevention, HIV patients should receive counseling on the risks of contact with *T. gondii* via eating of raw or undercooked meat (Kijlstra & Jongert, 2008). Thus awareness creation among the general public is of utmost importance, for anyone could acquire HIV at any point in their lifetime.

Tissue cysts of the parasite are destructible using a number of "physical procedures such as heat treatment, freezing, irradiation, high-pressure, acidity and enhancing solutions." However, the most reliable means is by use of heat, which can be achieved by cooking meat to an internal temperature of at least 66 degrees Celsius (Kijlstra & Jongert, 2008). In order to be certain about safe cooking temperature of meat, food thermometers are needed to determine the temperature of the meat deep down in the tissues (Cook to a Safe Minimum Internal Temperature | FoodSafety.Gov, 2019). The public should also be educated to practice good hand hygiene after gardening and handling of soil or raw meat and avoid handling cat excrement. Pet cats and house cats must be fed with commercially made cat

food or well-cooked food in place of raw meat. They should also wash their fruits and vegetables thoroughly before consumption (Basavaraju, 2016).

Among patients infected with HIV, cerebral toxoplasmosis has been found to occur more frequently in those with CD4 counts of less than 100 cells per microlitre in contrast to those with CD4 counts more than 101 cells per microlitre and even less so among those having CD4 counts of more than 350 cells per microlitre. Again, within a group of HIV patients with diagnosed toxoplasmosis, the fraction of those with suppressed viral load levels is often lower as opposed to those who have a viral load count of more than 50 copies per microlitre (Azovtseva et al., 2020).

In HIV patients who have never had cerebral toxoplasmosis, routine prophylaxis with co-trimoxazole must be commenced when CD4 count is less than 100 cells per microliter and must be continued until it has risen to more than 200 consistently for at least 6 months (Swami et al., 2015; Kirk et al., 1999). However, in resource-poor settings, WHO has suggested co-trimoxazole for all HIV patients for life without regard for CD4 count (Müller & Velez Lapão, 2021).

This strategy has proven to be highly effective at keeping opportunistic infections at bay, and not just cerebral toxoplasmosis. Of note is a study performed in Burkina Faso in which there was zero recorded case of cerebral toxoplasmosis among HIV patients who were on prophylactic co-trimoxazole out of 290 HIV patients studied (Bamba et al., 2017). This proves the usefulness of prophylaxis in preventing this severe opportunistic infection in this population. In addition, co-trimoxazole has been shown to reduce the burden of malaria and severe bacterial infections apart from prevention of OIs (Müller & Velez Lapão, 2021). These additional benefits are of immeasurable benefits in resource-poor settings such as Ghana, where disease often comes with serious economic implications on families. As such, this inexpensive intervention with very minimal adverse effects needs to be highly encouraged in all centres where HIV patients receive care. Alternatives that can be used for persons who are allergic to or intolerant of co-trimoxazole are dapsone alone or in combination with pyrimethamine and folic acid (Basavaraju, 2016).

Some authors suggest that all HIV patients must be screened for *T. gondii* antibodies to assess the possible risk of acquiring cerebral toxoplasmosis (Basavaraju, 2016). Another group of researchers who agreed to this

have suggested that this screening could be undertaken yearly for all HIV patients with CD4 counts lower than 200 cells per microlitre (Bamba et al., 2017). Additionally, some authors have proposed screening for *T. gondii* antigens by use of capture-ELISA in all HIV patients due to the risk of cerebral toxoplasmosis (Rostami et al., 2014).

Currently available treatments for cerebral toxoplasmosis do not exterminate the tissue cysts. Consequently, following the full course of treatment, all HIV patients treated for cerebral toxoplasmosis must be put on chemoprophylaxis to prevent recurrence of the infection, which typically occurs within 12 months, especially if HAART is not initiated (or re-initiated in the case of defaulters) (Lee et al., 2009). The first line combination for secondary prophylaxis is sulfadiazine and pyrimethamine and second line is pyrimethamine with clindamycin (Connolly et al., 2017). The prophylactic medication commonly used is co-trimoxazole i.e. sulfamethoxazole with trimethoprim due to its lower cost and ready availability. G6PD deficiency must first be ruled out (Matheus et al., 2021). Alternatively, the treatment regimen that was used to manage the acute disease can be given at halved doses as prophylaxis until the CD4 count is more than 200 cells per microliter for more than 6 months in the presence of normal brain imaging (Basavaraju, 2016).

Challenges of HIV Patients with Adherence to Preventive Measures

Medication adherence has been defined as “the extent to which the patient’s action matches the agreed recommendations” (Kelly et al., 2014). Adherence to antiretroviral therapy (ART) of 95% or more is necessary to achieve the utmost best results out of one’s treatment and reduce the chances of the HIV virus becoming resistant to the available antiretroviral medications (Obirikorang et al., 2013). Adherence to treatment is often measured in various studies, taking into account the facilitators and barriers influencing them. Different assessors in both qualitative and quantitative researches use different approaches. It is a widely known truth that there is no single most reliable standard way of measuring compliance with antiretroviral therapy (Soomro et al., 2019). Some of the approaches used in the assessment of adherence to treatments among people living with chronic conditions who are on long term medications are self-reporting by the individuals themselves, counting of pills, “pharmacy records, self-report electronic monitoring, and therapeutic drug levels”

(Soomro et al., 2019). The choice of technique chosen is oftentimes determined by factors such as the social circumstances and the resources that are available to the assessor. The ones that are most habitually employed in Africa are self-reporting and pharmacy refill because they are simpler to use and less expensive (Soomro et al., 2019). The main disadvantage of self-reporting and counting of pills is low discrimination between compliance and non-compliance. For instance, in self-reporting a person may provide a response indicating what they feel is socially acceptable and not necessarily, what they do. Similarly, when counting pills, some individuals may discard some pills to make the remainder fit in well with what is expected of them (Soomro et al., 2019). Some studies have found that adherence can be overrated to as high as 10 to 20 percent above the rates obtained by other more objective techniques (Mukui et al., 2016). That notwithstanding, self-reporting is the approach employed in assessing adherence to the preventive treatments in this study, and the reasons were because it is simpler and more straightforward to do, and also does not cost much in terms of time and resources.

The rates of non-adherence to antiretroviral (ARV) medicines demonstrate high variability depending on geographical location with some countries having very high rates (such as in some countries in North America) and others having very low rates (such as exists in Kenya) (Mukui et al., 2016). Ghana has an ARV non-adherence rate of approximately 14 percent, and the cumulative level on the African continent stands at around 23 percent (Mukui et al., 2016). Within the same country also, wide variations in adherence rates exist, with one of the causes being the issue of rural versus urban habitation which more often than not also come with inequalities in infrastructural amenities, access to facilities and availability of sufficient health care workforce, among others (Mukui et al., 2016).

For most HIV positive patients, their desire is to take their treatment in order to have good health outcomes and be able to go about living their normal lives, being mindful of the consequences of not adhering well to them. However, some situations make it difficult for them to fully adhere to treatment as expected, both by themselves and by their health care givers. Medication non-adherence has been identified to be quite prevalent (about 55.5%) among patients with chronic diseases in Ghana, and is particularly high (61.7%) among HIV positive individuals (B. Addo et al., 2018).

Some studies have identified higher rates of adherence to antiretroviral therapy among clients who have been on treatment for longer durations of time as compared with those who had been on treatment for shorter periods (Eshun-Wilson et al., 2019; Carlucci et al., 2008). Carlucci et al., 2008 found that the number of days a newly diagnosed HIV patient stays on antiretroviral treatment within the earlier months of starting treatment strongly foretells their general compliance to treatment (Carlucci et al., 2008).

This has been attributed to the same series of developments that take place in individuals with chronic conditions that allow them to deal with them (Eshun-Wilson et al., 2019). It progresses through many phases, such as gathering information about the condition (consciously by seeking out information from different sources, or unconsciously through daily experiences with the disease), making changes to one's way of living, "activating psychological, spiritual and social resources", and then eventually accepting to go about their lives with the condition (Eshun-Wilson et al., 2019). This procedure is made more tolerable when these patients receive the necessary reinforcements, when they have recovered from a disease caused by HIV and by the inner drive to continue to live to continue to take care of their wards (Eshun-Wilson et al., 2019). However the prospects of obtaining support from the social circles are grossly diminished among persons who are living with the HIV infection (Eshun-Wilson et al., 2019).

One of the most important obstacles HIV patients have to deal with in their adherence to care is periodic "stock-outs" of their medications (Moriarty et al., 2018). According to a study conducted at Komfo Anokye Teaching Hospital (KATH) in Kumasi, this situation often forces patients to either unintentionally interrupt treatment or fall on old stocks of medications which they may have been asked to stop taking for one reason or the other, or regimens available from their ART clinics which may be suggested to them in order to ensure continued treatment (Moriarty et al., 2018; Yarney et al., 2016). Shortages of co-trimoxazole preparations for children is reported to be one of the major factors responsible for irregularities in administration and missing doses among children born to HIV positive mothers. Such situations often force health care workers to dispense adult preparations, i.e. tablets, to children, often without proper education to caregivers as to how to use them. Some caregivers do not understand how to

convert these adult co-trimoxazole tablets into suitable preparations at correct doses for their children (Müller & Velez Lapão, 2021). Among the reasons cited as accounting for periodic stock-outs and inconsistent supply of medications are inaccuracies in records leading to imprecise "forecasting" of facilities demands, "logistical challenges" as well as the increasing numbers of persons living with HIV/AIDS (PLWHA) that need to be taken care of (Müller & Velez Lapão, 2021).

Additionally, due to shortages in medications, patients are sometimes given 2 separate review schedules, a longer date given by the attending clinician if they are clinically stable, and a shorter one from the pharmacy due to rationing of medications, and this double schedule is reported by some patients as difficult to follow (Yarney et al., 2016; Amankwah, 2015). This often leads to default, especially when financial cost of transportation on 2 separate schedule dates is a burden to them (Yarney et al., 2016). As such, this interruption in treatment leads to default, with its attendant negative effects such as drug resistance and poor treatment outcomes, mainly in settings lacking the resources to routinely check viral load and genotype (Moriarty et al., 2018).

Interestingly, in some studies conducted in some African countries, it was found that misconceptions about co-trimoxazole led to sub-optimal compliance with prophylaxis. Some patients thought it is a pain medication, others thought that taking it together with their ARVs was harmful to their health (Müller & Velez Lapão, 2021). Some also considered it an HIV medication in itself whereas others struggled to prepare suspensions with tablets for their children when paediatric preparations were not available (Müller & Velez Lapão, 2021). Still others just did not understand why they were to continue taking medications while they felt well. Misbeliefs about antiretroviral medications are also seen among HIV positive individuals in various parts of the world (*Prevalence, Determinants, and Impact of Suboptimal Adherence to HIV Medication in 25 Countries* | Elsevier Enhanced Reader, 2020). All these point to the fact that patients are not adequately educated or given enough information during adherence counseling and routine clinic visits (Müller & Velez Lapão, 2021) since good adherence counseling touches on all the important information patients need to know about their disease and its treatment, such as the purpose of the medications, their adverse effects and what to do when they do occur, among others (Prah et

al., 2018). Indeed a study done across 25 different countries on different continents reported that ARV medication non-adherence was seen more frequently among patients who had not received enough education regarding the usefulness of the medications from their health service providers (*Prevalence, Determinants, and Impact of Suboptimal Adherence to HIV Medication in 25 Countries* | Elsevier Enhanced Reader, 2020).

Stigma at home and in the community is another identified impediment-hampering adherence to treatment among PLWHA in Sub-Saharan Africa, especially among adolescents (S. A. Addo et al., 2018; Ammon et al., 2018). Though HIV is common in the West African sub-region and has been around for years with a lot of public education having gone on to try to destigmatize the condition, but there is still the risk of rejection and discrimination associated with being infected with it (Müller & Velez Lapão, 2021). There is a basic misunderstanding of HIV that leads people to shame and scorn those who are known by them to be living with it. Studies have found that both men and women fear losing their relations with spouses and families when they test positive to HIV, and since co-trimoxazole has widely been associated with HIV, it affects compliance with its use as well (Müller & Velez Lapão, 2021).

Some ART clients, particularly adolescent patients willingly skip their medications when they know they may be at places where someone could notice them take them or find out their HIV status. Such places include schools, churches, markets, among other social gatherings (MacCarthy et al., 2018). Some adolescent boarding students in secondary schools and even tertiary institutions try to hide their medications in places where it would be difficult for other persons to have access to, such as under trunks and suitcases, often founded on the advice of “overprotective” parents (Ankrah et al., 2016a). Such persons deliberately delay in order to take their medications at times when their colleagues are not in sight and no one else is likely to notice. In some instances when it gets difficult to have these privacy conditions fulfilled, they end up intentionally skipping them or even totally forgetting to take them (Ammon et al., 2018; Ankrah et al., 2016a).

Many households in Sub-Saharan Africa consist not only of the nuclear family but also members of the extended family and others, hence making them not private enough for medications to be kept freely in sight (Müller

& Velez Lapão, 2021; Kumarasamy et al., 2005). Some patients made conscious efforts to hide their medications (including co-trimoxazole) in containers of medications used to treat other chronic illnesses (such as asthma, diabetes and hypertension) in the hope that their status would not be known, and some mothers are unable to administer co-trimoxazole to their HIV exposed babies for similar reasons bordering on privacy and perceived stigmatization as above (Dzansi et al., 2020; Müller & Velez Lapão, 2021).

The subject of side effects of antiretroviral medications has risen to public health recognition in recent times owing to its capacity to impact resistance and effectiveness of HIV control (Tetteh et al., 2018). Medication side effects are also commonly cited as a reason for poor compliance with treatment among not only HIV clients but also persons living with other chronic diseases who are on long-term medications (Ammon et al., 2018). Some patients interrupt treatment as a result of unpleasant side effects. The unpleasant side effects most often reported by patients on co-trimoxazole are “itches and headaches, nausea and vomiting, skin lesions or oral wounds, skin rashes, and hypersensitivity reactions. Some patients (Müller & Velez Lapão, 2021) have also reported additionally, heartburn, throat dryness, dizziness, fatigue, appetite loss and numbness”. Rarely, however, “severe cutaneous reactions or burning sensations (e.g. Stevens-Johnson syndrome) required therapy interruption” with some receiving dapsone as an alternative to co-trimoxazole (Müller & Velez Lapão, 2021). Some patients who start having these side effects report back to their health care providers for substitution, counseling or reassurance, while others take them as excuses to default, especially when they continue to experience similar problems even after their medications have been changed once for them (Ankrah et al., 2016a). With regards to antiretroviral medications, the side effects most frequently associated with discontinuation of treatment are the ones relating to the digestive system such as diarrhea, vomiting, nausea and loss of appetite (Tetteh et al., 2018; *Prevalence, Determinants, and Impact of Suboptimal Adherence to HIV Medication in 25 Countries* | Elsevier Enhanced Reader, 2020). In spite of this challenge there is still substantial level of positivity in attitude toward the medications on the part of patients, with many of them understanding and accepting that even the best medicines are not free from side effects and hence they need to adjust themselves and accommodate them (Tetteh et al., 2018). It has been demonstrated in

previous studies that adequate adherence counseling enables patients to cope better with adverse effects of their medications, due to the fact that during these counseling sessions the patients are taken through these often inevitable effects of their medications and what to do when they do occur (Tetteh et al., 2018). With regards to adherence to ART some HIV patients have suggested that if their medications came with less side effects, they were going to be more compliant with them (Prah et al., 2018), further emphasizing the role of medication side effects in non-adherence to treatment.

Pill burden is another challenge often cited as the cause of non-adherence to treatment among HIV clients (Müller & Velez Lapão, 2021). In a study conducted among persons living with HIV and AIDS who were on antiretroviral medications in South Carolina, United States of America, it was reported that those who were on single tablet regimens had higher rates of adherence than those who were on multiple table regimens (Scott Sutton et al., 2016). The schedule of the doses further compounds this problem if the medications are required to be taken more often (Prah et al., 2018). In this study done in four health facilities in the Cape Coast metropolis it was found that ART clients who had been placed on regimens requiring more than one dose per day had an odds of missing a dose of 1.74 times as compared to their compatriots who were on once daily medication schedules (Prah et al., 2018). The authors of the above cited paper have suggested to drug manufacturers to keep on investigating the prospects of fabricating newer agents that stay longer in the human circulation when taken in so as to surmount the obstacles of pill burden and frequent dosing in order to improve upon compliance (Prah et al., 2018). In a qualitative study done in a teaching hospital in the Greater Accra Region of Ghana to assess the facilitators and barriers of adherence to ART among HIV positive patients receiving treatment, participants acknowledged that pill burden and complicated medication schedules made compliance burdensome for them (Dzansi et al., 2020). Additionally, some adolescent and young adult patients who participated in a qualitative research in Kampala, Uganda revealed that the mere thought of having medications to swallow was a perpetual memorial of their HIV positive status which to them made them uncomfortable (MacCarthy et al., 2018). Still a study conducted in 25 countries on ART adherence among persons living with HIV has also documented higher rates of non-adherence in those who reported being burdened with pills to swallow every day (*Prevalence,*

Determinants, and Impact of Suboptimal Adherence to HIV Medication in 25 Countries | Elsevier Enhanced Reader, 2020).

Forgetfulness is another problem HIV patients have when it comes to adhering to their treatment schedule (Ankrah et al., 2016a). Encumbered with tight schedules and the cares of life, some patients report being too busy to take their medications at times (Yarney et al., 2016). Being engaged in occupations that make individuals spend most of their time outside their homes is associated with a higher rate of missing doses (Prah et al., 2018). In the absence of conscious efforts made at keeping them in mind or of treatment supporters living in close proximity with them to remind them, adherence becomes difficult for such people (Müller & Velez Lapão, 2021). ART clients who had treatment supporters to serve as reminders for them to take their medications were found to be more adherent to treatment in one study (Prah et al., 2018), further buttressing the point that forgetfulness definitely impacts adherence negatively. Some patients in some studies have recounted that they make use of various sources of alarms to remind them to take their medicines (Dzansi et al., 2020; Prah et al., 2018). Still others have suggested that if a scheme existed at the ART clinics to prompt them to take their medications and also attend clinic they would be more adherent to their treatments, and have as an instance cited the use of calls and text messages as strategies that could help them in this regard (Prah et al., 2018).

Another impediment standing in the way of good adherence to treatment schedules by HIV patients is financial constraints (Ankrah et al., 2016a). Though the antiretroviral (ARV) medications themselves are free to patients in the country, and the opportunistic infection (OI) prophylaxis medications are available on the National Health Insurance Scheme (NHIS), some patients complain of lack of transportation fare to visit their ART centres for review, refill of their medications, laboratory tests, among others (Prah et al., 2018), and most of them blame this on the distance needed to travel to access the health facilities (Müller & Velez Lapão, 2021). In some jurisdictions, however, the antiretroviral medications are not free and patients have to buy them (Kumarasamy et al., 2005). Such patients are often forced to resort to other means if they are unable to afford their medications, such as seeking assistance from friends and family members, skipping doses for long periods until they are able to buy them, and even “selling family jewels” and other assets (Kumarasamy et al., 2005) With

respect to preparations of co-trimoxazole for children, some parents and guardians have reported lack of refrigerators at home for storage as a barrier to compliance in one study in Sub-Saharan Africa (SSA) (Müller & Velez Lapão, 2021).

In addition to the above, some persons living with HIV have complained of difficulties accessing food due to their low financial status and are therefore unable to take their medications which they are often advised to take after meals (S. A. Addo et al., 2018; Yarney et al., 2016; Obirikorang et al., 2013). Generally ART clients are mindful of the fact that food serves as a safeguard against some of the side effects of their antiretroviral medications, most notably dizziness and general body weakness (Dzansi et al., 2020). The antiretroviral drugs have been demonstrated to promote an improvement in appetite, and many of these patients are aware of them; however, due to poverty some are unable to obtain access to sufficient food needed to match their appetite, and are therefore unwilling to take the medications (Audain et al., 2015). A case in point was when a non-governmental organization offered assistance to some HIV positive individuals in a rural community in one African country but they were refused because they would not want to take them on empty stomachs (Audain et al., 2015). In Kampala, Uganda, one study found that among adolescents living with HIV, access to food which they know to help them overcome medication side effects is a major challenge to them owing to financial hardships, often restricting their adherence to treatment (MacCarthy et al., 2018). The WHO recognizes the importance of integrating alimentary assistance into HIV care programmes and has made recommendations regarding same (Audain et al., 2015). These include intake of normal quantities of vitamins, minerals and proteins, but prescribes an additional increment in energy sources of up to half of that which is recommended for HIV negative individuals (Audain et al., 2015). Vitamins and minerals are vital in ensuring a normal immune status among HIV infected persons; however, it is reported that many of these patients lack these nutrients. The combined effect of these deficits and the HIV positive status exert damaging consequences on each other irrespective of whether or not a patient is receiving antiretroviral therapy, often precipitating the progression to AIDS (Audain et al., 2015). An HIV positive individual living in a setting where food is difficult to come by is sometimes faced with the difficulty of choosing between spending their scarce financial resources on their food or on their treatments

which include medications, transportation to their health facilities and laboratory costs (Audain et al., 2015). In extreme cases patients have been reported to have acquired liver dysfunction as a result of taking their antiretrovirals (ARVs) in the presence of poor nutritional intake (Audain et al., 2015). Indeed a multi country study done with HIV infected individuals to assess adherence to ART actually found that lack of food to take medications was a frequent barrier to adherence (*Prevalence, Determinants, and Impact of Suboptimal Adherence to HIV Medication in 25 Countries* | Elsevier Enhanced Reader, 2020).

It has also been reported by some patients that they generally lack the impetus to take their medications. This is as a result of the combined effects of having to take so many medications, long periods of waiting at the ART clinics (particularly more difficult for mothers with babies), long treatment durations and busy schedules (Müller & Velez Lapão, 2021). This was more so in patients who were also on other medications for other chronic illnesses such as diabetes mellitus, hypertension or asthma (Müller & Velez Lapão, 2021). It sometimes gets depressing for these patients when they ponder over their 'predicament', which they think of as having changed their lives for the worse (Müller & Velez Lapão, 2021).

Interestingly, some sociocultural and religious beliefs also affect patients' compliance to co-trimoxazole prophylaxis and HIV treatment as a whole. These include the refusal to accept their HIV status for which reason some patients are lost to follow-up right from the day of diagnosis. Some studies in Sub-Saharan Africa have identified the role religious beliefs play in denial of HIV status; some are advised to pray for divine healing of HIV while "born-again Christians" are asked to stop taking co-trimoxazole on the grounds that prayers and "deliverance" have the power to heal them from the HIV infection and AIDS (Dzansi et al., 2020; Müller & Velez Lapão, 2021). Some patients are even brainwashed that they cannot take their "clinic medication with church tea" at the same time (Müller & Velez Lapão, 2021). Moreover, there is a perception among some people that orthodox medications are ineffective at curing HIV whereas traditional medicine is able to cure it, and this is worsened by the belief that the two categories of treatment options cannot be combined. As such these patients stop taking their medications, resort to these alternative treatments and are lost to follow-up (Müller & Velez Lapão, 2021).

This is especially so among the older folk who believe that they do not possess any control over their illnesses and that some higher powers determine their fates (Soomro et al., 2019). These beliefs coupled with the fact that the elderly folk are more likely to resort to traditional methods of healing and less likely to embrace “orthodox medications” makes adherence difficult among them (Soomro et al., 2019). In one qualitative study conducted in the Greater Accra Region, a knowledge of the advantages of the medications as well as the repercussions of not properly adhering to them were acknowledged by participants as driving good adherence as opposed to not being aware of these (Dzansi et al., 2020). The participants in this same study also acknowledged that they were motivated to adhere to treatment merely by the fear of dying from the condition (Dzansi et al., 2020) with the participants from another qualitative study also done in Ghana buttressing this point by adding that they wanted to keep on being alive in order to continue to take care of their dependents (Eshun-Wilson et al., 2019). Some authors have therefore advised that health care workers working with HIV patients need to brace them up by providing adequate adherence counseling to enable them stay motivated while receiving treatment so as to be more adherent to their treatments (Dzansi et al., 2020).

The role of family members and friends also has an impact on the compliance of HIV patients with their antiretroviral medications (Kumarasamy et al., 2005). The support of family is invaluable in ensuring the continuance of treatment and retention in care among HIV patients (Prah et al., 2018) and this support often comes “in the form of emotional/psychological, physical, and food provision” (Obirikorang et al., 2013). This group of people has been proven to be highly supportive to some patients in encouraging good adherence and thereby ensuring the continuity of care (Kelly et al., 2014). However, some family members and friends have been shown in some studies to subvert the efforts of HIV patients in complying with treatment (Müller & Velez Lapão, 2021). For instance, some family members have been reported by participants in some studies to discourage patients from taking their medications and in the worst scenarios have even disposed of their medications without their knowledge. Some husbands, refusing to accept the HIV statuses of their wives, have discouraged them from taking their medications or administering them to their children (Müller & Velez Lapão, 2021). Some adolescents and young adults are

documented in one study in Uganda to have complained about ambiguous family support, sometimes brought about by “constant change in guardianship” among those who have lost their real parents to HIV and AIDS, and this impedes their adherence to antiretroviral medications (MacCarthy et al., 2018). However, peer support networks among adolescents with the same HIV status has been acknowledged by respondents in one Ugandan study to contribute towards enhancing adherence (MacCarthy et al., 2018). Improved outcomes in terms of immune restitution as a result of such peer support has also been demonstrated in that study (MacCarthy et al., 2018).

Abuse of recreational drugs is another factor cited in a lot of published works as accounting for non-adherence to ART among people with HIV (Reda & Biadgilign, 2012; Bhatti et al., 2016). Alcohol, heroin and cocaine have been cited among the list of such drugs (Bhatti et al., 2016). These drugs give rise to impaired cognitive function, poor judgment, disrupted social life among others that negatively impact on adherence to treatment (Bhatti et al., 2016).

Psychiatric illnesses are also one of the major comorbidities of HIV infected individuals (Reda & Biadgilign, 2012; Bhatti et al., 2016). Conditions such as depression, anxiety and stress often resulting from poverty, have been shown to contribute to reduced adherence (Bhatti et al., 2016).

Patients’ failure of comprehending their medication dosing directives given by their health care providers due to lack of formal education is also a recognized cause of high non-adherence among HIV patients on ARV medications, particularly in Sub-Saharan Africa (Bhatti et al., 2016). It renders patients incapable of heeding the guidelines given to them about the medications, leading to poor compliance (Bhatti et al., 2016).

Pitfalls in Health Care Affecting Implementation of Preventive Measures

In Sub-Saharan Africa, the required number of healthcare professionals is often insufficient in all areas of healthcare (Zachariah et al., 2009). There has been a disproportionate rise in the patient-to-health provider ratio as a result of the acceleration of HIV case finding, enrollment into care, and the adoption of the treat-all (universal treatment) policy in 2015, which has led to a larger number of HIV patients on treatment and needing

ongoing care (Müller & Velez Lapo, 2021). The region is bedeviled with frequent expatriation of skilled workers due to “difficult working conditions and low motivation” as well as a vast field of work as far as HIV and other infectious diseases are concerned. Hence, health staff often assign duties to less qualified persons, and this affects the quality of patient care (Zachariah et al., 2009). In one study involving many health facilities at all levels in the country, some staff complained of high numbers of patients at their ART centres being a challenge to service delivery (S. A. Addo et al., 2018).

Additionally, the huge numbers of patients being attended to by these workers puts a burden on them (S. A. Addo et al., 2018). This shortage of health staff cuts across all categories including doctors, who, on the average per person, have to attend to about twenty to forty patients prior to lunchtime, as well as pharmacists and nurses (Müller & Velez Lapão, 2021). Due to the inadequate numbers of pharmaceutical staff in some settings, nurses are sometimes forced to take up this role with very little knowledge about how to correctly dispense the medications to patients. Dispensing of medicines by such untrained personnel is usually unaccompanied by adequate education and instructions on their usage such as adverse reactions to expect and the actions to be taken when they show up (Müller & Velez Lapão, 2021).

ART clinics in Sub-Saharan Africa are often overcrowded with little or no privacy for patients (Reda & Biadgilign, 2012), and the step by patients to attend them is a bold one considering the risk of being seen by others in the community while waiting in the queue to be seen by their clinicians, access laboratory services or to receive medications such as co-trimoxazole (Müller & Velez Lapão, 2021). This alone is enough to adversely affect compliance with treatment in many HIV patients. Studies have shown that not feeling comfortable taking one’s medications in the presence of others is a strong predictor of poor adherence to treatment (Müller & Velez Lapão, 2021).

Shortage of medications is another important barrier to effective adherence to ART and CPT. Several studies have corroborated the wide gaps that exist in ARV medication distribution among various jurisdictions, with deprived and resource-poor settings having more frequent shortages than their well to do counterparts (Müller & Velez Lapão, 2021; Bhatti et al., 2016; Reda & Biadgilign, 2012). This frustrates efforts at ensuring good

adherence among affected individuals. The most significant reason given for this unfortunate scenario is the “weak procurement and supply management systems” (Reda & Biadgilign, 2012).

“Shortage of test reagents” is also another obstacle faced by ART clients in their course of management. When ART laboratories lack appropriate reagents to run investigations such as viral load and CD4 count, it becomes difficult to monitor patients for their immunologic and virologic statuses, which are important indicators of the risk of cerebral toxoplasmosis and other OIs (S. A. Addo et al., 2018).

Based on research works on resistance patterns done in various parts of the West African sub-region, there has been an increasing worry over how effective co-trimoxazole is as a prophylactic medication against bacterial and parasitic opportunistic infections in HIV patients. For instance, one study conducted in Tanzania found high rates of resistance of intestinal coliforms to co-trimoxazole (Müller & Velez Lapão, 2021). Another similar study (market survey of paediatric suspensions of co-trimoxazole) done in Nairobi County in Kenya also identified some substandard samples that fell short of the required criteria for safety and efficacy of medicines, such as the active pharmaceutical ingredients, microbial contamination levels and acidity levels (Irungu et al., 2021). In much the same way, samples of co-trimoxazole collected on the open market in Ghana, Nigeria and the United Kingdom in one research work revealed that some of these medications (all bought from Ghana and Nigeria) failed the acceptable standards expected of pharmacological agents in order to be effective against diseases and also help prevent the development of drug resistance (Fadeyi et al., 2015). Factors such as easy access to this important medicine (as well as antibiotics in general) in unauthorized places are believed to have accounted for this trend (Müller & Velez Lapão, 2021). Other possible explanations include the fact that most pharmaceutical manufacturers have stopped researching into antibiotics due to financial and “regulatory challenges” with only about four main giants (namely AstraZeneca, Sanofi Aventis, GlaxoSmithKline and Novartis) involved in antimicrobial research in the entire world; as such there has been mushrooming of several generic antimicrobials by different manufacturers (Fadeyi et al., 2015). Yet again, unscrupulous prescription of antibiotics and insufficient dose administration have also contributed to drug resistance (Fadeyi et al., 2015). As a result, the inertia to comply

with CPT is high among those who are well informed about such news (Müller & Velez Lapão, 2021). The impact of such counterfeit drugs poses a threat to patient safety giving rise to prolongation of the time taken for their infections to heal, and this also negatively impacts on health resources, economically on the productivities of the patients themselves as well as on the people who take care of them (Kumarasamy et al., 2005).

Other organizational factors have also been found in some African studies as a factor-inhibiting adherence to co-trimoxazole prophylaxis as well as ART among PLWHA. Long waiting hours at the ART clinics have been cited as a deterrent to some patients from keeping up with their scheduled appointments, and patients often face the dilemma of “spending a full day waiting at the clinic, dedicating the time to their work or addressing other family members’ needs” (Müller & Velez Lapão, 2021). Other inefficiencies in the health system that have also been reported to dissuade HIV patients from regularly seeking care include missing laboratory test results, health facilities dispensing medication quantities that are short of the recommended number that would be enough to last before the next appointment, facility infrastructure that make it practically impossible to “ensure patient privacy and confidentiality” as well as lack of follow-up of patients who are unable to report on their appointment dates (Müller & Velez Lapão, 2021). The authors in one study conducted in Ghana have proposed that health care providers who work with HIV clients continue to find ways of reducing waiting times at the ART centres such as “appointment scheduling” for specified dates and times so as to minimize the times spent waiting in queues to be seen and thereby encourage these patients to follow through with their care at the health facilities (Dzansi et al., 2020).

Deficiency of facilities is another challenge to the implementation of preventive measures against OIs in HIV patients. Lack of equipment to screen for *T. gondii* serologic status is a problem facing the health sector in their role in the prevention of cerebral toxoplasmosis. Now only a few teaching hospitals and private laboratories have the capacity to test for *T. gondii* serology. Of 172 health facilities sampled across the country in one study, only 10 (0.06%) had equipment for testing for HIV viral load levels (S. A. Addo et al., 2018).

Studies done in some deprived areas have revealed that some health facilities lack weighing scales for measuring the weight of children to help guide the correct dosing of

co-trimoxazole for them. As such prescribers are forced to rely on age for, approximating the dosages, which is less accurate, and may result in insufficient (and for that matter ineffective) doses or vice versa (Müller & Velez Lapão, 2021). Some studies have even uncovered patients’ unwillingness to shuttle between facilities for tests and/or services as being a barrier to compliance with schedules and treatment, and this oftentimes is as a result of financial difficulties (for transportation) and further delays (Müller & Velez Lapão, 2021).

Lack of periodic on-the-job training and technical support is another point raised in a survey of staff at ART sites across the country when assessing their challenges, where some health workers themselves lamented “inadequate on the job training” as a challenge in HIV “service delivery” (S. A. Addo et al., 2018). Related to the above is the challenge of “knowledge gaps” among health care providers dealing with HIV patients. For instance, a study conducted in the Kumasi metropolis among nurses found that many of them held misconceptions about how HIV is spread and were uncomfortable dealing with infected patients for fear of acquiring the infection from them (Boakye & Mavhandu-Mudzusi, 2019). This was found to affect their attitudes to these patients negatively (Boakye & Mavhandu-Mudzusi, 2019). Some HIV care workers do not receive adequate training in the implementation of HIV programmes and as such lack the requisite knowledge to make informed decisions regarding the treatment and prophylaxis for patients according to standard practices (Müller & Velez Lapão, 2021). In addition, health workers involved in HIV care do not always have access to guidelines regarding co-trimoxazole prophylaxis or understand them. Among the areas identified that health care providers lacked knowledge in are co-trimoxazole preventive therapy (CPT) for babies, pregnant women, inclusion and exclusion criteria as well as the general dispensing of the drug (Müller & Velez Lapão, 2021). In view of these, some authors have suggested the need for continuing training and refresher courses for all health staff involved in HIV care with the aim of enlightening them, rectifying their misbeliefs, fostering an accommodating attitude towards HIV patients, and improving the practice of acceptable standards in their service delivery to persons living with the infection (Boakye & Mavhandu-Mudzusi, 2019).

Similarly, opportunities for further career development was found by some researchers to be considered an important incentive to health workers amidst the heavy

workload and pressure encountered in the discharge of their duties. As a result, there is a high tendency of losing them to places where such incentives are provided, thus aggravating the already existing problem of low staff numbers (Müller & Velez Lapão, 2021). Effective HIV management requires a strong collaboration between health staff involved in prevention of mother to child transmission of HIV (PMTCT), maternal and child health as well as HIV and tuberculosis (TB) care. This requires coordinated efforts of leadership concerned, with clear guidelines on the roles of each unit involved. However, some studies have uncovered gaps in this regard. For instance, some nurses and lay counsellors reported being unclear about the roles, they were required to play as far as CPT for babies born to HIV positive mothers were concerned (Müller & Velez Lapão, 2021). Some HIV care personnel regard the guidelines on prophylaxis as complex and difficult to implement, and as such if poorly supervised are not motivated to give of their best (Müller & Velez Lapão, 2021). Another challenge within the health facility circles raised by some HIV clients as inhibiting adherence to treatment is the issue of disrespect from some health care workers towards such clients (Eshun-Wilson et al., 2019).

Theoretical Framework

The study is based on the social ecological model (SEM). This model was first introduced by Urie Bronfenbrenner in the 1970s, and subsequently developed into a theory by sociologists in the 1980s (Social-Ecological Model Offers New Approach to Public Health, 2017). This theory emphasizes linkages and relationships among multiple determinants of health. It recognizes the influence of an individual's environment on health, and that these influences occur at diverse levels, interact intricately with, and complement one another (Golden & Earp, 2012). Its focus is on how the environment shapes behaviour and how there can be multiple levels of influence on a specific behaviour or behavioral pattern. Changes in these interactions often affect health. The settings in which individuals live can affect their health status and wellbeing (The Social-Ecological Model, 2021). An understanding of these interrelationships is crucial to the designing and implementation of effective public health interventions (Social-Ecological Model Offers New Approach to Public Health, 2017).

There are five (5) levels of influence affecting the health of individuals and populations according to this model. Complex interactions occur at each level of the model,

and it is important that these levels are targeted and worked on simultaneously in order for any public health interventions to be effective (The Social-Ecological Model, 2021). These levels are individual, interpersonal, institutional, community and social (policy) levels. Individual: Factors pertaining to a person's biology and "personal history" such as age, sex, genetic make-up, educational level, economic status, among others come into play here. These factors have the ability to strongly influence behavior and health. For instance, a person's economic status could determine their approach to healthcare and for that matter their health status (Social-Ecological Model Offers New Approach to Public Health, 2017). Plans directed towards prevention need to be aimed at "attitudes, beliefs and behaviors" of the individual that strongly affect the outcome of interest (The Social-Ecological Model, 2021).

Interpersonal: The kind of affiliations and ties between individuals also plays a role in their behaviours that affect their health. These relationships include families, friends and their traditions that bind them together, and their closeness to an individual makes them exert great influence and also contribute much to their individual experiences (Social-Ecological Model Offers New Approach to Public Health, 2017; The Social-Ecological Model, 2021).

Community: The context in which an individual dwells and interacts socially also influences behaviour and health. These include neighborhoods, schools and workplaces. Interventions for prevention must be aimed at "improving the physical and social environment" of these contexts (The Social-Ecological Model, 2021). Institutional/organizational: Organizations play a substantial role in nurturing behaviours through the regulation and reinforcement of rules, ordinances and injunctions that direct information and human actions. For instance, a school "controls the dissemination of knowledge" and this is important in "communicating information about safe health practices" (Social-Ecological Model Offers New Approach to Public Health, 2017).

Societal (social, policy): This level has to do with the broader context of the larger society that influences a greater number of people (The Social-Ecological Model, 2021). Policies that create an enabling environment (or otherwise) affect health of large numbers of people in the local, national and international settings. As such, this level is also referred to as the enabling environment level

by some authors (Social-Ecological Model Offers New Approach to Public Health, 2017). The recognition of these complexities existing and interacting with individuals is crucial to the designing of health promotion strategies. The desired end of a programme determines the level that must be tackled in order to achieve its goals (Golden & Earp, 2012). For instance, interventions at the individual level often seek to make changes in the “knowledge, beliefs and skills of individuals” (Golden & Earp, 2012). Similarly, programmes aimed at interpersonal and institutional level changes must target relationships within the society as well as the milieu of organizations (Golden & Earp, 2012). This study seeks to examine the factors affecting HIV clients’ exposures and adherence to toxoplasmosis preventive measures at the individual, interpersonal, community and institutional levels. Further studies could focus more on the societal level.

CONCLUSION

Even though, with the advent of modern effective ARV medications, AIDS-defining illnesses such as cerebral toxoplasmosis occur less commonly as compared to the pre-HAART era, the need to continuously monitor HIV-positive individuals cannot be overemphasized. Careful monitoring of these patients makes it easier to put in place timely measures such as OI prophylaxis and review of ART to help maintain optimum CD4 counts as well as adequate viral suppression to help prevent AIDS-defining illnesses such as cerebral toxoplasmosis from occurring. There is therefore a need to address the challenges posing barriers to the effectiveness of preventive strategies needed to halt or at least minimize the occurrence of cerebral toxoplasmosis. These challenges often range from the individual, interpersonal, community, institutional, and societal levels as categorized by the social ecological model. The focus of this study was on the first four levels, i.e., individual through institutional. Further studies could look at the societal level as well.

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Data Availability

Data used for this research is available upon request from the corresponding author.

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