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Burden of HIV on Society Current Management Options and Future Prospective

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Authors' contributions

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Review Article

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ABSTRACT

Nevertheless, there is still a disparity in the availability of antiretroviral therapy (ART), especially in low- and middle-income nations, due to obstacles such as financial constraints, inadequate infrastructure,and on going social stigma. The future outlook for HIV management is optimistic, as current research is dedicated to exploring innovative treatment methods such as long-acting injectable, gene editing medicines, and therapeutic vaccinations. Furthermore, progress in pre-exposure prophylaxis (PrEP) and other preventive measures provide optimism for decreasing the number of new infections. Furthermore, it is crucial to make endeavors towards tackling societal factors that influence health outcomes, such as poverty, education, and gender inequality, as they play a vital role in attaining long-lasting advancements in HIV prevention and care. Notwithstanding these progressions, there are still obstacles to overcome, such as the rise of drug-resistant

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variations, deficiencies in testing and diagnosis, and enduring social obstacles. To tackle these difficulties, a comprehensive strategy is needed that combines biological, behavioral, and structural interventions, with a focus on fairness and human rights. To reduce the impact of HIV/AIDS on society and achieve the objective of ending the epidemic, it is important to continue investing in research, improving health systems, and promoting collaboration across all sectors.

Keywords: Human immunodeficiency virus; economic productivity loss; encompassing healthcare cost; affecting people's health.

1. INTRODUCTION

HIV/AIDS continues to be one of the most dangerous infections affecting people's health worldwide. Since its discovery in the early 1980s, HIV has affected millions of people worldwide, greatly raising morbidity and mortality rates. Understanding the complex nature of HIV can help people create strategies that effectively combat the infection, lessen stigma, boost studies, and enhance the quality of life for those who suffering with HIV [1]. The first HIV infections were reported in the 1980s, which had a big impact on global health. The virus swiftly spread to nearby countries despite first being thought to be an unidentified illness that predominantly affected men. Research in virology, immunology, and public health has advanced significantly as a result of scientists' efforts to comprehend and combat HIV. HIV was once a cause of death, but with the discovery of the virus, the creation of diagnostic tools, and the introduction of Antiretroviral Therapy (ART), it is now a chronic, manageable condition for those who can obtain it [2].

Nevertheless, HIV/AIDS persists as a significant issue in numerous underdeveloped nations with limited resources, causing loss of human life. Over the course of the last three decades, the prevalence of HIV/AIDS has escalated rapidly, making it one of the ten most significant global health challenges [3]. In 2019, the Joint United Nations Program on HIV/AIDS (UNAIDS) documented that there were approximately 38 million individuals living with HIV. Out of this total, around 36.2 million were adults and 1.8 million were children between the ages of 0 and 14. Additionally, approximately 1.7 million people contracted HIV/AIDS for the first time, while 690,000 individuals lost their lives due to diseases related to HIV/AIDS [4]. HIV/AIDS has an impact on the progress and advancement of human development. Due to advancements in medical treatments, the life expectancy of individuals with HIV/AIDS has risen, resulting in a decline in mortality rates. Consequently, many individuals living with HIV/AIDS are now in a stable health condition. Universal access to HIV/AIDS treatment is lacking, and the likelihood of viable therapies and vaccines remains questionable [5].

HIV belongs to the Lentivirus genus in the Retroviridae family, specifically in the Orthoretrovirinae subgroup [6]. HIV is categorized into two forms, HIV-1 and HIV-2, based on genetic traits and variations in viral antigens. SIV, which stands for simian immunodeficiency virus, belongs to the genus Lentivirus, along with the immunodeficiency viruses found in non-human primates. Based on existing epidemiologic and phylogenetic research, it is inferred that HIV was introduced into the human population between 1920 and 1940. HIV-1 originated from immunodeficiency viruses found in Central African chimpanzees (SIVcpz), while HIV-2 came from immunodeficiency viruses found in West African sooty mangabeys (SIVsm) [7,8].

An important characteristic of the pandemic in the present decade is the growing prevalence of HIV-1 infections in women [9] which also has consequences for the transmission of the virus from mothers to their children. Currently, around 42% of the global population affected by the infection consists of women, with more than 70% of them residing in sub-Saharan Africa. In total, 25% of all newly acquired HIV-1 infections occur in individuals who are under the age of 25. The prevalence of HIV-1 infection is significantly higher in female adolescents compared to their male counterparts, with rates being three to six times greater [10,11]. This disparity is mostly ascribed to the sexual behavior of young women, who tend to engage in relationships with older men. The prevalence of HIV-1 infection in the population, along with factors such as concurrent sexual relationships, partner change, sexual practices, the presence of other sexually transmitted diseases [12-14], and population mobility patterns [14] due to economic reasons or events like natural disasters and wars, all contribute to an increased likelihood of acquiring HIV-1 [15,16]. Recent results support a clear

association between the risk of acquiring HIV-1 through sexual activity and occasional use of recreational drugs or alcohol [17].

HIV targets and eradicates the CD4 cells of the immune system, which are the primary cells responsible for combating infections in the body. Decreased CD4 cell count hampers the body's ability to combat infections. If therapy is unsuccessful, HIV can gradually deteriorate the body's immune system and progress to Acquired Immunodeficiency Syndrome (AIDS), a clinical illness characterised by immune system failure that leads to opportunistic infections [18]. On a global scale, the prevalence of HIV and the number of deaths caused by AIDS have gradually decreased over time [19]. This can be ascribed to the life-preserving antiviral medication. HIV is classified into two types, HIV type 1 (HIV-1) and HIV type 2 (HIV-2), based on variations in viral antigens and genetic traits. HIV-1 is highly pathogenic and is the primary driver of the worldwide AIDS epidemic, whereas HIV-2 is less pathogenic and less prevalent, with its clinical manifestations being linked to those of HIV-1 [20]. Significantly, the majority of HIV-2 cases have been documented in nations located in West Africa and have spread to countries that have historical and socio-economic connections to this region [21].

The presence of genetic diversity in HIV-1 is attributed to the error-prone nature of the reverse transcriptase enzyme, recombination events that occur during virus replication, the fast turnover of HIV-1 in the body, and the selective pressures exerted by the immune system [22]. HIV-1 utilizes an intricate process called recombination as a means of survival to evade the immune system. The primary challenge in treating HIV and developing effective medications is the extensive genetic diversity of HIV-1 [23]. This diversity manifests swiftly, with certain variants being perceived as more virulent and displaying resistance to various antiretroviral medicines. The heightened genetic diversity of HIV-1 poses significant challenges in the fields of clinical medicine and public health [24,25].

While HIV-2 is less prevalent worldwide, it significantly contributes to the occurrence of diseases in numerous places. It is most prevalent in West Africa, but due to globalisation, there has been a significant increase in the number of cases in other regions of Africa, Europe, India, and the United States. The latest global estimate is that there are approximately 1 to 2 million individuals living with HIV-2, although this figure is likely to be lower than the actual number. HIV-2 was initially identified in the United States during the late 1980s [26]. Presently, it is estimated that approximately 1% of individuals living with HIV in the US are infected with HIV-2. Healthcare professionals typically have limited knowledge about HIV-2, and there is a lack of detailed information about the disease. Our current knowledge on the frequency, therapy, and surveillance of this virus is restricted when compared to HIV-1. So far, the strategy to dealing with HIV-2 has mostly been based on information from studies on HIV-1, even though there are significant distinctions between the two [27]. The relatively lower occurrence of HIV-2 in comparison to HIV-1 has led to a scarcity of pharmacological trials or epidemiological studies aimed at addressing the current gaps in our knowledge of HIV-2 care. Due to its worldwide spread, medical professionals must acquire knowledge about the distinctions between HIV-1 and HIV-2, while also maintaining a vigilant mindset regarding HIV-2 in individuals from countries where it is prevalent [28,29].

The rapid dissemination of HIV-2 was accelerated by the ongoing colonial conflicts in Guinea and other parts of West Africa from the 1960s to the 1970s. Consequently, there was a substantial movement of people across West Africa, as well as a significant number of individuals leaving the region to settle in Europe. During ongoing battles, blood products were extensively utilised for treating injuries, while sexual connections developed between military personnel and civilian residents. Additionally, widespread immunisation campaigns were implemented, but without employing contemporary sterilisation techniques [30].

HIV-2 emerged in Guinea Bissau due to these causes and quickly spread to nearby countries and subsequently to distant Portuguese possessions such as Cape Verde, Angola, Mozambique, India, and Brazil. As a consequence, Portugal now has the highest frequency of HIV-2 infection in Europe due to this outcome [31]. Approximately 1.2 million individuals deceased and 2 million individuals acquired new HIV/AIDS infections over a period of one year. Hence, HIV/AIDS is a significant worldwide health challenge [32].

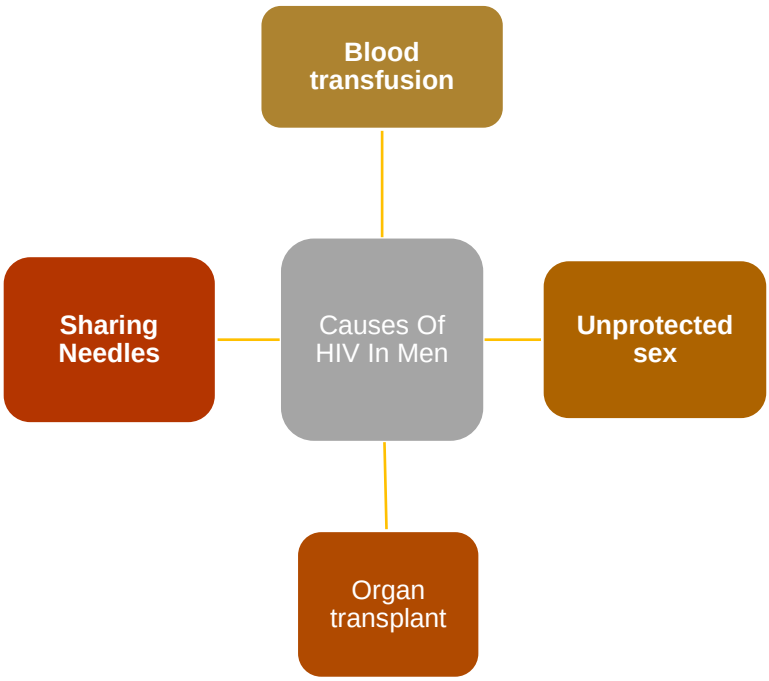

Fig. 1. Major causes of HIV in men

Following the implementation of multiple antiretroviral therapy (ART), HIV/AIDS transitioned into a chronic condition, necessitating the provision of extended care and support for affected individuals. HIV/AIDS primarily affects people in their productive years, in contrast to other illnesses [33,34]. HIV/AIDS-related chronic illness necessitates increased healthcare expenses for households afflicted by the virus. Hence, HIV/AIDS leads to the reduction of savings and productive assets, while also exacerbating the indebtedness of households impacted by HIV [35]. Additionally, the increased healthcare expenses of households result in reduced investments in nutritious food for family members, farming or business ventures, and children's education. Following the implementation of antiretroviral therapy (ART), mortality rates have decreased. However, a significant number of individuals (1.2 million) still succumb to HIV/AIDS annually. Mortality occurring within the productive years of an individual's life is a significant determinant of the economic consequences of HIV/AIDS [35]. The impact of HIV/AIDS at the household level include both direct costs, which include medical and non-medical expenses, and productivity costs, such as the loss of labour time due to the illness of household members who are HIV positive. Additionally, there is also the time spent by others in caring for these individuals [36]. The evidence indicates that HIV/AIDS imposes substantial financial burden on households as they struggle to cover healthcare expenses and compensate for the income they have lost.

According to the latest report from The Joint United Nations Programme on HIV/AIDS, there were 38.4 million individuals living with HIV infections in 2021, and 1.5 million persons contracted HIV as new infections [37]. The introduction of combination antiretroviral therapy (cART) has significantly transformed the progression of HIV infection by effectively lowering the presence of HIV in the bloodstream, rejuvenating the immune system, and enhancing the overall well-being of those living with HIV [37]. HIV treatment currently involves the use of five different classes of antiretrovirals that target various stages of the HIV life cycle. These include entry inhibitors that prevent the attachment of HIV envelope glycoprotein gp120 to CCR5 co-receptors (such as maraviroc) or block cell fusion mediated by HIV gp41 (like enfuvirtide). Additionally, there are nucleoside reverse transcriptase inhibitors (NRTIs) and non-nucleoside reverse transcriptase inhibitors (NNRTIs) that hinder the reverse transcription of viral RNA into cDNA. Furthermore, integrase strand transfer inhibitors (INSTIs) are used to inhibit the integration of proviral DNA into the host genome. Lastly, protease inhibitors (PIs) are employed to impede the protease-mediated cleavage of gag and gag-pol precursors,

resulting in the production of non-infectious virus particles [38]. Nevertheless, the appearance of drug resistance and multidrug resistant strains continues to be a significant factor in the failure of combination antiretroviral therapy (cART), leading to an increased likelihood of HIV-disease progression and death [39]. Drug cross-resistance can happen within the same class and impacts all major categories of antiretroviral medicines [40]. The most recent WHO HIV medication Resistance Report reveals a significant rise in the occurrence of acquired and transmitted HIV medication resistance among individuals who have not yet received antiretroviral therapy (ART). This increase poses a significant challenge to achieving the goal of ending the HIV-1 epidemic as a public health concern by 2030 [41].

2. REPLICATION CYCLE OF HIV/AIDS

The Human Immunodeficiency Virus, also known as HIV, is a virus that assaults the immune system. It primarily targets CD4 cells, which are a type of white blood cell that plays an important role in the body's defense against infection. Initially, the HIV virus attaches itself to the surface of CD4 cells by attaching to specific receptors on the cell membrane. This process is known as the "surface attachment." Although the CD4 receptor is one of the principal receptors that HIV utilizes, it is also necessary for HIV to have a coreceptor, which is often either CCR5 or CXCR4, in order to permit entry into the cell. Once it has attached itself to the host cell, HIV will fuse with the membrane of the host cell, thereby releasing its genetic material into this cell. This genetic material, which is made up of RNA, is subsequently transformed into DNA by an enzyme known as reverse transcriptase. This enzyme is a trait that is unique to retroviruses such as HIV. The freshly synthesized viral DNA is then carried into the nucleus of the CD4 cell, where it is integrated into the DNA of the host cell with the assistance of integrase, which is another viral enzyme.

Once it has been integrated, the DNA of the virus becomes an indelible component of the genetic material of the host protein. The machinery of the host cell is responsible for the transcription of the integrated viral DNA into messenger RNA (mRNA), which subsequently guides the production of new viral proteins and the RNA genome. New viral RNA, proteins, and enzymes are assembled into complete viral particles, also known as virions, at the surface of the CD4 cell that is infected with the virus. The freshly constructed virions bud forth from the CD4 cell that is infected, obtaining an envelope that is derived from the membrane of the host cell and is studded with viral glycoproteins such as gp120 and gp41. The immature viral particles go through a process called maturation after they

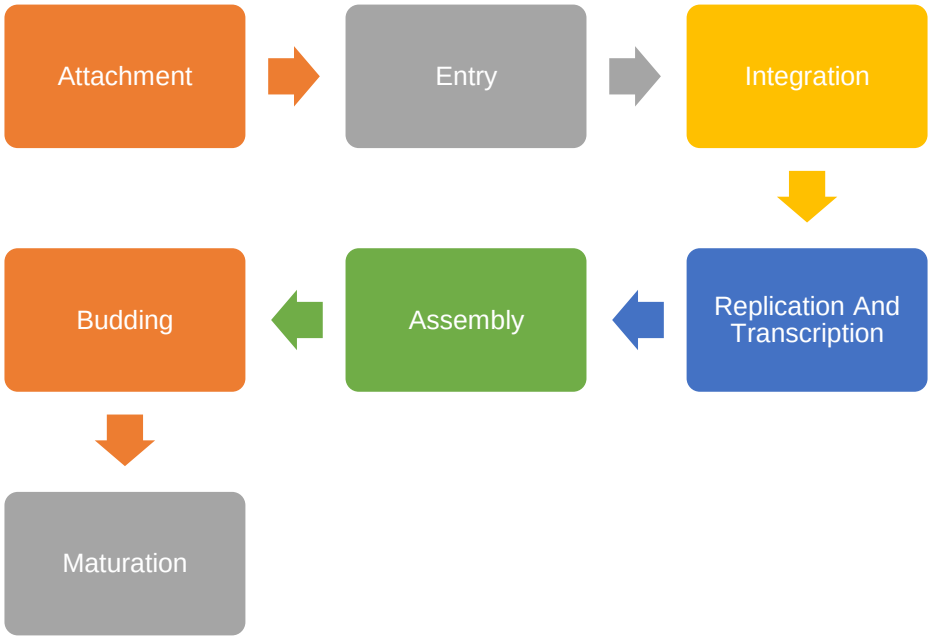

Fig. 2. Replication cycle of HIV/AIDS

have undergone budding. During this process, viral enzymes split big precursor proteins into smaller functional pieces, which ultimately results in mature infectious virions that are capable of infecting other CD4 cells. During this cycle, HIV continues to reproduce and infect new CD4 cells, which ultimately results in a gradual decrease in the immune system's capacity to defend itself against infections and diseases. AIDS, also known as acquired immunodeficiency syndrome, is a condition that is characterized by severe immunodeficiency and vulnerability to opportunistic infections and malignancies. If HIV infection is not treated, it can proceed to AIDS [32]. The overall life cycle of HIV/AIDS is presented in Fig. 3.

3. INCIDENCE AND IMPACT OF THE HIV/AIDS PANDEMIC

HIV, a type of virus that affects humans, continues to be a highly important infectious illness on a global scale. It has a considerable influence on public health, social interactions, and economic progress. Gaining a comprehensive understanding of the epidemiology of HIV is essential for successfully implementing efficient prevention, treatment, and control methods. This article examines the worldwide distribution and patterns of HIV, encompassing trends, factors that contribute to the spread of the virus, groups that are impacted, and the difficulties encountered in preventing and managing HIV [42]. The global HIV/AIDS epidemic is comprised of multiple distinct epidemics that are unevenly distributed throughout sub-Saharan Africa. Each epidemic has its own unique characteristics, which are influenced by factors such as geography, the specific population affected, the prevalence of risky behaviors and practices, and the timing of the virus's introduction [43]. Furthermore, the epidemic's transmission can be affected by biological factors that either heighten or diminish vulnerability to the virus, modify the contagiousness of individuals with HIV, and expedite the path from infection to disease and mortality. Biological factors that can contribute to the spread of HIV include the prevalence of common sexually transmitted diseases (STDs), the practice of male circumcision, and the specific viral properties of both HIV-1 and HIV-2, including their many genetic strains [44].

At the time HIV was introduced into chosen groups in sub-Saharan Africa, there were numerous behavioral patterns and biological circumstances that could lead to fast HIV transmission. In a short span of time, significant HIV outbreaks occurred in certain regions, impacting more than 11 million African adults and causing 3 million deaths attributable to AIDS thus far. The World Health Organization predicts that many more fatalities will occur in the coming years. These estimates account for more than two-thirds of the global aggregate of all HIV infections and AIDS cases [45,46]. According to the World Health Organization in 1993, by the year 2000, the number of individuals infected with HIV in Africa is projected to reach 20 million, with a minimum of 8 million deaths from AIDS. The African area will have the most significant impact of HIV in terms of illness and death, as well as significant economic, demographic, and societal ramifications.

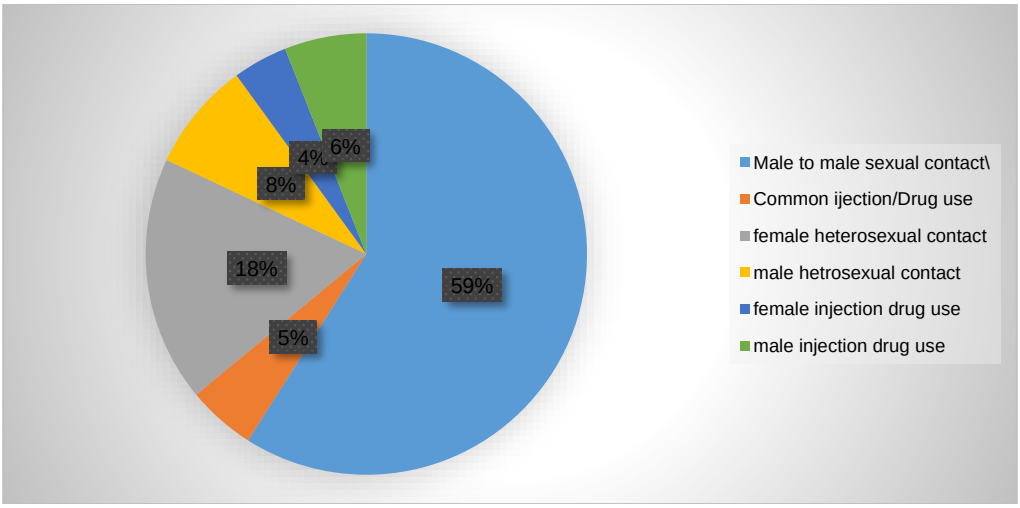

Fig. 3. Core epidimology

Sub-Saharan Africa exhibits geographical, demographic, socioeconomic, and cultural diversity, resulting in varying levels and distribution of HIV infection and AIDS across the continent. Hence, it is arduous, if not unattainable, to make broad generalizations regarding the AIDS epidemic in this particular region. However, certain general characteristics and tendencies are observable [47]. We strive to offer concrete illustrations whenever feasible, while emphasizing that the reported infection rates are relevant solely to the particular population and geographic location mentioned.

Only a limited number of comprehensive sero-prevalence studies have been carried out in sub-Saharan Africa, providing mostly information on the populations most susceptible to HIV infection. Furthermore, sentinel surveillance systems have been established to track variations in the prevalence of HIV infection within particular subgroups of the population [48]. These subgroups include individuals engaged in high-risk behaviors, such as women involved in commercial sex work or patients receiving treatment for sexually transmitted diseases. Additionally, the surveillance systems also encompass groups that are more representative of the overall population, such as blood donors and women seeking prenatal care, who are at relatively lower risk of HIV infection [49].

Recent research indicates that the prevalence of HIV is lower in rural areas compared to metropolitan areas. Nevertheless, there is evidence of a rising prevalence of HIV infection in rural regions. Typically, the most prevalent rates of infection are observed in individuals aged 20 to 40, particularly among those with STDs and tuberculosis. Additionally, certain occupational groups, such as long-distance truck drivers, military personnel, and women employed in the commercial sex and entertainment industries (including those working in bars and hotels), are also at higher risk. Commercial sex workers in East and Central Africa have reported HIV infection rates above 80 percent [50,51]. The prevalence of HIV infection among populations of commercial sex workers in specific countries. Undoubtedly, the AIDS epidemic in each country may be perceived as a sequence of epidemics occurring within certain subpopulations, each with different levels of vulnerability. In Nairobi, Kenya, the available data clearly indicate that HIV infection is mostly spreading among commercial sex workers, followed by patients visiting STD clinics, which likely includes many clients of these sex workers [52]. Ultimately, the virus is seen to be disseminating among the overall populace, as indicated by the initially gradual but progressively increasing transmission among expectant females. HIV induces immunosuppression, resulting in susceptibility to opportunistic infections. These infections that take advantage of opportunities continue to weaken the immune system, making it challenging for the body to defend against new illnesses. Tuberculosis is the prevailing opportunistic disease and a significant contributor to mortality, causing approximately 21 deaths per 100,000 individuals due to HIV infection in Nigeria [53,54]. According to the 2014 Global AIDS Response Country Progress Report, the epidemic has had a widespread impact on children, resulting in around 2.23 million children in the country becoming orphaned due to the infection. According to the most recent figures, around 37.7 million individuals across the globe are currently affected with HIV/AIDS. Although the occurrence of HIV has reached a stable level in various areas, there are still ongoing instances of new infections, which contribute to the ongoing existence of the pandemic. The region of Sub-Saharan Africa continues to have the highest number of persons infected by HIV, with roughly 25.6 million individuals living with the virus [55]. This accounts for almost 68% of the total global burden.

HIV prevalence exhibits significant variation across countries and populations in regions such as Asia, Eastern Europe, and Latin America. Key populations with an elevated risk of contracting HIV include males who engage in sexual activity with other men (MSM), individuals who inject drugs, transgender people, individuals involved in sex work, and prisoners. Within these populations, the prevalence of HIV might be significantly greater than that observed in the overall population, mostly as a result of many social, economic, and behavioral factors.

4. STAGING, PROGNOSIS AND COMPLICATIONS OF HIV

The patients who have HIV and CD4 counts that are more than 200 but lower than 500 do not have AIDS; rather, they are at risk of developing chronic infections in addition to illnesses that are not infectious. Alternately, it is possible to develop diseases such as persistent candidiasis of the mouth or recurrent vaginal candida.

Patients have the potential to develop severe outbreaks of herpes simplex or herpes zoster, also known as shingles. In addition, patients are at a greater risk developing malignancies that are significantly more challenging to treat than those that are found in healthy individuals. It is generally accepted that patients with normal CD4 counts (more than 500) enjoy a decent quality of life, with a lifetime that is within four years of that of an individual who does not have HIV. Individuals who have a CD4 count that is lower than 200 are diagnosed with AIDS and are at risk for contracting opportunistic infections. Beginning treatment with HAART often results in a lifespan of two years for the individual. It is possible for these people to have a normal life expectancy if they are treated with antiretroviral drugs and obtain a CD4 count that is higher than 500 [56-59].

When a patient has HIV with a CD4 count that is higher than 500 (which is considered normal), the prediction is that they will have the same life expectancy as someone who does not have HIV. Approximately one to two years is the average amount of time that a person with untreated AIDS can expect to live following the initial opportunistic infection. Antiretroviral therapy has the potential to raise CD4 levels, so transforming the patient's status from that of someone with AIDS to person with HIV [60-62].

5. TRANSMISSION MODES OF HIV

The primary mode of transmission for the virus is through sexual contact between individuals engaged in high-risk heterosexual activities, such as sex workers and their clients, as well as individuals who are already infected with HIV. This demonstrates the probability of HIV infection originating from these specific subpopulation groupings, which has been overlooked until now. Overall, the prevalence of MoT among individuals engaging in high-risk heterosexual activities suggests the development of a focused HIV epidemic among specific subgroups such as female sex workers. The situation gets increasingly precarious as the majority of reported cases have contracted the infection through heterosexual contact with individuals who are HIV-positive. This illustrates that individuals with HIV have either deliberately transferred the virus to their spouses or sexual partners, or unknowingly done so due to their lack of awareness about their own HIV status, primarily because they were diagnosed late. Recent studies in Bhutan reveal a significant delay in diagnosing HIV patients, as seen by the average time interval of 4 years between first infection and first diagnosis. The majority of individuals were infected between 5 and 8 years before being diagnosed [63-65].

Based on findings from African nations with a widespread HIV epidemic, heterosexual transmission of HIV is predominantly higher among females than males. The gender ratio of infections in African populations with an HIV prevalence level above 1% varies from 1.3 : 1 in Zambia to 2.21 in the Ivory Coast, as shown by empirical estimations [66]. In addition, the UNAIDS pandemic report indicates that almost 60% of people who have HIV in sub-Saharan Africa are women, resulting in a female-to-male infection ratio of 1.48 [67].

HIV is predominantly spread through unsafe sexual activity, encompassing vaginal, anal, and oral sexual activity [68]. Possible ways of transmission encompass the act of sharing contaminated needles and syringes among individuals who engage in drug injection, transmission from mother to child during pregnancy, childbirth, or nursing, and exposure to infected blood or blood products [69]. The probability of HIV transmission is contingent upon several factors, including the viral load of the infected person, the nature of the sexual activity, the presence of other sexually transmitted diseases (STIs), and the utilization of preventative measures such as condoms and pre-exposure prophylaxis (PrEP). Engaging in high-risk sexual behaviors, such as having several sexual partners, participating in transactional sex, and substance addiction, greatly increases the chances of acquiring HIV [70].

6. SOCIOECONOMIC IMPACT OF HIV/AIDS ON SOCIETY

The socioeconomic consequences of HIV/AIDS are widespread and have a significant and long-lasting impact on many aspects of society, ranging from individual households to entire nations. The core of this influence is an intricate network of interrelated outcomes, starting with the overwhelming healthcare expenses borne by both governments and people. The cost of antiretroviral medication, medical care, and support services puts further pressure on healthcare systems that are already under strain,

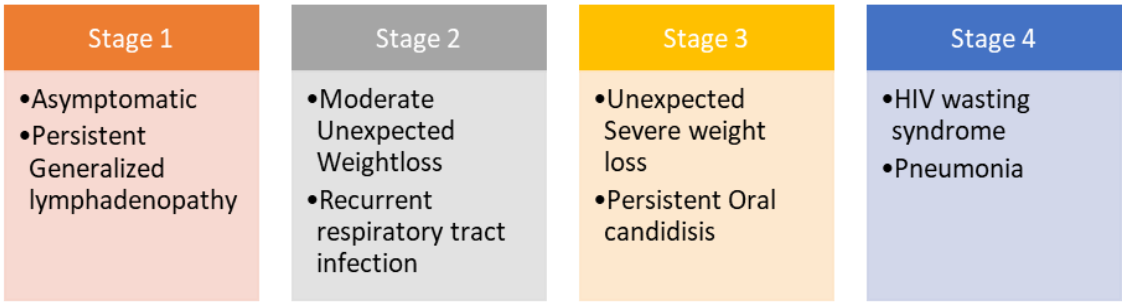

Fig. 4. Stages of HIV

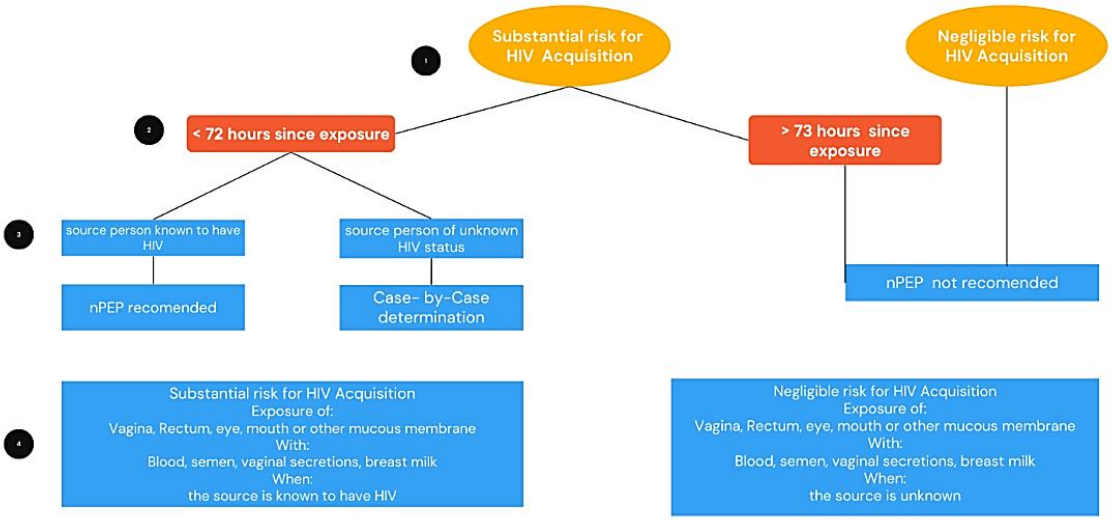

Fig. 5. Prognosis of HIV

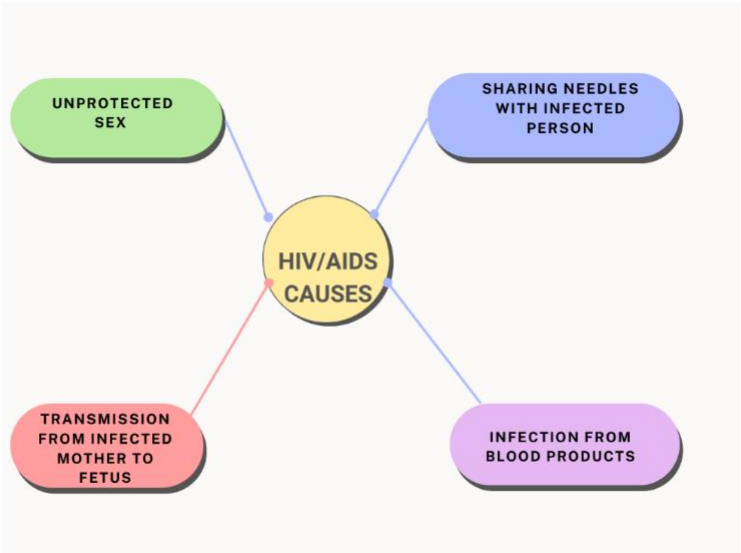

Fig. 6. Common causes of HIV

especially in low- and middle-income countries with limited resources [71]. Simultaneously, the disease negatively impacts productivity by depleting the energy and workforce of individuals through illness and untimely demise. This depletion has a ripple effect on the economy, leading to a scarcity of workers, reduced productivity, and increased labour expenses [72]. Businesses are faced with the consequences of absenteeism and the challenge of finding and training new employees. In addition, the gradual and harmful spread of HIV/AIDS coincides with the harmful presence of poverty, causing a harmful loop in which medical costs, reduced earnings, and increased caring responsibilities push individuals and families into the depths of financial hardship. Consequently, the disease's transmission is intensified when disadvantaged groups face obstacles in obtaining healthcare, education, and preventive services. However, the socioeconomic consequences go beyond just financial burden, spreading across society with the harmful effects of stigma and prejudice. People affected by HIV/AIDS face social stigmatisation, discrimination in the workplace, and barriers to accessing healthcare [73,74]. This creates an environment of marginalisation and exclusion that worsens the impact of the disease. HIV/AIDS disrupts support networks and strains relationships within families and communities. It notably affects vulnerable populations, such as children who have lost their parents to the disease, causing them to experience psychological distress and material difficulties. Moreover, the disease serves as a powerful driver for worsening gender disparities, disproportionately impacting women and girls who face institutional obstacles to obtaining education, economic independence, and healthcare [75].

The intersection of gender inequality and sickness sustains ongoing cycles of vulnerability, intensifying the long-term socioeconomic consequences for future generations. However, in the face of the challenging effects of HIV/AIDS on society, there are signs of optimism that arise from focused endeavors to address the disease, including work in prevention, treatment, reducing stigma, and alleviating poverty [76]. Through the strategic allocation of resources, utilization of specialized knowledge, and demonstration of empathy, society can establish a trajectory towards resilience and inclusivity. This trajectory aims to alleviate the impact of HIV/AIDS and create opportunities for a more promising future for all individuals.

7. CURRENT MANAGEMENT STRATEGIES FOR HIV/AIDS

Managing HIV/AIDS requires a comprehensive approach that includes prevention, treatment, care, and support services. Considerable achievements have been achieved in the past few decades in the fight against the HIV/AIDS epidemic, mostly as a result of improvements in antiretroviral therapy (ART), increased availability of treatment, and focused endeavors to overcome social and institutional obstacles [77,78]. The prevention of new HIV infections continues to be a fundamental aspect of managing HIV/AIDS. Essential measures to prevent something from happening include.

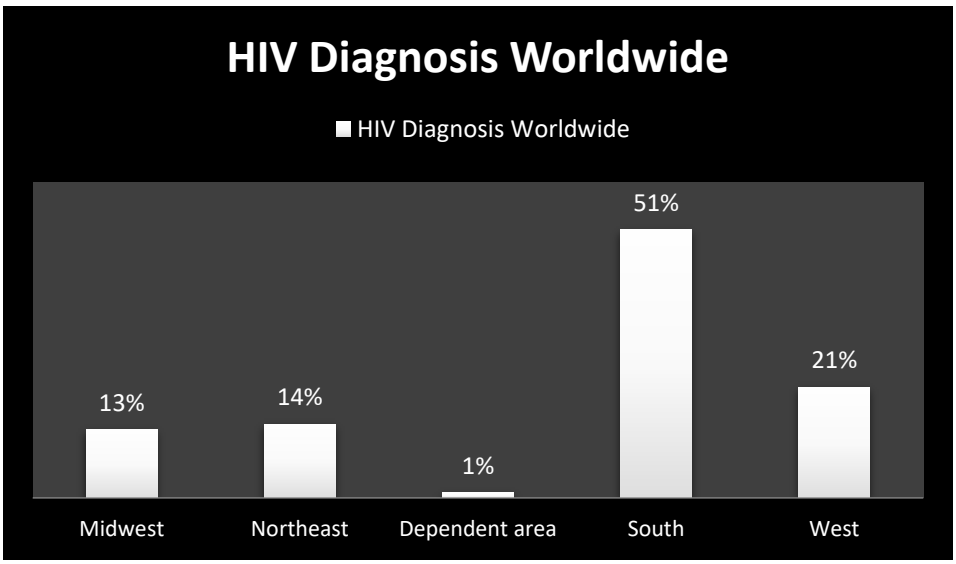

Fig. 7. Percentage of HIV diagnosis World Wide

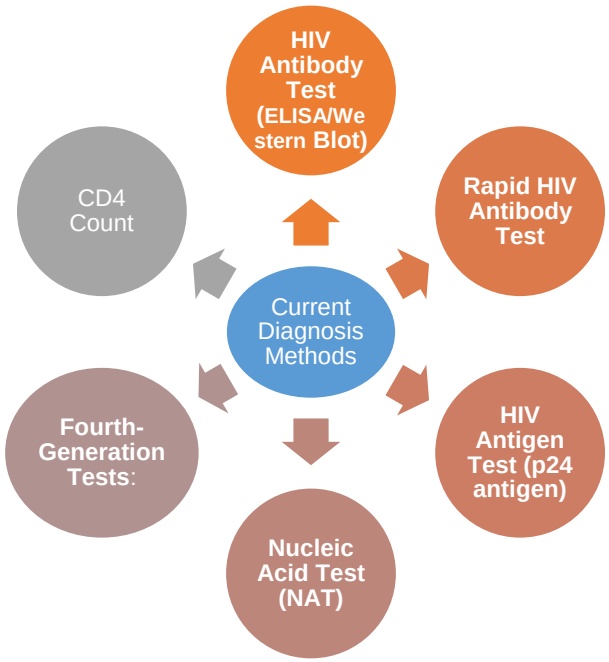

Fig. 8. Management Strategies for HIV/AIDS

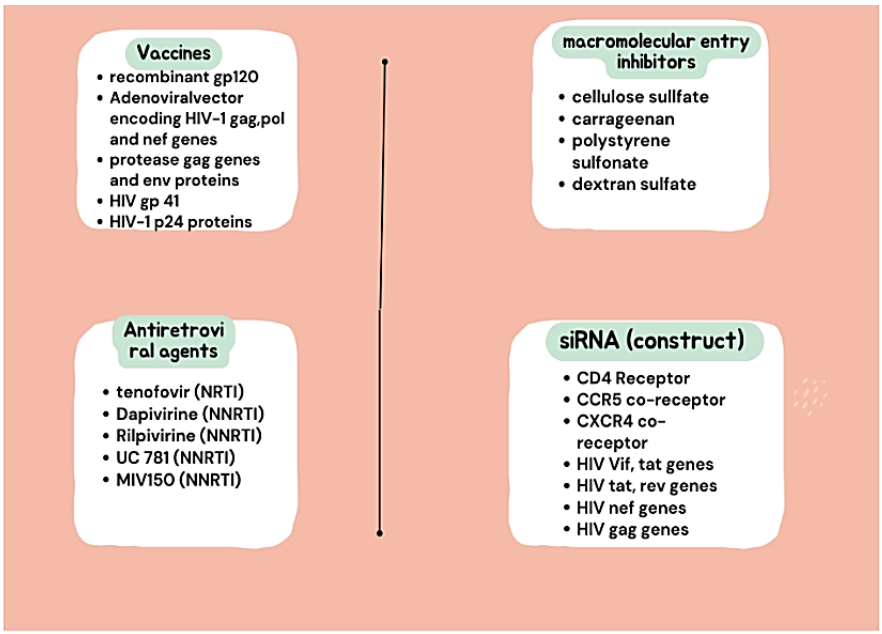

Fig. 9. Modalities available for HIV

Ensuring Safe Sexual Behavior Encouraging the utilization of condoms and promoting safe sexual practices effectively diminishes the likelihood of HIV transmission, particularly among vulnerable populations such as men who engage in sexual activities with other men (MSM), individuals involved in sex work, and those who administer drugs through injection (PWID) [79].

Harm reduction programs to mitigate the spread of HIV among people who inject drugs (PWID), it is beneficial to establish harm reduction initiatives, such as needle exchange programs and opioid replacement therapy. These programs facilitate access to clean injecting equipment and minimize drug-related damage, therefore decreasing the likelihood of HIV transmission [80].

Voluntary Medical Male Circumcision studies have demonstrated that male circumcision effectively decreases the likelihood of heterosexual transmission of HIV. Encouraging the practice of voluntary medical male circumcision in areas with high rates of HIV prevalence can aid in the efforts to limit the spread of the virus [81].

Pre-Exposure Prophylaxis (PrEP) is a preventive measure where HIV-negative individuals take antiretroviral medication to avoid contracting HIV. Consistent use of PrEP has demonstrated excellent efficacy and is advised for those with a high risk of contracting HIV [82,83]. Treatment as Prevention (TasP) is the early initiation of Antiretroviral Therapy (ART) in individuals with HIV. This approach not only enhances their health outcomes but also decreases the likelihood of transmitting the virus to uninfected partners. TasP, or Treatment as Prevention, has played a vital role in HIV prevention initiatives, highlighting the significance of ensuring that everyone has equal access to treatment [84,85]. Assessment and examination early detection of HIV is crucial for promptly starting treatment and minimizing the advancement and spread of the illness. Essential approaches for HIV testing and diagnosis Enhanced Testing Services by expanding the availability of HIV testing services in diverse venues such as healthcare facilities, community-based organizations, and mobile testing units, we may effectively target marginalized people and enhance the overall coverage of testing. Implementing regular HIV screening as a standard aspect of medical care, especially in areas with high rates of infection, aids in the identification of undiagnosed cases and facilitates the connection of persons to appropriate care and treatment [86-88]. Fig. 9 shows current modalities available for HIV.

Ensuring the use of HIV self-testing kits enables individuals to privately test for HIV at home, hence decreasing obstacles to testing and reaching communities that may not have access to conventional testing services [89]. Provider-Initiated Testing and Counselling (PITC) involves incorporating HIV testing and counselling into regular healthcare services. This approach guarantees that patients are provided HIV testing during their healthcare visit, which helps in detecting the infection early and connecting the person to appropriate medical care [90].

7.1 Possible Courses of Treatment

Antiretroviral therapy (ART) is the fundamental component of HIV treatment, efficiently reducing the virus, maintaining immune function, and enhancing health outcomes. Crucial elements of HIV treatment encompass ART Initiation Current guidelines advise promptly commencing antiretroviral therapy (ART) upon HIV diagnosis, irrespective of CD4 cell level, to optimise personal health advantages and mitigate HIV transmission to others [91].

First-line and second-line therapy antiretroviral therapy (ART) regimens usually involve the use of three or more antiretroviral medicines from various pharmacological classes. The initial treatment often consists of a combination of two nucleoside reverse transcriptase inhibitors (NRTIs) together with either an integrase strand transfer inhibitor (INSTI) or a non-nucleoside reverse transcriptase inhibitor (NNRTI). If treatment failure occurs or if medication resistance develops, second-line therapy may be necessary [92].

Adherence support guaranteeing compliance with Antiretroviral Therapy (ART) is crucial for the success of therapy [93]. Adherence support services, such as counselling, reminders, and peer support programs, assist persons in following their drug regimens and attaining viral suppression.

Monitoring treatment is crucial to regularly monitor the amount of virus in the body (viral load), the number of CD4 cells, and the overall clinical condition of the patient. This is necessary to evaluate the effectiveness of the treatment, identify cases where the treatment is not working, and make informed decisions for clinical care [94]. People who have HIV may also have coinfections, such as hepatitis B or C, or comorbidities, such as cardiovascular disease or diabetes, which need extra attention and supervision [95].

7.2 Antiretroviral Therapy

Prior to 1996, there were limited antiretroviral treatment choices available for HIV-1 infection. The primary approach to treating HIV-1 involved administering prophylactic measures against prevalent opportunistic infections and addressing AIDS-related diseases. The management of HIV-1 infection underwent a significant

transformation in the mid-1990s with the discovery of drugs that inhibit the reverse transcriptase and protease enzymes, which are crucial for the replication of HIV-1 [96-98]. Additionally, the introduction of drug regimens that combine these inhibitors has improved the effectiveness and long-term sustainability of treatment.

Since the early 1990s, the treatment for HIV-1 has progressed from using single antiviral medications to a more advanced approach that involves administering a combination of antiretroviral agents (ARVs). The introduction of combination therapy, generally referred to as HAART, for the management of HIV-1 infection played a crucial role in decreasing the illness and death rates linked to HIV-1 infection and AIDS. Combination antiretroviral therapy effectively inhibits viral replication and lowers the amount of HIV-1 virus in the bloodstream to levels that cannot be detected by highly sensitive clinical tests. This leads to a notable restoration of the immune system [99-101], as indicated by an increase in CD4+ T-lymphocytes in circulation. Crucially, the use of three antiretroviral medicines that target at least two different molecular targets is the fundamental approach to prevent the development of drug resistance.

A standard initial HIV treatment regimen consists of a combination of at least two drug classes, with a total of three HIV drugs. While this medication does not offer a cure, it can extend the lifespan of patients and decrease the transmission of HIV. The practice of using antiretroviral medication to reduce transmission has become common among HIV-positive individuals who have an HIV-negative partner [102].

Antiretroviral therapy has achieved significant success in transforming HIV into a chronic illness in numerous regions, with the occurrence of AIDS progression becoming uncommon. Research has demonstrated that the implementation of a 3-drug treatment has resulted in a significant reduction, ranging from 60% to 80%, in the occurrence of AIDs, hospitalization, and mortality. The CDC aims to execute a 90-90-90 plan by 2030, which entails achieving a 90% diagnosis rate for HIV, ensuring that 90% of individuals receive therapy, and achieving a 90% suppression rate.

The objective of HIV medications is to inhibit the replication of the HIV virus. Antiretroviral therapy employs a total of six medication classes [103]. These medications are typically categorized based on the specific phase of the HIV life cycle that they block. Typical combinations consist of two nucleoside reverse transcriptase inhibitors (NRTIs) plus either one non-nucleoside reverse transcriptase inhibitor (NNRTI), a protease inhibitor (PI), or an integrase inhibitor (II). Individuals who come into touch with HIV-positive bodily fluids through skin punctures, injured skin, or direct contact with mucosal membranes are susceptible to transmission. It is advisable to initiate antiviral therapy promptly [104]. The guidelines of the United States Public Health Service suggest initiating preventive treatment within 72 hours after exposure. The suggested treatment plan consists of emtricitabine, tenofovir, and raltegravir for a duration of four weeks. Individuals who have been exposed to HIV should get further HIV testing at 6, 12, and 24 weeks. If the test findings are negative after 24 weeks, the individual is deemed non-infectious. In 2019, the FDA granted approval for the use of tenofovir alafenamide / emtricitabine as pre-exposure prophylaxis (PrEP) for adolescents and adults who weigh a minimum of 77 lb (35 kg) [105]. The term "Recent HIV infection" refers to the period of time that occurs within 6 months after the initial infection. The selection of an HIV treatment regimen is frequently influenced by the potential drug interactions with the patient's current drugs and the undesirable effects they may suffer. Immediate treatment is recommended for pregnant patients to prevent the transfer of HIV from mother to child and safeguard the health of the woman [106,107].

8. FUTURE PROSPECTS

Researchers are making significant progress in comprehending the HIV virus and devising novel strategies to attack it, which bodes well for the future of HIV therapy and prevention. The discovery of long-acting antiretrovirals (ARVs) is a highly anticipated improvement in HIV treatment. These formulations, whether given through injections or implants, have the potential to revolutionise HIV management by providing consistent medication levels and decreasing the need for daily pill regimens. This can enhance adherence to treatment and improve treatment outcomes. Recent clinical trials evaluating the efficacy of long-acting antiretroviral drugs (ARVs) such cabotegravir and rilpivirine have demonstrated encouraging outcomes [108,109]. These findings suggest that these drugs could be

used as maintenance therapy for individuals with HIV. In addition, the appearance of broadly neutralizing antibodies (bNAbs) offers a new approach for both treatment and prevention. The efficacy of these antibodies in lowering viral load and delaying viral rebound has been established when used in combination with other antiretroviral drugs, and they are capable of targeting multiple strains of HIV [110]. Current research is dedicated to enhancing the effectiveness, longevity, and administration techniques of broadly neutralizing antibodies (bNAbs) in order to maximize their therapeutic efficacy [111].

Researchers in the field of drug development are currently investigating novel categories of antiretroviral medicines that exhibit enhanced effectiveness, safety, and resistance characteristics. These innovative medications have the potential to overcome current treatment obstacles and combat drug resistance by targeting various stages of the viral lifecycle, such as entrance, replication, and maturation [112]. In addition to advancements in drug development, substantial strides are being achieved in the pursuit of a potent HIV vaccine. Although the virus is intricate and can avoid detection by the immune system, progress in developing and administering vaccines is helping us get closer to achieving this much anticipated objective [112]. Several vaccine candidates, such as viral vector vaccines, DNA vaccines, and protein subunit vaccinations, are now being tested in clinical trials to assess their safety and effectiveness in preventing HIV infection [113]. Despite existing hurdles, such as the requirement for extensive cross-reactivity against many HIV strains, the creation of a potent vaccine would have a transformative impact on efforts to combat HIV/AIDS.

Gene editing technologies, such CRISPR-Cas9, provide a viable pathway for HIV therapy and research aimed at finding a cure. These technologies allow for accurate alteration of the HIV genome inside infected cells, which could potentially result in a functional cure or long-lasting remission [114]. Gene editing technologies have the potential to revolutionize HIV management and provide a viable cure by interrupting viral replication, boosting immune responses, and eliminating hidden reservoirs of the virus [115]. Although gene editing techniques are now in the experimental phase, continuous research and clinical trials are enhancing our comprehension of their safety, effectiveness, and suitability for use in clinical settings [116].

Not only are there advancements in treatment methods, but there is also notable development in efforts aimed at preventing HIV. Microbicides are topical substances specifically developed to prevent the transmission of HIV during sexual activity. They show potential as an extra method of prevention, especially for women in situations where using condoms may be difficult [117]. Long-acting pre-exposure prophylaxis (PrEP) formulations, such as injectable medications and implanted devices, have the potential to provide continuous protection against HIV with less frequent administration, thus overcoming challenges related to adhering to daily oral PrEP. These advancements broaden the array of choices accessible for HIV prevention, enabling individuals to select the strategy that most effectively aligns with their requirements and preferences [118].

In addition to biological therapies, digital health technologies and telemedicine are revolutionizing the delivery of HIV care and support services. Mobile health applications, remote monitoring technology, and virtual consultations facilitate remote access to care and support for those living with HIV, therefore mitigating obstacles such as transportation expenses and the social stigma linked to clinic visits. Integrated care models that integrate HIV services with other healthcare services, such as sexual and reproductive health, mental health, and substance use treatment, offer comprehensive and holistic support for individuals living with HIV, addressing their diverse needs and enhancing health outcomes [119].

Community engagement and empowerment are essential for promoting and enhancing HIV treatment and prevention initiatives. Ensuring meaningful engagement of affected people in research, advocacy, and decision-making processes guarantees that solutions are culturally suitable, responsive to community needs, and distributed fairly. Community-based organizations, peer support networks, and grassroots initiatives are essential in reaching marginalized populations, diminishing social disapproval, and fostering consciousness and instruction regarding HIV/AIDS [117].

Ultimately, the future of HIV treatment and prevention is marked by a wide range of inventive strategies, including new antiretroviral medications, vaccines, gene editing techniques, and digital health solutions. These discoveries have the capacity to revolutionize the HIV/AIDS

situation, providing new optimism for people living with HIV and communities impacted by the pandemic. To attain the aim of ending the HIV/AIDS pandemic, it is crucial to continue investing in research, infrastructure, and community engagement. These investments will help convert scientific discoveries into practical improvements in HIV outcomes.

9. CONCLUSION

With the ongoing changes in HIV/AIDS treatment and prevention, we are on the verge of making significant advancements towards achieving a world free of HIV/AIDS. Through years of research, invention, and team effort, we are now closer than ever to accomplishing this ambitious objective. Advancements in antiretroviral therapy, such as the creation of long-acting ARVs and broadly neutralizing antibodies, provide new opportunities for efficiently controlling the virus and enhancing the well-being of people with HIV. Advancements in prevention techniques, such as the development of long-acting PrEP formulations and microbicides, enable individuals to effectively safeguard themselves against HIV transmission and decrease the number of new infections. In addition to biological therapies, the use of digital health solutions, community participation, and integrated care models is transforming the way HIV services are provided, guaranteeing fair and equal access to care and support for everyone. Nevertheless, our pursuit of a future free from HIV/AIDS is not devoid of obstacles. Progress is hindered by stigma, prejudice, and institutional hurdles, especially among marginalized and underprivileged people. To tackle these difficulties, it is necessary to make a focused and coordinated attempt to uphold human rights, diminish disparities, and cultivate inclusive communities that enable all individuals to obtain the necessary resources and assistance to flourish. Through the utilization of scientific advancements, innovative approaches, and the mobilization of communities, we have the ability to conquer these challenges and pave the way for a future in which HIV/AIDS no longer poses a risk to global health and well-being. Collectively, we have the chance to construct a society in which each person may exist without being affected by the negative consequences of HIV/AIDS, where optimism prevails over hopelessness, and where empathy and unity lead us towards a more promising tomorrow for everyone.

CONSENT AND ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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