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Journal of AIDS and HIV Research

ARTICLES

Full Length Research Paper

Endemic analysis of HIV/AIDS transmission in the presence of antiretroviral therapy

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This paper presents a dynamical model that studies the effect of anti-retroviral therapy on human immunodeficiency virus (HIV)/acquired immunodeficiency syndrome (AIDS) transmission. Basic qualitative properties of the model are derived. The model is shown not to exhibit backward bifurcation and thus, disease eradication is possible when the basic reproduction number is less than unity. A critical level of anti-retroviral therapy administration that needs to be achieved for possible disease eradication was also derived.

Key words: HIV/AIDS, mathematical modeling, equlibrium points.

INTRODUCTION

Human Immunodeficiency Virus (HIV)/Acquired immunodeficiency syndrome (AIDS) epidemics are a major challenge to global health and much time, effort and resources have been devoted to a search for a cure to completely avert the situation, but still to no avail. The situation has transformed beyond the immediate effect of the virus into degenerating emotional challenges for the fact that HIV is incurable. The highly active antiretroviral therapy (HAART) has however proven to be effective in curtailing the spread of the HIV virus and AIDS related mortality (Perelson and Nelson, 1999; Palella Jr et al., 1998; Jones and Perelson, 2005). In 2005, about 3.1 million people died from AIDS and 4.9 million people became infected with HIV worldwide (Okosun et al., 2013). In 2010 it was estimated that about 34 million people were living with the HIV/AIDS virus worldwide with about 2.7 million people newly infected. The number of people who died due to AIDS related sicknesses was 1.8 million (UNAIDS, UNAIDS World AIDS Day Report, 2011).

Sub-Saharan Africa is one of the worst hit continents with about 22.9 million people living with HIV/AIDS most of whom are within the active working population aged between 15 and 49 years.

Commercial sex is still an important factor in many of the HIV epidemics in Western, Central and Eastern Africa. It is estimated that sex workers (HIV infection among sex workers, their clients, or their other sex partners) alone accounted for almost one third (32%) of new HIV infections in Ghana, 14% in Kenya and 10% in Uganda (UNAIDS, 2010). The effects of the HIV/AIDS epidemic is the shock, then denial, guilt, anger,

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and sadness before finally adjustment to the reality, a very common phenomenon with so many other diseases where, for example, there is a social stigma. Also, the repercussion of the infection is a reduction in productivity which subsequently aggravates the incidence of poverty.

Many preventive and treatment strategies such as use of condoms, sticking to one sex partner, antiretroviral therapy (ART) have been suggested. The ART provides a maximal and durable suppression of the viral load and helps to slow the disease progression, reduces HIV-related morbidity and mortality and improves the quality of the life of the infected person (Okosun et al., 2013).

A lot of mathematicians and scientists have conducted various studies to find a remedy to the HIV/AIDS pandemic. A very important tool that is usually employed in epidemiological studies of this nature is mathematical modelling. It can be used to study the epidemiological patterns for disease control to predict the short and long term transmission dynamics of HIV/AIDS. Anderson et al. (1986) presented a simple mathematical HIV transmission model to investigate the effects of various factors on the overall pattern of the AIDS epidemic. Makinde (2009) studied the transmission dynamics of infectious diseases with waning immunity using the non-perturbative approach while Agraj et al. (2007) also worked on the spread of AIDS epidemic with vertical transmission by considering a non-linear mathematical model. Several other mathematicians and scientists such as Busenburg et al. (1993), Karrakchou et al. (2006), Perelson and Nelson (1999) and Adams et al. (2004) have investigated into the HIV/AIDS transmission dynamics using mathematical modelling, a proven tool for epidemiological investigation. The study therefore seeks to analyze the dynamics of the long term effects of the treatment of HIV/AIDS on the spread of the disease.

FORMULATION OF THE MODEL

The spread of HIV/AIDs was studied with anti-retroviral treatment. The population was subdivided into four mutually exclusive compartments of susceptibles, S, infectives that are not on treatment, L_1, infectives on treatment, L_2 and full-blown AIDS population, A. The schematic diagram is as shown in Figure 1.

From the flow diagram, the model equations are as follows:

$$\frac{d}{dt} S(t) = Q - \frac{c\left(\beta_1 I_1 + \beta_2 I_2\right) S}{N} - \mu S$$

$$\frac{d}{dt} I_1(t) = \frac{c\left(\beta_1 I_1 + \beta_2 I_2\right) S}{N} - \left(\sigma_1 + \theta + \mu\right) I_1$$

$$\frac{d}{dt} I_2(t) = \theta I_1 - \left(\sigma_2 + \mu\right) I_2$$

$$\frac{d}{dt} A(t) = \sigma_1 I_1 + \sigma_2 I_2 - \left(\alpha + \mu\right) A$$

With initial conditions given as:

$$S(0) = S_0, I_1(0) = I_{10}, I_2(0) = I_{20}, A(0) = A_0$$

where the parameter in the model are described as follows: N(t) = total population size at time t, S(t) = size of the susceptible population at time t, I_1(t)= size of the infective population not under treatment at time t, I_2(t)= The size of the infective population under treatment at time t, A(t) = size of the full blown AIDS population at time t, Q_0 rate of recruitment of susceptibles into the population, u= natural death rate, α=rate of death due to the infection of the AIDS virus, c = the number of sexual partners of an infected person, β_1= rate of contact between the susceptible and those infectives not under treatment, β_1=rate of contact between the susceptible and those infectives under treatment, θ=rate at which the infectiv.es not under treatment are introduced to treatment, σ_1 and σ_2 are the rate of conversion from HIV to full blown AIDS of those not under treatment, and the under treatment, respectively.

Properties of the model

Feasible region

Summing all the model equations gives:

$$\frac{dN}{dt} = -\mu N + Q - A\alpha$$

Thus, we have:

$$N \leq \frac{q}{\mu} \cdot \left(1 - e^{-\mu \cdot t}\right)$$

so that as:

$$t \rightarrow \infty \ N \rightarrow \frac{Q}{\mu}$$

The feasible region of the model given as:

$$\Omega = \left\{\left(S, I_1, I_2, A\right) \in \mathbb{R}^4 \middle| S + I_1 + I_2 + A \leq \frac{Q}{\mu}\right\}$$

is positively invariant and hence, we can sufficiently perform the analysis of the model in Ω.

Basic reproduction number

It was taken note that the disease-free (DFE) of the
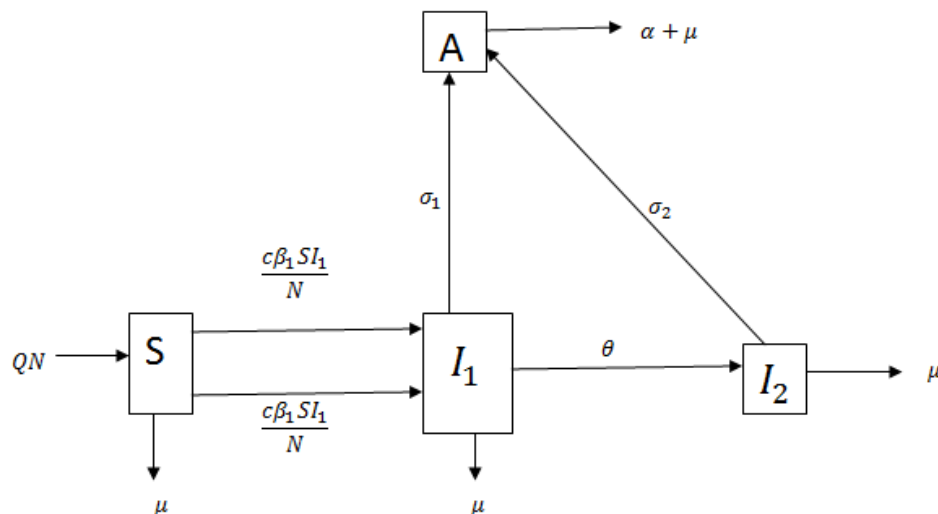
Figure 1. Schematic diagram of the model.

model is given by

$$DFE = \left(\frac{Q}{\mu}, 0, 0, 0 \right)$$

To determine the basic reproduction number of the model, we use the linearization technique, which seeks a condition under which all eigenvalues of the Jacobian model evaluated at the disease-free equilibrium will have negative real parts.

The Jacobian of the model is given by:

Where $\dfrac{c\left(\beta_1 I_1 + \beta_2 I_2 \right)}{N} = \lambda$ and $\dfrac{c\left(\beta_1 I_1 + \beta_2 I_2 \right)}{N^2} = \dfrac{\lambda}{N}$

Evaluating the Jacobian at the DFE gives:

$$J = \begin{vmatrix} \dfrac{\lambda S}{N} - \lambda - \mu & -\dfrac{c\beta_1 S}{N} + \dfrac{\lambda S}{N} & -\dfrac{c\beta_2 S}{N} + \dfrac{\lambda S}{N} & \dfrac{\lambda S}{N} \\ -\dfrac{\lambda S}{N} + \lambda & \dfrac{c\beta_1 S}{N} - \dfrac{\lambda S}{N} - \sigma_1 - \theta - \mu & \dfrac{c\beta_2 S}{N} - \dfrac{\lambda S}{N} & -\dfrac{\lambda S}{N} \\ 0 & \theta & -\sigma_2 - \mu & 0 \\ 0 & \sigma_1 & \sigma_2 & -\alpha - \mu \end{vmatrix}$$

$$J = \begin{bmatrix} \dfrac{\lambda S}{N} - \lambda - \mu & -\dfrac{c\beta_1 S}{N} + \dfrac{\lambda S}{N} & -\dfrac{c\beta_2 S}{N} + \dfrac{\lambda S}{N} & \dfrac{\lambda S}{N} \\ -\dfrac{\lambda S}{N} + \lambda & \dfrac{c\beta_1 S}{N} - \dfrac{\lambda S}{N} - \sigma_1 - \theta - \mu & \dfrac{c\beta_2 S}{N} - \dfrac{\lambda S}{N} & -\dfrac{\lambda S}{N} \\ 0 & \theta & -\sigma_2 - \mu & 0 \\ 0 & \sigma_1 & \sigma_2 & -\alpha - \mu \end{bmatrix}$$

The Jacobian evaluated at the DFE has four eigenvalues, two of which are-μ and $-(\alpha+\mu)$ which are negative. The remaining two are eigenvalues of the sub-Jacobian given by:

$$J_1(DFE) = \begin{bmatrix} c\beta_1 - \sigma_1 - \theta - \mu & c\beta_2 \\ \theta & -\sigma_2 - \mu \end{bmatrix}$$

The eigenvalues of the sub-Jacobian are solutions of the characteristic equation given by:

$$\lambda^2 + \left(-c\beta_1 + \left(\sigma_1 + \theta + \mu \right) + \left(\sigma_2 + \mu \right) \right) \lambda + \left(-c\beta_1 + \left(\sigma_1 + \theta + \mu \right) \right) \left(\sigma_2 + \mu \right) - \theta c\beta_2 = 0$$

It is easy to show that the eigenvalues are both negative (or have negative real parts) if

$$c\left(\beta_1 \left(\sigma_2 + \mu \right) + \beta_2 \theta \right) < \left(\sigma_1 + \theta + \mu \right) \cdot \left(\sigma_2 + \mu \right).$$

If we define the basic reproduction number of the model as $R_0 = \dfrac{c\left(\beta_1 \left(\sigma_2 + \mu \right) + \beta_2 \theta \right)}{\left(\sigma_1 + \theta + \mu \right) \cdot \left(\sigma_2 + \mu \right)}$,

then the following lemma is implied.

Lemma 1: The DFE is locally asymptotically stable if $R_0 < 1$

Solving for θ in $R_0 \leq 1$ gives a critical value below which θ must not go if we seek to control the spread of the disease. This critical value is given by:

$$\theta_{critical} = \frac{\left(c\beta_1 - \left(\sigma_1 + \mu \right) \right) \left(\sigma_2 + \mu \right)}{\left(c \cdot \beta_2 - \left(\sigma_2 + \mu \right) \right)}.$$

ENDEMIC EQUILIBRIUM OF THE MODEL

The model can be shown to have an endemic equilibrium $E^* = \left(S^*, I_1^*, I_2^*, A^* \right)$ defined as

$$S^{*`} = \frac{Q}{\lambda + \mu} \quad, \qquad I_1^{*`} = \frac{\lambda Q}{\left(\lambda + \mu \right) \left(\sigma_1 + \theta + \mu \right)} \quad I_2^{*`} = \frac{\theta \lambda Q}{\left(\lambda + \mu \right) \left(\sigma_1 + \theta + \mu \right) \left(\sigma_2 + \mu \right)}$$

and

$$A^{*`} = \frac{\left(\sigma_1 \cdot \left(\sigma_2 + \mu \right) + \sigma_2 \theta \right) \lambda Q}{\left(\lambda + \mu \right) \left(\sigma_1 + \theta + \mu \right) \left(\alpha + \mu \right) \cdot \left(\sigma_2 + \mu \right)}$$

Substituting the endemic equilibrium into $\lambda = \dfrac{c\left(\beta_1 I_1 + \beta_2 I_2\right)}{N}$ gives the following quadratic equation:

$$\left[\mu\left(\left(\sigma_2 + \mu\right)\cdot\left(\sigma_1 + \theta + \mu\right) + \left(\mu + \sigma_2 + \theta\right)\alpha\right)\right]\lambda^2 - \mu\left(\alpha + \mu\right)\cdot\left(\sigma_1 + \theta + \mu\right)\cdot\left(\sigma_2 + \mu\right)\cdot\left(R_0 - 1\right)\lambda = 0$$

The quadratic equation above has two roots; namely λ=0, which corresponds to the DFE and the second root is given by:

$$\lambda = \dfrac{\mu\left(\left(\sigma_2 + \mu\right)\cdot\left(\sigma_1 + \theta + \mu\right) + \left(\mu + \sigma_2 + \theta\right)\alpha\right)}{\mu\left(\alpha + \mu\right)\cdot\left(\sigma_1 + \theta + \mu\right)\cdot\left(\sigma_2 + \mu\right)\cdot\left(R_0 - 1\right)}$$,which corresponds to the endemic equilibrium

The following result is easily established.

Lemma 2: When the model has a globally asymptotically stable DFE.

Proof
When the non-zero root of the endemic equilibrium polynomial equation is negative, leading to a negative endemic equilibrium, which epidemiologically does not exist? Hence, for, only the DFE exists which is asymptotically stable. Therefore, the DFE is globally asymptotically stable when concluding the proof.

BIFURCATION ANALYSIS

The condition that R_0 be less than unity for disease eradication is sometimes not sufficient even though it is always necessary. When forward bifurcation occurs, then the condition is necessary and sufficient, but when backwards bifurcation occurs, the condition is no longer sufficient for disease eradication. Here, we perform bifurcation analysis of the model by using Theorem 4.2 of Casillo-Chavez and Song (2004), which states if 0 is an equilibrium point of the dynamical system:

$$\frac{dx}{dt} = f(x) \ ,$$

then the local dynamics of the system are completely determined by the bifurcation coefficients given by:

$$a = \sum_{ijk=1}^{4} v_k w_i w_j \frac{\partial^2}{\partial x_i \partial x_j} f_k\left(DFE, c^*\right)$$

and

$$b = \sum_{ijk=1}^{4} v_k w_i \frac{\partial^2}{\partial x_i \partial c^*} f_k\left(DFE, c^*\right)$$

where $f_k (x)$ is the kth component of $f(x)$ and c^* is a bifurcation parameter.

The Jacobian of the model evaluated at the disease-free equilibrium can be shown to have right and left eigenvectors (associated with a simple Eigenvalue) given respectively by:

$$w = \left[-\dfrac{\left(\sigma_1 + \theta + \mu\right)\left(\sigma_2 + \mu\right)}{\mu}, \ \dfrac{\sigma_2 + \mu}{\theta}, \ 1, \ \dfrac{\sigma_1\left(\sigma_2 + \mu\right) + \sigma_2 \theta}{\theta\left(\alpha + \mu\right)} \right]^T$$

and

$$v = \left[0, \ \frac{(\sigma_2 + \mu)\,\theta}{(\sigma_2 + \mu)^2 + c\beta_2\,\theta}, \ \frac{c\beta_2\,\theta}{(\sigma_2 + \mu)^2 + c\beta_2\,\theta}, \ 0 \right]$$, so that the bifurcation coefficients are given

by:

$$a = -2 \cdot \frac{(\sigma_2 + \mu)\,c\mu\left(\beta_1\left(\sigma_2 + \mu\right) + \beta_2\,\theta\right)\left((\sigma_2 + \mu)\left(\mu + \alpha + \sigma_1 + \theta\right) + \alpha\,\theta\right)}{\left((\sigma_2 + \mu)^2 + \theta c\beta_2\right)\theta\left(\alpha + \mu\right)Q}$$

and

$$b = \frac{(\sigma_2 + \mu)\left(\beta_1\left(\sigma_2 + \mu\right) + \beta_2\,\theta\right)}{(\sigma_2 + \mu)^2 + \theta c\beta_2} \ .$$

Lemma 3: The model exhibits forward bifurcation for R_0 in the neighborhood of unity.

Conclusion

In this paper, a nonlinear epidemic model has been proposed and qualitatively analysed to study the effect of anti-retro-viral therapy on the dynamics of HIV/AIDs transmission. Basic properties of the model are derived and discussed. It is shown that when the basic reproduction number is less than unity, the disease eradication is possible and when the basic reproduction number is greater than unity then the disease persists. A minimum level of anti-retro-viral therapy administration needed for successful combating of the disease is derived.

Conflict of interests

The authors have not declared any conflict of interests.

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Full Length Research Paper

Pattern of home-based care in human immunodeficiency virus-infected patients attending adult antiretroviral therapy clinic of Jos University Teaching Hospital, Nigeria: A review from September, 2008 to December, 2013

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Home based care (HBC) is a key component of care and support for people infected with human immunodeficiency virus (HIV). Understanding the pattern of HBC needs in a population is beneficial in planning and providing optimal HBC services for the people. This retrospective study assessed the pattern of home based care needs and services in patients of the adult antiretroviral therapy (ART) clinic of Jos University Teaching Hospital (JUTH), Jos, Nigeria. All documented home based care visits to patients of the clinic from September 2008 to December 2013 were reviewed. Relevant information was obtained from the patients' clinical and home visit records. Data was analysed using Epi info version 7 statistical software. A total of 152 patients with 542 home visits were reviewed. There were 112 (73.7%) females and 40 (26.3%) males, with a mean age of 34±8.9 years at the time of initial home visits. The three commonest primary reasons for home visits were psychological counselling (22.7%), adherence counselling (15.5%) and ill-health (12.4%), while follow up visits accounted for 32.5% of the home visits. The 3 most frequent services provided during home visits were counselling on clients medication for adherence (77.5%), basic nursing care (61.6%), and psychological counselling (41.5%). By December 2013, out of 152 patients reviewed, 61.8% were alive, 15.1% had died and 23.1% were lost to follow up. The services provided during home visits extended beyond the patients' perceived needs (primary reasons for visit). Home based care brings to light some patient needs that may not be evident or catered for at the facility level of care. This supports the endorsement of home based care as a useful strategy to complement facility care towards achieving an overall patient well-being.

Key words: Home based care, human immunodeficiency virus (HIV), adult, Nigeria.

INTRODUCTION

The scourge of human immunodeficiency virus (HIV) infection and acquired immunodeficiency syndrome (AIDS) continue to be a weighty public health concern especially in underdeveloped countries. In 2010, it was

estimated that worldwide, over 34 million people were HIV-positive and approximately 68% of them lived in sub-Saharan Africa (UNAIDS, 2010). In this geographical region of the world, the typical pattern of healthcare is a combination of overburdened healthcare services with insufficient financial resources, inadequate infrastructure, few hospital beds and fewer health workers to cope with the health burdens faced (WHO, 2008; Tillekeratne et al., 2009). The HIV pandemic, which is greatest in sub-Saharan Africa, contributes immensely to the health burden, and this further overstretches the already overburdened health systems (UNAIDS, 2014; WHO, 2008). In 2012, Nigeria, not left out of the scourge, was reported to have an estimated 3.7% of its population living with HIV and ranked second place among the countries with the highest burden of HIV (NACA, 2012).

Antiretroviral therapy (ART) for HIV/AIDS in low-income countries has majorly changed the clinical management of people living with HIV and AIDS (PLWHA), and has greatly improved the survival rate. Unfortunately however, ART is not accessible to all eligible patients, and one major reason for this is the disparity in provision of ART services between urban and rural areas (Kipp et al., 2011). Home based care (HBC) is defined as any form of care given to ill people in their homes (WHO, 2002). It includes physical, psychosocial, palliative and spiritual activities with the goal to provide hope through high quality and appropriate care that helps ill people and families to maintain their independence and achieve the best possible quality of life (WHO, 2002). HBC has long been part of HIV care, even before the era of ART and the availability of ART has not decreased the need for HBC (Bowie et al., 2010).

The World Health Organisation, the government of several countries as well as care givers of PLWHA have acknowledged HBC as a necessary component of HIV care and support (WHO, 2002; Pindani et al., 2013; Ibrahim et al., 2011; WHO, 2000). HBC programmes have been developed with a view to assisting families and care givers in providing HIV-related care to patients, and this has aided in reducing the burden on hospitals caring for PLWHA (Makoae and Jubber, 2008). It has been estimated that up to 90% of illness care may be provided in the home by untrained family and associates (Ogden et al., 2006). In resource constrained settings burdened by HIV/AIDS such as found in sub-Saharan Africa, home based care plays a valuable and strategic role in complementing existing health care services by extending the continuum of care for PLWHA and their families into the home, thus bridging the gap between facility and home care (Ibrahim et al., 2011; Ogden et al., 2006; Aantjes et al., 2014). HBC is ideally provided by trained members of the community, and is meant to

supplement hospital care not replace it. However, in some instances, HBC is the only option available for many HIV/AIDS patients who do not have access to healthcare facilities for various reasons and it replaces hospital care (Aantjes et al., 2014). Furthermore, such care is usually carried out by persons who have no training or contact with professional help. An effective HBC programme for PLWHA can yield major health and social benefits not only to the patients, but also to their families and therefore the community (Mupfurima, 2013).

The pattern of HIV disease presentation and its progression may vary from one population to another, and this in turn will influence the pattern of HBC needs of patients in these various populations (Bowie et al., 2006; WHO, 2004; Harding et al., 2003); as such, an assessment of the HBC needs of a population would be helpful in understanding the pattern for that specific population. Though it has been reported that HBC studies have been small with only a few done in developing countries (Young and Busgeeth, 2010), several of the studies have reported the positive impacts of HBC and have also contributed to evidence-based decision making (Jaffar et al., 2009; Oguntibeju et al., 2011; Amoran et al., 2012; Agbonyitor et al., 2009; Samson-Akpan et al., 2012).

Jos University Teaching Hospital (JUTH), a beneficiary of the national ART programme, AIDS Prevention Initiative in Nigeria (APIN) and the US President's Emergency Plan for AIDS Relief (PEPFAR), has been providing comprehensive HIV/AIDS care since 2001 and caters for a large number of patients. The HBC programme commenced at this centre in September 2008, and since then, there has been no research related to its activities. This retrospective study aims to describe the home based care needs and services provided to adult patients enrolled in APIN ART Centre JUTH, who had HBC visits from September 2008 to December 2013.

METHODOLOGY

This is a retrospective, hospital based study undertaken at the adult ART clinic of the APIN Centre located in JUTH, an urban tertiary health institution in the metropolitan city of Jos, the capital of Plateau State, Nigeria. The state has a population of 3,206,531 (National Bureau of Statistics, 2006) and consists of people from all works of life. HIV infection prevalence reports in Plateau state surveys have ranged from of 4.88% in the general populations, with most of the infected people younger than 40 years and a significantly higher prevalence in females than males (Gomwalk et al., 2012), to 8.2% in pregnant women (Sagay et al., 2005) and 48% in commercial sex workers (Imade et al., 2008). The state is well known for tourism and usually attracts a high influx of visitors. In recent times, frequent civil unrest has also led to the deployment of uniformed service personnel to the state to maintain peace. Both

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of these are factors that can promote the spread of HIV. The adult ART clinic serves as a point of care and treatment for non-emergency, adult HIV-infected patients enrolled into its programme.

Home based care services

HBC was offered to patients as part of the centre's care and support programme. It utilised a facility-coordinated, HBC programme made up of a team of healthcare workers and volunteer support group members (PLWHA from the clinic). The healthcare workers in the team were equipped with specialized training in HBC as devised by the APIN programme and in turn trained and re-trained the support group members to equip them with the knowledge and skills to carry out HBC according to APIN recommendations which were: the development of lay participants into caregivers with sufficient information about HIV care and support, equipped with problem-solving skills for addressing issues related to HIV at individual and community level, who also understood the operations and coordination of the various components of community care and support services. The healthcare workers coordinated activities at the facility level while volunteer support group members went into the community for home visits (two volunteers per home) to provide the needed care. Patients visited at home were usually sick patients (who did not require hospital admission or chronically ill patients discharged from admission, while on going care was still needed), patients who needed additional psychosocial, nutritional, spiritual or adherence counselling and patients who needed assistance with some house hold activities. Only patients enrolled in the APIN programme, living within Jos and environs, who gave consent for home visits qualified for home visits if the need arose. As part of the regular clinical care routine, patients to be visited at home were identified by health workers either at the facility during their regular clinic visits or at the point of discharge after hospital admission. Outside clinic visits, APIN JUTH enrolled patients requiring home visits were also identified within the community by volunteer support group members living within that same community. Any such patients identified were then referred to the home based care team of health workers to confirm the need for home visit. A standard HBC kit which contained supplies that might be needed to provide care in the home was made available for each home visit. At each home visit, the home based caregivers (volunteer support group members) provided care and charted their activities on a HBC data collection form provided by the facility and submitted the completed forms to the healthcare workers at the facility thereafter. The volunteer caregivers were provided with phone numbers with which to contact the facility workers if they needed advice. Follow up visits were carried out where necessary and all services rendered were documented in the same format. Services provided were not restricted by the main reasons for home visits and home visits did not take the place of routine clinic visits. The volunteers were provided with an allowance to cover for expenses incurred from transportation to and from the patients' homes, and any phone calls made to the health care providers to ask for advice.

Subjects and data

The subjects comprised of adults HIV-infected patients aged 18 years and above receiving care at the adult ART clinic, who consented to and had home visits during the study period from September 2008 to December 2013. Out of a total of 154 patients with 544 home visits, two patients, accounting for two home visits were excluded because they had no traceable hospital records. Pre-existing relevant data of the remaining 152 patients with 542 home visits were reviewed. The patients' basic sociodemographic

and clinical information was obtained from the APIN/PEPFAR electronic data bank while information about home visits was obtained from the home visit records. The information extracted included age, sex, marital status, level of education, disease stage, baseline CD4 level, CD4 level at the time of initial home visit, ART status, tuberculosis treatment history, reasons for home visits, types of services provided and survival status. Patients' survival status was assessed from medical records as at December 2013 and grouped as follows: "alive" if they were still receiving care or were traceable by the tracking team; "dead" if they had died and this had been reported; or "lost to follow up" if they had missed two clinic appointments before this time and subsequently could not be traced by the tracking team.

Data analysis

Data obtained was analysed using Epi info version 7. Qualitative data was presented as frequencies and percentages while quantitative data was presented as mean and standard deviation. Chi square was used to compare categorical variables while Student T-test and Mann-Whitney/Wilcoxon Two Sample test were used to compare means of variables. A p value of ≤0.05 was considered statistically significant.

Ethical consideration

Ethical approval for the study was obtained from Jos University Teaching Hospital Ethical Review Committee. Prior to enrolment into the APIN program, written informed consent was obtained from all patients for the use of their data in research. Consent was also obtained from each patient prior to commencing the home visits. Rather than health workers visiting patients' homes, privately trained and trusted lay community members who were themselves PLWHA (support group members of the clinic) were engaged as caregivers to maintain confidentiality for the patients within their neighbourhood. The information obtained was kept anonymous and confidential.

RESULTS

Sociodemographic and clinical characteristics

One hundred and fifty-two patients were reviewed; of these, 112 (73.7%) were female and 40 (26.3%) were male. Their mean age at initial visit was 34±8.9 years with females being younger than males (31.7±7.4years compared to 40.4±9.6 years, p value=0.0000). Most of the patients (46.7%) were married and more than half of them had either secondary (29.6%) or tertiary (29.6%) education. At presentation, the median baselineCD4 level of the patients was 94.5 cells/mm^3, and the majority (39.5%) of them were in WHO stage III of the disease. At the time of home based care visit, 133 (87.5%) of them were on ART, 94 (61.8%) had a history of current or previous tuberculosis treatment and their median CD4 count was 165.5 cells/mm^3. By the end of the review period (December 2013), 94 (61.8%) patients were alive while the rest had either died or were lost to follow up. The sociodemographic and clinical characteristics of the 152 patients are summarized in Table 1. Except for the

Table 1. Characteristics of patients by gender (n=152).

Variable	Total	Female n=112	Male n=40	P-value
Age at initial visit (Mean±SD years)	34±8.9	31.7±7.4	40.4±9.6	0.0000*
Marital status n (%)				
Single	39 (25.7)	28 (25.0)	11 (27.5)	
Married	71 (46.7)	47 (42.0)	24 (60.0)	
Separated	11 (7.2)	10 (8.9)	1 (2.5)	0.3
Divorced	4 (2.6)	4 (3.6)	-	
Widowed	27 (17.8)	23 (20.5)	4 (10.0)	
Educational status n (%)				
None	24 (15.8)	19 (17.0)	5 (12.5)	
Primary	38 (25.0)	28 (25.0)	10 (25.0)	0.35
Secondary	45 (29.6)	36 (32.1)	9 (22.5)	
Tertiary	45 (29.6)	29 (25.9)	16 (40.0)	
Visits per patient n (%)				
1 – 5	121 (79.6)	91 (81.2)	30 (75.0)	
6 – 10	22 (14.5)	15 (13.4)	7 (17.5)	0.69
>10	9 (5.9)	6 (5.4)	3 (7.5)	
Median CD4 (cells/mm^3)				
Baseline	94.5	96	90	0.51
At initial home visit	165.5	195	118.5	0.07
WHO clinical stage n (%)				
I	31 (20.4)	24 (21.4)	7 (17.5)	
II	35 (23.0)	28 (25.0)	7 (17.5)	0.40
III	60 (39.5)	44 (39.3)	16 (40.0)	
IV	26 (17.1)	16 (14.3)	10 (25.0)	
ART status n (%)				
On ART	133 (87.5)	100 (89.3)	33 (82.5)	0.26
Not on ART	19 (12.5)	12 (10.7)	7 (17.5)	
TB treatment history n (%)				
Yes	94 (61.8)	66 (58.9)	28 (70)	0.22
No	58 (38.2)	46 (41.1)	12 (30)	
Survival status n (%)				
Alive	94 (61.8)	72 (64.3)	22 (55)	
Dead	23 (15.1)	15 (13.4)	8 (20)	0.51
Lost to follow up	35 (23.1)	25 (22.3)	10 (25)	

*Statistically significant.

median age, there was no statistically significant difference between the males and the females.

Home based care visits

A total of 542 home based care visits were carried out, with 2,159 activities recorded as services rendered during those visits. Most of the patients, 121 (79.6%), had between 1 and 5 visits each, while a fewer number, 9 (5.9%) had more than 10 visits each. There was a gradual increase in the total number of home visits each year from 2 in 2008 to 164 in 2013. A majority of the visits

(32.5%) were on account of follow up. The three commonest primary reasons for home visit were psychological counselling (22.7%), adherence counselling (15.5%) and ill health (12.4%). The least common reasons for home visits (spiritual counselling, basic nursing services, environmental sanitation/hygiene, nutritional counselling, legal aid counselling and psychosocial care/welfare support) were grouped together as others (5.7 %), followed by health education (11.2%). The three most frequent services provided during home visits were counselling on clients medication for adherence (77.5%), basic nursing care (61.6%), and psychological counselling (41.5%). Housekeeping (39.3%), health education (36.5%) and spiritual support counselling (31.2%) were also services that were frequently provided by the care givers. The least frequent service provided was that of distribution of information, education and communication (IEC) materials, followed by legal aid counselling (3.1%). The reasons for home visits and services rendered are summarised in Tables 2 and 3.

DISCUSSION

The results of this study describe the pattern of HBC needs and services in a population of HIV-infected patients receiving care in a Nigerian ART clinic. The reasons for visit versus the range of services provided, show that the needs of the HIV patients stretched beyond the routine clinical services provided at the facility, and HBC serves as a useful strategy to identify and cater for those needs. The study also demonstrates the important role of the health facility as a coordinating body for HBC activities thus highlighting the need for cooperation between facility care and HBC. The busy nature of the clinic with few clinical staff and large patient load may result in some services at the facility being provided sub optimally and some of these services can be provided in the patients' home.

The sociodemographic characteristics of the patients showed a predominantly female population with females being younger than males. This profile generally represents what obtains in other Nigerian studies involving HIV patients (Laah and Ayiwulu, 2010; Nakama et al., 2015; Odimayo et al., 2010). Home based care studies in other parts of Africa among HIV populations have also shown a predominance of females of a younger age group than men (3, 8) and this is in keeping with reports of increased susceptibility to HIV in younger women (Ramjee, 2013; Glynn et al., 2001). A greater proportion of the patients presented with advanced disease (39.5% in WHO stage III and 17.1% in WHO stage), with a median baseline CD4 count level of 94.5 cells/mm^3 and 61.8% of them had received TB treatment prior to or during the period of home visit. All of these were factors that qualified them to be on ART in line with

ART treatment guidelines during that period (2008 to 2013), and accordingly, 87.5% of them were on ART. This can explain why there was a slight rise in baseline median CD4 level from 94.5 cells/mm^3 at presentation to 165.5 cells/mm^3 at the time of initial home visit.

Follow up was the most frequent reason for home visit, and this is logical considering that conditions which required HBC to be initiated in the first place could continue for a substantial period of time thereby necessitating continued follow up. Since low CD4 levels predisposes patients to the risk of opportunistic infections and consequently ill-health, it was expected that the subjects in this study would have ill- health as the commonest reason for home visit, however this was not the case. A plausible explanation for this would be that patients with ill-health would have been initially attended to by physicians either at the facility clinic or referred for hospital admission, and only thereafter would they have been recommended to the HBC team for follow up, as such, the reasons for home visits in such patient may have been documented as follow up rather than ill-health. The association of advanced stage of disease with increased morbidity has been documented in separate HBC studies carried out in Tanzania, Uganda and Malawi, all three reported a preponderance of patients with advanced stage disease and this was associated with high morbidity (Tillekeratne et al., 2009; Bowie et al., 2006; Jaffar et al., 2009). The morbidity rate in the Ugandan study was low compared to that of the Malawian and Tanzanian study, and this can be attributed to the fact that majority of the Ugandan patients, just as in this study were on ART while only a few of the Malawian and Tanzanian patients were on ART (Tillekeratne et al., 2009; Jaffar et al., 2009).

Psychological counselling, an integral part of patient management was the commonest primary reason (22.7%) for visit in this study, and this service was provided in 225 (41.5%) home visits. It is recognised that the diagnosis of HIV often generates emotions related to fears and uncertainties (Chippindale, 2001). Accordingly, the study subjects are likely to have been experiencing such. These, together with the ensuing adjustments to life style modifications required by HIV care are known to predispose to psychological and psychosocial stress. Addressing such stresses requires psychological counselling mostly with repeated sessions thus accounting for the high frequency of psychological counselling in the study.

Adherence counselling (15.5%) was the second most frequent primary reason for home visit while counselling on clients medications for adherence was the most frequent service offered (77.5%). This could easily be attributable to the fact that the vast majority of patients (87.5%) were on ART and thus needed counselling for adherence, symptom management and adverse drug reaction. Counselling on medication for opportunistic infections including tuberculosis also accounted for the

Table 2. Distribution of reasons for home visits according to year and gender (n=542).

Year/Gender	Psychological Counselling [n =123, Freq (%)]	Adherence counselling [n =84, Freq (%)]	Ill Health [n =67, Freq (%)]	Health Education [n =61, Freq (%)]	Others [n =31, Freq (%)]	Follow up [n =176, Freq (%)]	Total [n =542, Freq (%)]
2008							
F (1)	-	-	1 (1.5)	-	-	-	
M (1)	-	-	1 (1.5)	-	-	-	2 (0.4)
2009							
F (42)	4 (3.2)	14 (16.7)	7 (10.5)	2 (3.3)	7 (22.6)	8 (4.5)	
M (13)	1 (0.8)	5 (5.9)	5 (7.5)	-	-	2 (1.1)	55 (10.1)
2010							
F (65)	15 (12.2)	18 (21.4)	6 (9.0)	8 (13.0)	1 (3.2)	17 (9.7)	
M (21)	6 (4.9)	2 (2.4)	1 (1.5)	5 (8.2)	1 (3.2)	6 (3.4)	86 (15.9)
2011							
F (84)	25 (20.3)	9 (10.7)	14 (20.8)	10 (16.4)	2 (6.4)	24 (13.6)	
M (17)	8 (6.5)	2 (2.4)	-	4 (6.6)	-	3 (1.7)	101 (18.6)
2012							
F (104)	28 (22.8)	4(4.8)	6 (9.0)	18 (29.5)	8 (25.9)	40 (22.7)	
M (30)	9 (7.3)	2 (2.4)	1 (1.5)	2 (3.3)	1 (3.2)	15 (8.5)	134 (24.7)
2013							
F (89)	21 (17.1)	12 (14.3)	15 (22.3)	8 (13.1)	10 (32.2)	23 (13.1)	
M (75)	6 (4.9)	16 (19.0)	10 (14.9)	4 (6.6)	1 (3.2)	38 (21.6)	164 (30.3)
Total	123 (22.7)	84 (15.5)	67 (12.4)	61 (11.2)	31 (5.7)	176 (32.5)	542

F = female; M = male; Freq = frequency.

services rendered in this category (Table 3). The presence of opportunistic infections is in keeping with the advanced stage of disease recorded in the bulk of these patients.

Health education as a reason for home visit was not frequent (11.2%), however, this service was provided in 36.5% of home visits showing that HBC provided an avenue to reinforce health education. Health education is generally geared towards improving health literacy which has beenshown to be a significant factor in achieving better health and treatment outcomes in PLWHA (Kalichman and Rompa, 2000).

Reasons for home visit that were least frequently encountered were grouped together as others. They included spiritual counselling, basic nursing services, environmental sanitation/ hygiene, nutritional counselling, legal aid counselling and psychosocial care/welfare support; all of which together formed 5.7% of the reasons for visit. The services rendered in

Table 3. Distribution of home based care services provided to patients in 542 home visits.

Home based care service	Frequency (%)
Counselling on clients medications for adherence	
ART adherence and ARV symptom management	290 (53.5)
OI medication adherence counselling and support	53 (9.8)
TB- DOTS	62 (11.4)
Adverse drug reaction counselling and support	15 (2.8)
Total	420 (77.5)
Basic nursing	
Bed bathing	25 (4.6)
Wound care	20 (3.7)
Routine General Skin Care	45 (8.3)
Oral Hygiene and Care	139 (25.6)
Universal Precautions for family members	97 (17.9)
Assist with feeding	8 (1.48)
Total	334 (61.6)
Psychological/Mental health care counselling	225 (41.5)
House-keeping services	
Cooking	56 (10.3)
Sweeping	62 (11.4)
Fetching water	49 (9.0)
Washing	46 (8.5)
Total	213 (39.3)
Health education	198 (36.5)
Environmental sanitation and hygiene education	
Water guard supplied	180 (33.2)
Spiritual support counselling	169 (31.2)
Psychosocial care and welfare support for client/family members	113 (20.8)
Malaria care	
Anti-malaria medication	92 (17.0)
Nutritional support and counselling	92 (17.0)
Pain management-Dispensing of prescribed medication	44 (8.1)
Management of other OIs-administer prescribed medications	29 (5.4)
Counselling for TB prevention and referral for TB screening	21 (3.8)
Legal aid counselling	17 (3.1)
Distribution of IEC materials	12 (2.2)
Overall total of services provided	2,159

Multiple services were provided at each home visit.

response to this category of reasons for visit were much more frequent and so they were not grouped together. Though basic nursing services was not documented as a main reason for home visit, it was however found to be the second most frequent service provided to patients during home visits and this could be related to the advanced stage of disease found in a majority of the patients as well as the recurrent need during follow up visits. Indeed, basic nursing care, along with psychological care and spiritual care have been acknowledged as essential and much need services in HBC (Ibrahim et al., 2011). Most of the nursing services

in this category were not practicable in the clinic as the setting, job description and staff strength was not tailored towards providing such adept nursing services. Patients requiring such services were usually those that were referred for hospital admission where they could get the required services.

As a result, for patients requiring basic nursing services without hospital admission, HBC services accommodated the need. Housekeeping, a part of the recommended HBC services formed 36.5% of the services rendered to patients in this study. PLWHA at an advanced stage of the disease such as the majority of patients in this study are weakened by the disease and unable to carry out most activities of daily living. Often times, their families are faced with the burden of caring for them. Housekeeping services are typical of services that cannot be provided in the clinic, but contribute not only to easing the burden of care on the patients but also to lighten the burden of care for the family. Counselling for TB prevention and referral for TB screening complemented the DOTS programme being offered at facility level. Other services provided for the patients in this study are as summarized in Table 3.

More than half of the patients (61.8%) were still alive and receiving care at the end of the period under review, however 15.1% had died and 23.1% were lost to follow up. The deaths can be attributed to the fact that a majority of the patients presented at an advanced stage of disease. The patients lost to follow up could not be traced by the tracking team and may have died, relocated residence or sought healthcare elsewhere without requesting an appropriate referral from the facility.

Most developing countries present a similar picture of scarce clinical staff and overwhelming patient load which results in services provided at sub optimal levels and this is further complicated by psychosocial issues in the patients such as poverty and stigma (Ibrahim et al., 2011; Jaffar et al., 2009). This study illustrates how collaboration between facility care and HBC has been utilized as a strategy to extend the continuum of care beyond the facility into the home with the involvement of support group members. The assistance given to patients in their homes was provided entirely by volunteer PLWHA who were members of the facility support group.

Engaging the peer support/volunteers as caregivers not only helped to reduce stigma that may arise from the community if health workers are identified visiting homes, but it also made it easier to identify enrolled patients at the community level compared to if the task was left to facility workers.

Different aspects of the role of HIV HBC in resource limited settings has been explored by researchers and some of the conclusions drawn are worthy of note. It has been reported that the persistent need for home based care was because despite the availability of ART, it was not accessible to eligible patients; however the beneficial effect of ART was said to be most pronounced in those who had been stabilised by the HBC team before treatment started (Bowie et al., 2010). Though there have been reports that combining HBC with ART was associated with improved ART outcomes (Zachariah et al., 2007; Wouters et al., 2008), in contrast, it has also been reported that additional HBC support was not associated with improved treatment outcome, but this report was accompanied by further speculation that the conclusions drawn may have been because the quality of the HBC program was suboptimal (Estopinal et al., 2012). Other researchers concluded that HBC strategy with trained lay workers supporting ART drug delivery and patient monitoring was as effective as a nurse/doctor-led, clinic-based strategy for good patient outcomes, and so HBC could be employed to make ART available to those that did not have access to ART clinics (Kipp et al., 2011; Jaffar et al., 2009). It has also been recommended that more needs to be incorporated into the HBC programmes in order to improve care for PLWHA (Tillekeratne et al., 2009). Gathering evidence from these reports, it can be deduced that when HBC services are provided at optimal levels with adequately trained caregivers, it does contribute positively to improving ART outcomes. Though the aim of this study was not to show the association between HBC and ART outcome of patients, it does point to benefits of facility and HBC collaboration. It also provides a baseline of the pattern of needs which can be used to improve services as well as raise questions for further research in this field.

Conclusion

Though the subjects were few, the study was able to show that the services provided during home visits extended beyond the patients' perceived needs (primary reasons for visit). Home based care brings to light some patient needs that may not be evident or catered for at the facility level of care. The patients in this study were not representative of all the patients that actually needed HBC. The HBC visits were limited by the willingness and location of residence of the patients. Those who declined the offer of HBC or lived outside of the city where the facility was located did not qualify for HBC even if they needed it.

Conflict of Interests

The authors have not declared any conflict of interests.

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