Original Research Article

A cluster randomized trial evaluating a care model adapted to people living with HIV in Senegal

ABSTRACT

Aims: To compare the retention rate of the ART-stable (on ART for ≥ 6 months with a stable condition) people living with HIV (PLHIV) between a care model adapted to PLHIVs (CMAP) combining task shifting and differentiated follow-up (intervention) .and the standard of care (control)

Study design: Cluster randomized trial with both quantitative and qualitative components

Place and Duration of Study: Between July 2017 and July 2019 in the 12 health districts of Saint and Tambacouda regions, Senegal

Methodology: We included 1014 PLHIVs (504 in the intervention arm, 510 in the control

arm). The mean age was 40.6 ± 13 years; 72% were female, 39.7% at WHO clinical stages 3-4. Arms were compared using Targeted Maximum Likelihood Estimation accounting for clustering.

A socio-anthropological survey was carried out among caregivers and PLHIVs through focus group discussions and interviews to elicit the perceptions on the CMAP. The interviews were subjected to thematic analysis with Atlas Ti

Results: After 18 months of follow-up, the retention rate was 94.4%(95% CI; = 93.8-96.2) in the CMAP arm versus 92.8% [95% CI = 90.2%-93.7%] in the control arm. The duration of the trip to the health facility (26 minutes vs 68 minutes; p <0.01), the transport costs (1 US$ vs 6 US$; p < 0.01) and the time spent in the health facility (31 minutes vs 89 minutes; p < 0.01) were lower in the intervention arm.

Six (6) focus groups and 25 interviews involving 42 caregivers and 28 PLHIVs were conducted in the CMAP arm. The qualitative analyses revealed that caregivers and PLHIVs were supportive of CMAP.

Conclusion: The CMAP was associated with increased retention, shorter travel time and decreased cost in HIV care

key words *Task shifting, differentiated care, HIV, Senegal*

Abbreviations

ART	antiretroviral therapy
CI	confidence interval
CMAP	care model adapted to PLHIVs
IQR	interquartile range
PLHIV	people living with HIV
TMLE	targeted maximum likelihood estimation

1. INTRODUCTION

The effectiveness of antiretroviral therapy (ART) has been proven to be effective in prolonging the lives of people living with HIV (PLHIV) and improve their quality of life.
The HIV epidemic in Senegal is concentrated with a prevalence of 0.3% in the general population but high among key or priority populations such sex workers , men who have sex with men, and injection drug users(1).
Senegal was the first country in Africa to set up a government program for the management of PLHIVs with ART in 1998. After an initial pilot phase of eighteen months that showed treatment effectiveness similar to results reported by Western countries (2), Senegal put in

place a national strategy for decentralization and facilitation of access to ART in 2001. ART is currently offered free of charge across all regions in the country.

In Senegal, the health system is pyramidal with three levels: the central level is national in character with the university hospitals; the intermediate or regional level is made up of regional hospitals whilst the peripheral level with the health districts forms the operational units of the system. Each health district coordinates the health centres and health posts. Typically, the health posts are staffed by community health workers and managed by nurses. A health centre may be responsible for and supervise several health posts. An assessment in the country showed a shortage of health personnel, especially doctors. Doctors, until recently, were the only health personnel authorized to prescribe ART. This created an enormous workload on the existing staff thereby compromising the quality of services offered to PLHIVs(3–5).

Task shifting is defined as a process of delegation whereby tasks are moved, where appropriate, to less specialized health workers was recommended by the World Health Organization (WHO) to deal with the human resource deficit(6) has been implemented in a number of countries and has been reported to be effective(7–11) . In the context of HIV, the adoption of a public health approach is central to the principle of task shifting. The public health approach uses standardized, simplified, and decentralized systems that can maximize the role of primary health care and community care workers (6).In Senegal, the Ministry of Health (MOH) approved in 2014 the implementation of task shifting to address these identified challenges(12). By delegating the care of PLHIV to health posts, Senegal would be able to decentralize HIV care using a public health approach. After initial training, follow up of stable PLHIVs was moved to the health posts.

PLHIVs on ART for more than six months without weight loss, serious comorbidity or treatment failure were considered stable and were subject to non-medical follow-up, particularly by nurses at health posts with differentiated care according to the profile of the PLHIV. The benefits of the differentiated follow up has been documented(13–17). The differentiated follow-up consisted of giving different appointment frequency depending on the clinical profile. Appointment could be monthly, quarterly or six monthly. Appointment reminders can be sent by text message if necessary, encouraging peer support and the initiation of support groups related to HIV care.

We hypothesized that a care model adapted to PLHIVs (CMAP) combining tasks shifting of PLHIV's care to paramedical/community staff and a differentiated follow-up of stable PLHIVs would improve the PLHIVs care and the retention rate.

2. MATERIAL AND METHODS

We conducted a cluster randomized trial with both quantitative and qualitative components from 2017 July to 2019 July. Two regions with different epidemiological profiles were targeted to assess the CMAP in different contexts in Tambacounda and Saint Louis regions located in the south-east and north of the country respectively. Tambacounda is designated as a priority region in the fight against HIV/AIDS with a prevalence of 0.9%. The area of the region is 42,706 km² (21.7% of the national territory) with an estimated population of 716,594. It is subdivided into seven health districts (Bakel, Dianké Makha, Goudiry, Kidira, Koumpentoum, Maka Colibantang and Tambacounda). It has a regional hospital, eight health centres and 104 health posts. The number of PLHIV on ART was 1137 in 2018(18,19). The Saint Louis region has 957,600 inhabitants in an area of 19,034 km^2. The region had 111 health posts, 7 health centres and three hospitals in five health districts (Dagana, Pètè, Podor, Saint Louis, and Richard Toll). The epidemic in the region is concentrated with a prevalence of 0.4% and more accessible health facilities. The number of PLHIV regularly monitored was 1205 in 2018(19,20).

The study had two (2) arms. Arm A received the intervention (CMAP) while the arm B received the standard of care. After an initial (theoretical and practical) training in group A

districts, follow-up on ART including the provision of ART and differentiated follow-up of stable PLHIV were shifted to the nurses, midwives, and community staff in the health posts. frequency of follow-up according to the patient's profile, which can be quarterly or biannual. Appointments reminders by text message were done as needed as well as an invitation to peer support. In the standard of care, the care of PLHIV was provided by doctors with monthly or bimonthly appointments. The randomization unit was the health district. The package of services in the intervention arm (Arm A) included care was provided by paramedical/community staff with differentiated follow-up (variable frequency of appointments, peer coaching, appointment reminders as needed, participation in support groups). In the arm B, all PLHIV were followed upon the basis of monthly or bimonthly appointments. The consultation was done by the doctors. Their prescription was presented at the pharmacy to take the ARVs. Social services could be called upon if necessary. In both arms, a biological follow-up assessment was carried out every six months with a complete blood count, blood glucose, transaminases, serum creatinine, CD4, CD8 and plasma viral load

The study was carried out in all 12 health districts of the two (2) regions and all PLHIVs who met the selection criteria during September 2017-July 2018 were included

The inclusion criteria were:

- Documented HIV infection (HIV-1 or HIV-2 or HIV-1 + HIV-2)
- on ART and stable
- Informed consent

The exclusion criteria were:

- Treatment failure
- Comorbidities like diabetes, poorly controlled hypertension, cancer
- Other comorbidity requiring medical management

2.1 QUANTITATIVE

The primary outcome was retention in care. Geographical and financial accessibility was a secondary outcome. Arms were compared using Targeted Maximum Likelihood Estimation (TMLE), accounting for clustering. A sample of 982 patients was required to show a 1.5% difference in retention rate between the arms, considering a population retention rate of 90% with $\alpha = 5\%$, and $\beta \leq 20\%$.

All statistical tests were two-sided and considered statistically significant at a 5% threshold. Statistical analyses were performed using version 16.1 of Stata.

2.2 QUALITATIVE

A socio-anthropological survey was carried out among caregivers through focus group discussions and semi-structured interviews. The interviews elicited the perceptions of PLHIVs on the CMAP to guide its scaling up. The interviews were recorded, transcribed, and subjected to thematic analysis with Atlas Ti.

2.3 ETHICAL APPROVAL

The protocol was approved by the National Ethics Committee for Health Research (CNERS) on November 7, 2016 (N°0161MSAS/DPRS/CNERS).

3. RESULTS AND DISCUSSION

3.1 RESULTS

3.1.1 QUANTITATIVE

Overall, 1014 PLHIVs in the 12 health districts of Saint Louis and Tambacounda were included. The mean age was 40.6 ± 13.5 years; 41.7 ± 13.4 years in the intervention arm; 39.8 ± 13.6 years in the control arm. A proportion of 72% (95% CI: 63.8-86.2) were female, 39.7% (95% CI: 33.8-46.2) at WHO clinical stages 3-4. Their characteristics are summarized in Table I.

Table I. Characteristics of the population included in the cluster randomized trial comparing a care model adapted to people living with HIV with the standard of care in Senegal by study arm (CMAP arm, Control arm)

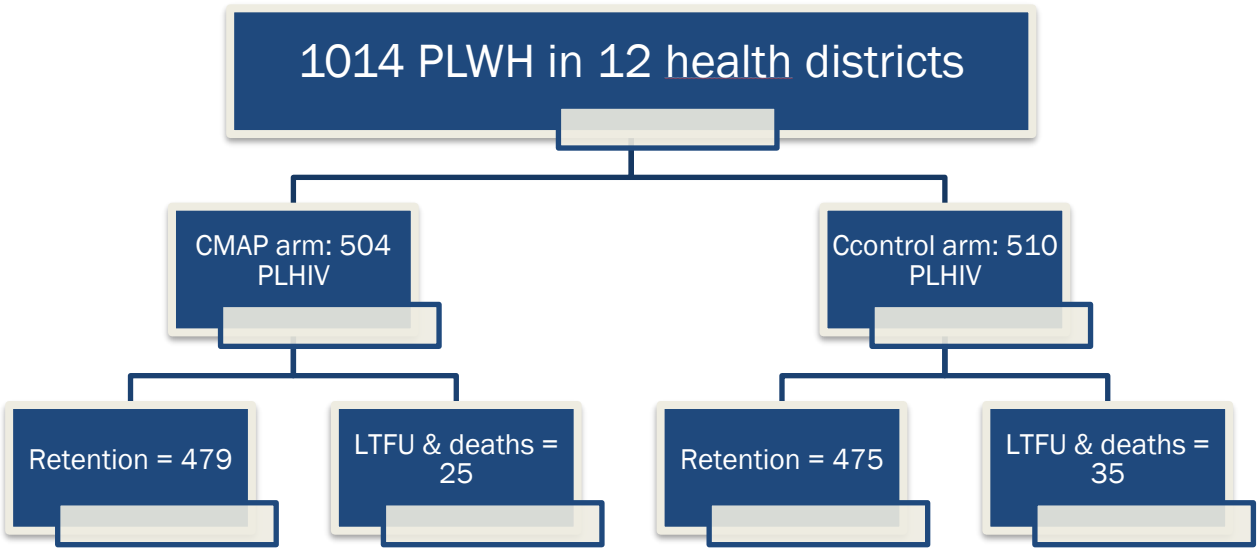
Variables	CMAP[a] arm N=429 Median (IQR[b]) or n (%)	Control arm N=585 Median (IQR) or n (%)	Total N=1014 Median (IQR) or n (%)
Age	42 (34 - 50)	40 (32 – 48.8))	41 (33 – 49)
Sex			
Female	298 (69.5)	430 (73.9)	728 (72.0)
Male	131 (30.5)	152 (26.1)	283 (28.0)
WHO clinical stage			
1-2	252 (61.9)	307 (59.0)	559 (60.3)
3-4	155 (38.1)	213 (41.0)	368 (39.7)
HIV serotype			
	403 (93.9)	550 (94.0)	953 (94.0)
HIV-1			
HIV-2	20 (4.7)	28 (4.8)	48 (4.7)
HIV1+HIV-2	6 (1.4)	7 (1.2)	13 (1.3)

163 *[s]care model adapted to PLHIV* *[b] interquartile range*

164

165

166 The flowchart of the study is presented in figure 1.



167

168 Figure 1. Flowchart of the cluster randomized trial comparing a care model adapted to
169 people living with HIV with the standard of care in Senegal

170

171 ***3.1.1.1 RETENTION***

172 After 18 months of follow-up, the retention rate was 94.4% [95% CI: 93.8-96.2] in the
173 intervention group versus 92.8% [95% CI: 90.2-93.7] in the control group; *P*= .04 (figure 2).

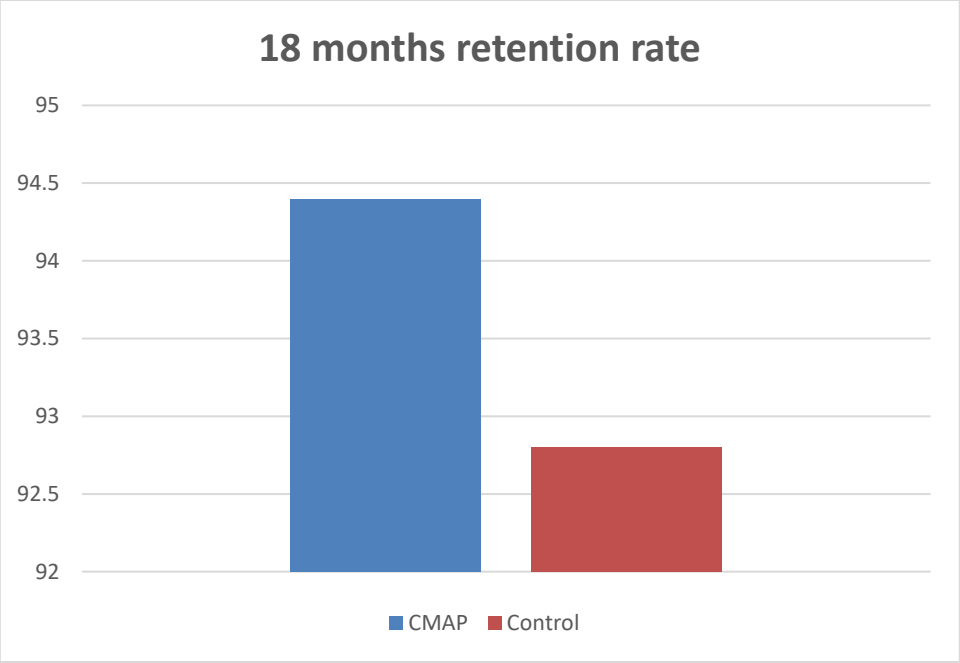


Figure 2. Retention rate by arm in the cluster randomized trial comparing a care model adapted to people living with HIV with the standard of care in Senegal

HIV viral load was measured for 411 PLHIV: 43.1% [95% CI = 41.28-48.13]. It was undetectable for 79.6% [95% CI = 75.27-83.29] : 83.4% [95% CI = 77.19-88.53] in CMAP arm versus 76.5% [95% CI = 70.50-81.84] in control arm; P=.08).

3.1.1.2 ACCESSIBILITY

The duration of the trip to the health facility (26 minutes vs 68 minutes; *P* <.001), the transport costs (1 US$ vs 6 US$; *P* < .001) and the time spent in the health facility (31 minutes vs 89 minutes; *P* < .001) were lower in the CMAP arm.

3.1.2 QUALITATIVE

Six (6) focus groups involving 25 nurses; 17 semi-structured interviews with doctors, social workers and community staff members; and 28 interviews with PLHIVs were conducted in the CMAP arm in Saint louis and Tambacounda. The qualitative analyses revealed that caregivers and PLHIVs were supportive of the CMAP and determined the ideal conditions for successful scale-up: a) optimal communication and organization of caregivers between the health centre and the health posts (clinicians, nurses, community staff); b) health districts with limited access to physicians; c) initial training and supervision of the nurses and the community staff.

2.2 DISCUSSION

This CMAP showed a higher retention rate than that obtained with the standard of care for PLHIVs that existed in Senegal. Simple and objective measures of outcomes were used. The study design and the analyses carried out made it possible to control the confounding factors.

Several studies reported that nurse-initiated and monitored ART was noninferior to clinician-initiated and monitored ART in adult PLHIVs. (21–30). Some studies have reported, with the nurse's model, a reduction in the proportion of people lost to follow-up in South Africa, Rwanda, Ethiopia and Swaziland (22,22,29,31–33) , and a higher rate of retention on ART(31,32,34). One study in South Africa reported a higher probability of lost to follow up(23) but that was not in line with our results. In addition to the different epidemic contexts between Senegal and South Africa, differences between this observational study and ours could help explain this result. For example, in this study, PLHIV who had been on ART for at least 16 weeks were eligible with clinical criteria like that of our study in addition to having a last viral load< 50 copies/ml. It has been reported that differentiated care models, including task-shifting had similar outcomes in viral load suppression compared to the standard HIV care (23,33–35). These results are in agreement with those of our study. Other studies have reported that viral load suppression was higher in the community based differentiated service delivery models(36,37).

As in our study, a lower cost was reported with task-shifting (21,33,38,39) as well as with differentiated service delivery (40). The health-related quality of life associated with task shifting was reportedly higher compared with the standard of care (8). Consistent with our study, a reduced patients' travel time, and visit time were reported with differentiated care models as well as a higher adherence and enhanced social support in Malawi, South Africa, Lesotho, Uganda, and Nigeria (40–44).

This study is the first one to demonstrate the effectiveness of task shifting and differentiated service delivery in a context of concentrated epidemic. Such a model could be replicated in countries with a similar context (systemic and epidemiological) like that of Senegal.

4. CONCLUSION

The CMAP was associated with increased retention, shorter travel time and decreased cost in HIV care. Expansion of this approach across the country will offer invaluable benefits to PLHIV

CONSENT (WHERE EVER APPLICABLE)

After a full reading of the information leaflet, the participants were required to provide informed consent. If the candidate agreed to participate, together with the investigator, they completed, dated, and signed two copies of the consent form. (Appendizx I)

ETHICAL APPROVAL (WHERE EVER APPLICABLE)

Ethical approval was obtained from the National Ethics Committee for Health Research (CNERS) of the Ministry of Health (MOH) in Senegal on November 09, 2016 (N°00000161MSAS/DPRS/CNERS)

REFERENCES

1. World Health Organization. Senegal country profile 2023 [Internet]. HIV Country Intelligence. 2023 [cited 2024 Jan 14]. Available from: https://cfs.hivci.org/

2. Laurent C, Diakhaté N, Gueye NFN, Touré MA, Sow PS, Faye MA, et al. The Senegalese government's highly active antiretroviral therapy initiative: an 18-month follow-up study. AIDS Lond Engl. 2002 July 5;16(10):1363–70.

3. CNLS, Sènègal. Rapport d'activité sur la riposte au sida au Sénégal. Sènègal; 2016.

4. Synthèse données région de Tamba, 2016.

5. Synthèse données région de Saint Louis, 2018.

6. World Health Organization. Task shifting to tackle health worker shortages. 2007.

7. Crowley T, Mayers P. Trends in task shifting in HIV treatment in Africa: Effectiveness, challenges and acceptability to the health professions. Afr J Prim Health Care Fam Med. 2015 July 30;7(1):807.

8. Suzan-Monti M, Blanche J, Boyer S, Kouanfack C, Delaporte E, Bonono RC, et al. Benefits of task-shifting HIV care to nurses in terms of health-related quality of life in patients initiating antiretroviral therapy in rural district hospitals in Cameroon [Stratall Agence Nationale de Recherche sur le SIDA (ANRS) 12110/Ensemble pour une Solidarité Thérapeutique Hospitalière en Réseau (ESTHER) substudy]. HIV Med. 2015 May;16(5):307–18.

9. Iwu EN, Holzemer WL. Task shifting of HIV management from doctors to nurses in Africa: clinical outcomes and evidence on nurse self-efficacy and job satisfaction. AIDS Care. 2014 Jan;26(1):42–52.

10. Mdege ND, Chindove S, Ali S. The effectiveness and cost implications of task-shifting in the delivery of antiretroviral therapy to HIV-infected patients: a systematic review. Health Policy Plan. 2013 May;28(3):223–36.

11. Lazarus JV, Safreed-Harmon K, Nicholson J, Jaffar S. Health service delivery models for the provision of antiretroviral therapy in sub-Saharan Africa: a systematic review. Trop Med Int Health TM IH. 2014 Oct;19(10):1198–215.

12. World Health Organization. Guide Pour la prise en charge de l'infection par le VIH au Sènègal [Internet]. Available from: https://www.divisionsidaist.gouv.sn/wp-content/uploads/2022/03/Guide_PEC_VIH_2019.pdf

13. Davis N, Kanagat N, Sharer M, Eagan S, Pearson J, Amanyeiwe UU. Review of differentiated approaches to antiretroviral therapy distribution. AIDS Care. 2018 Aug;30(8):1010–6.

14. Roberts DA, Tan N, Limaye N, Irungu E, Barnabas RV. Cost of Differentiated HIV Antiretroviral Therapy Delivery Strategies in Sub-Saharan Africa: A Systematic Review. J Acquir Immune Defic Syndr 1999. 2019 Dec;82 Suppl 3(Suppl 3):S339–47.

15. Mesic A, Fontaine J, Aye T, Greig J, Thwe TT, Moretó-Planas L, et al. Implications of differentiated care for successful ART scale-up in a concentrated HIV epidemic in Yangon, Myanmar. J Int AIDS Soc. 2017 July 21;20(Suppl 4):21644.

16. Hagey JM, Li X, Barr-Walker J, Penner J, Kadima J, Oyaro P, et al. Differentiated HIV care in sub-Saharan Africa: a scoping review to inform antiretroviral therapy provision for stable HIV-infected individuals in Kenya. AIDS Care. 2018 Dec;30(12):1477–87.

17. Mukumbang FC, Van Belle S, Marchal B, van Wyk B. An exploration of group-based HIV/AIDS treatment and care models in Sub-Saharan Africa using a realist evaluation (Intervention-Context-Actor-Mechanism-Outcome) heuristic tool: a systematic review. Implement Sci IS. 2017 Aug 25;12(1):107.

18. Région médicale de Tambacounda. Comité régional de lutte contre le sida. Revue bilan règional 2018.

19. Conseil National de Lutte contre le Sida. Rapport annuel 2018. Dakar, Senegal;

20. Règion mèdicale de Saint Louis. Revue annuelle conjointe des indicateurs de santé 2018-2019. 2019.

21. Humphreys CP, Wright J, Walley J, Mamvura CT, Bailey KA, Ntshalintshali SN, et al. Nurse led, primary care based antiretroviral treatment versus hospital care: a controlled prospective study in Swaziland. BMC Health Serv Res. 2010 Aug 5;10:229.

22. Brennan AT, Long L, Maskew M, Sanne I, Jaffray I, MacPhail P, et al. Outcomes of stable HIV-positive patients down-referred from a doctor-managed antiretroviral therapy clinic to a nurse-managed primary health clinic for monitoring and treatment. AIDS Lond Engl. 2011 Oct 23;25(16):2027–36.

23. Grimsrud A, Kaplan R, Bekker LG, Myer L. Outcomes of a nurse-managed service for stable HIV-positive patients in a large South African public sector antiretroviral therapy programme. Trop Med Int Health TM IH. 2014 Sept;19(9):1029–39.

24. Bemelmans M, van den Akker T, Ford N, Philips M, Zachariah R, Harries A, et al. Providing universal access to antiretroviral therapy in Thyolo, Malawi through task shifting and decentralization of HIV/AIDS care. Trop Med Int Health TM IH. 2010 Dec;15(12):1413–20.

25. Sekiziyivu BA, Bancroft E, Rodriguez EM, Sendagala S, Nasirumbi MP, Najjengo MS, et al. Task Shifting for Initiation and Monitoring of Antiretroviral Therapy for HIV-Infected Adults in Uganda: The SHARE Trial. J Acquir Immune Defic Syndr 1999. 2021 Mar 1;86(3):e71–9.

26. Kiweewa FM, Wabwire D, Nakibuuka J, Mubiru M, Bagenda D, Musoke P, et al. Noninferiority of a task-shifting HIV care and treatment model using peer counselors and nurses among Ugandan women initiated on ART: evidence from a randomized trial. J Acquir Immune Defic Syndr 1999. 2013 Aug 1;63(4):e125-132.

27. Boullé C, Kouanfack C, Laborde-Balen G, Carrieri MP, Dontsop M, Boyer S, et al. Task shifting HIV care in rural district hospitals in Cameroon: evidence of comparable antiretroviral treatment-related outcomes between nurses and physicians in the Stratall ANRS/ESTHER trial. J Acquir Immune Defic Syndr 1999. 2013 Apr 15;62(5):569–76.

28. Sanne I, Orrell C, Fox MP, Conradie F, Ive P, Zeinecker J, et al. Nurse versus doctor management of HIV-infected patients receiving antiretroviral therapy (CIPRA-SA): a randomised non-inferiority trial. Lancet Lond Engl. 2010 July 3;376(9734):33–40.

29. Shumbusho F, van Griensven J, Lowrance D, Turate I, Weaver MA, Price J, et al. Task shifting for scale-up of HIV care: evaluation of nurse-centered antiretroviral treatment at rural health centers in Rwanda. PLoS Med. 2009 Oct;6(10):e1000163.

30. Monyatsi G, Mullan PC, Phelps BR, Tolle MA, Machine EM, Gennari FF, et al. HIV management by nurse prescribers compared with doctors at a paediatric centre in Gaborone, Botswana. South Afr Med J Suid-Afr Tydskr Vir Geneeskd. 2011 Dec 14;102(1):34–7.

31. Bedelu M, Ford N, Hilderbrand K, Reuter H. Implementing antiretroviral therapy in rural communities: the Lusikisiki model of decentralized HIV/AIDS care. J Infect Dis. 2007 Dec 1;196 Suppl 3:S464-468.

32. Assefa Y, Kiflie A, Tekle B, Mariam DH, Laga M, Van Damme W. Effectiveness and acceptability of delivery of antiretroviral treatment in health centres by health officers and nurses in Ethiopia. J Health Serv Res Policy. 2012 Jan;17(1):24–9.

33. Long L, Brennan A, Fox MP, Ndibongo B, Jaffray I, Sanne I, et al. Treatment outcomes and cost-effectiveness of shifting management of stable ART patients to nurses in South Africa: an observational cohort. PLoS Med. 2011 July;8(7):e1001055.

34. Fairall L, Bachmann MO, Lombard C, Timmerman V, Uebel K, Zwarenstein M, et al. Task shifting of antiretroviral treatment from doctors to primary-care nurses in South Africa (STRETCH): a pragmatic, parallel, cluster-randomised trial. Lancet Lond Engl. 2012 Sept 8;380(9845):889–98.

35. Selke HM, Kimaiyo S, Sidle JE, Vedanthan R, Tierney WM, Shen C, et al. Task-shifting of antiretroviral delivery from health care workers to persons living with HIV/AIDS: clinical outcomes of a community-based program in Kenya. J Acquir Immune Defic Syndr 1999. 2010 Dec;55(4):483–90.

36. Brian J, Waiswa S, Balinaine J, Lomuria R, Nabutanyi GG, Ongala E, et al. Sustained Retention, Viral Load Suppression and their Determinants Among Clients on HAART Enrolled Under Differentiated Service Delivery Models in Eastern Uganda. Res Sq. 2023 Oct 4;rs.3.rs-3377046.

403 37. Kipp W, Konde-Lule J, Rubaale T, Okech-Ojony J, Alibhai A, Saunders DL.
404 Comparing antiretroviral treatment outcomes between a prospective community-
405 based and hospital-based cohort of HIV patients in rural Uganda. BMC Int
406 Health Hum Rights. 2011 Nov 8;11 Suppl 2(Suppl 2):S12.

407 38. Babigumira JB, Castelnuovo B, Lamorde M, Kambugu A, Stergachis A,
408 Easterbrook P, et al. Potential impact of task-shifting on costs of antiretroviral
409 therapy and physician supply in Uganda. BMC Health Serv Res. 2009 Oct
410 21;9:192.

411 39. Babigumira JB, Castelnuovo B, Stergachis A, Kiragga A, Shaefer P, Lamorde
412 M, et al. Cost effectiveness of a pharmacy-only refill program in a large urban
413 HIV/AIDS clinic in Uganda. PloS One. 2011 Mar 28;6(3):e18193.

414 40. Nichols BE, Cele R, Lekodeba N, Tukei B, Ngorima-Mabhena N, Tiam A, et al.
415 Economic evaluation of differentiated service delivery models for HIV treatment
416 in Lesotho: costs to providers and patients. J Int AIDS Soc. 2021
417 Apr;24(4):e25692.

418 41. Prust ML, Banda CK, Callahan K, Nyirenda R, Chimbwandira F, Kalua T, et al.
419 Patient and health worker experiences of differentiated models of care for stable
420 HIV patients in Malawi: A qualitative study. PloS One. 2018;13(7):e0196498.

421 42. Georgette N, Siedner MJ, Petty CR, Zanoni BC, Carpenter S, Haberer JE.
422 Impact of a clinical program using weekly Short Message Service (SMS) on
423 antiretroviral therapy adherence support in South Africa: a retrospective cohort
424 study. BMC Med Inform Decis Mak. 2017 Feb 20;17(1):18.

425 43. Alamo ST, Wagner GJ, Ouma J, Sunday P, Marie L, Colebunders R, et al.
426 Strategies for optimizing clinic efficiency in a community-based antiretroviral
427 treatment programme in Uganda. AIDS Behav. 2013 Jan;17(1):274–83.

428 44. Umar NA, Hajara MJ, Khalifa M. Reduction of client waiting time using task
429 shifting in an anti-retroviral clinic at Specialist Hospital Bauchi, Nigeria. J Public
430 Health Afr. 2011 Mar 1;2(1):e2.