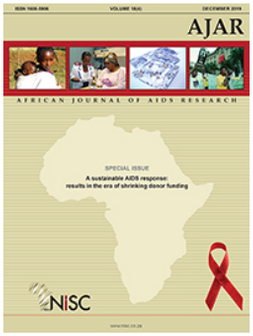

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Research Article

Which delivery model innovations can support sustainable HIV treatment?

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The rapid scale-up of antiretroviral treatment (ART) for HIV since the mid-2000s, mostly through disease-specific or "vertical" programmes, has been a highly successful undertaking, which averted millions of deaths and prevented many new infections. However, the dynamics of the HIV epidemic and changing political and financial commitment to fight the disease will likely require new models for the delivery of ART over the coming decades if the promises of universal treatment are to be met. Delivery model innovations for ART are intended to improve both the effectiveness and efficiency of the HIV treatment cascade, reaching new people who require ART and providing ART to more people without an increase in resources. We describe twelve models for ART delivery, which could be achieved through five categories of delivery innovations: integrating ART ("vertical ART plus", "partially-integrated ART" and "fully-integrated ART"); modifying steps in the ART value chain ("professional task-shifted ART", "people task-shifted ART" and "technology-supported ART"); eliminating steps in the ART value chain ("immediate ART" and "less frequent ART pick-up"); changing ART locations ("private-sector ART", "traditional-sector ART" and "ART outside the health sector"); and keeping the status quo ("vertical ART"). The different delivery model innovations are not mutually exclusive and several could be combined, such as "vertical ART plus" with "task-shifted ART". Suitability of the models will highly depend on local and national contexts, including existing health systems resources, available funding, and type of HIV epidemic. Future implementation research needs to identify which models are the best fit for different contexts.

Keywords: HIV, AIDS, health systems, delivery model innovations, sustainability, integration

Background

The rapid scale-up of antiretroviral treatment (ART) for HIV since the mid-2000s has been an unprecedented achievement in public health. The rapid expansion of access to treatment – mostly through vertical programmes funded by international donor organisations (Dieleman et al., 2018) – has averted millions of deaths and prevented many infections in low- and middle-income countries (LMICs) (Granich et al., 2015; Murray et al., 2014; Smith et al., 2014). Despite the success of the current HIV response, there are three important reasons why now is the time to rethink the delivery models for HIV treatment for the coming decades.

First, major global donors are slowly pulling back. The HIV epidemic predominantly affects resource-poor communities, mostly in sub-Saharan Africa. Here, the lack of sufficient health facilities and the push for a rapid scale-up of HIV services resulted in the creation of vertical ART delivery systems. These services are predominantly funded and sustained by international donor organisations, like the US President's Emergency Plan for AIDS Relief (PEPFAR) and the Global Fund to Fight AIDS, Tuberculosis and Malaria. Yet, while the number of people on lifelong ART continues to increase (UNAIDS, 2017), the available funding falls short. Although overall health aid is higher than ever before (Schäferhoff, Martinez, Ogbuoji, Sabin, & Yamey, 2019), donor HIV spending in LMICs has declined by more than $1 billion annually since 2015 (Dieleman et al., 2018; Kates, Wexler, & Lie, 2017). These shortages threaten the sustainability of the international AIDS response.

Second, non-communicable diseases (NCDs), such as diabetes, cardiovascular diseases and cancer, have been recognised as a growing source of morbidity and mortality in LMICs with generalised HIV epidemics (Allen et al., 2017). As people with HIV are living longer due to successful ART (Hontelez et al., 2012), NCDs have become a leading cause of comorbidity for this population (Haacker, Bärnighausen, & Atun, 2019; Kemp et al., 2018; Osetinsky et al., 2019).

Third, the global health agenda is increasingly pushing for a shift from vertical programmes towards more integrated service delivery within the general health system. The sustainable development goals emphasise targets that call

for ending the HIV, tuberculosis, and malaria epidemics; transforming maternal and child health; tackling the growing burden of NCDs; and reaching larger numbers of people for universal-test-and-treat programmes, all of which should be achieved through universal health coverage (UHC) (Bekker et al., 2018; United Nations, 2017).

Financial, epidemiological and political sustainability will need to be at the core of every country's future HIV response (Oberth & Whiteside, 2016; Phillips et al., 2015), triggering a need for innovative health systems thinking. Sustainable delivery models should allow for tailored country-owned ART delivery models that aim for overall cost reduction while ensuring high quality care, as well as reaching people living with HIV that the current programmes do not reach – these are important but ambitious demands on future ART delivery models.

In this article, we propose twelve models – based on five delivery model innovations – for ART delivery, which could respond to the current challenges and opportunities. First, we suggest integration of ART with other health services. Integration can be achieved to different degrees – adding health services to vertical ART (model 1), partial integration of ART with other vertical health programmes (model 2), or full integration of ART into primary healthcare (model 3). Second, we propose modifying one or several steps in the healthcare value chain – through task-shifting of ART delivery to lower-level health workers (model 4) or to patients, family members, or community members (model 5), or through ART delivery supported by technology (model 6). Third, we describe models where steps in the healthcare value chain would be eliminated – through immediate ART initiation following a positive HIV test (model 7) or less frequent ART delivery for patients who are stable on treatment (model 8). The fourth innovation is based on using new places for ART delivery, which could be private health facilities (model 9), traditional healers (model 10), or locations outside the healthcare system (model 11). Of course, one important delivery model is the status quo, i.e. vertical ART services provided apart from other health services (model 12). All delivery model innovations need to be benchmarked against the performance of the status quo, which over the past two decades has proven to be highly successful. An overview of the described delivery model innovations and related ART delivery models is presented in Figure 1.

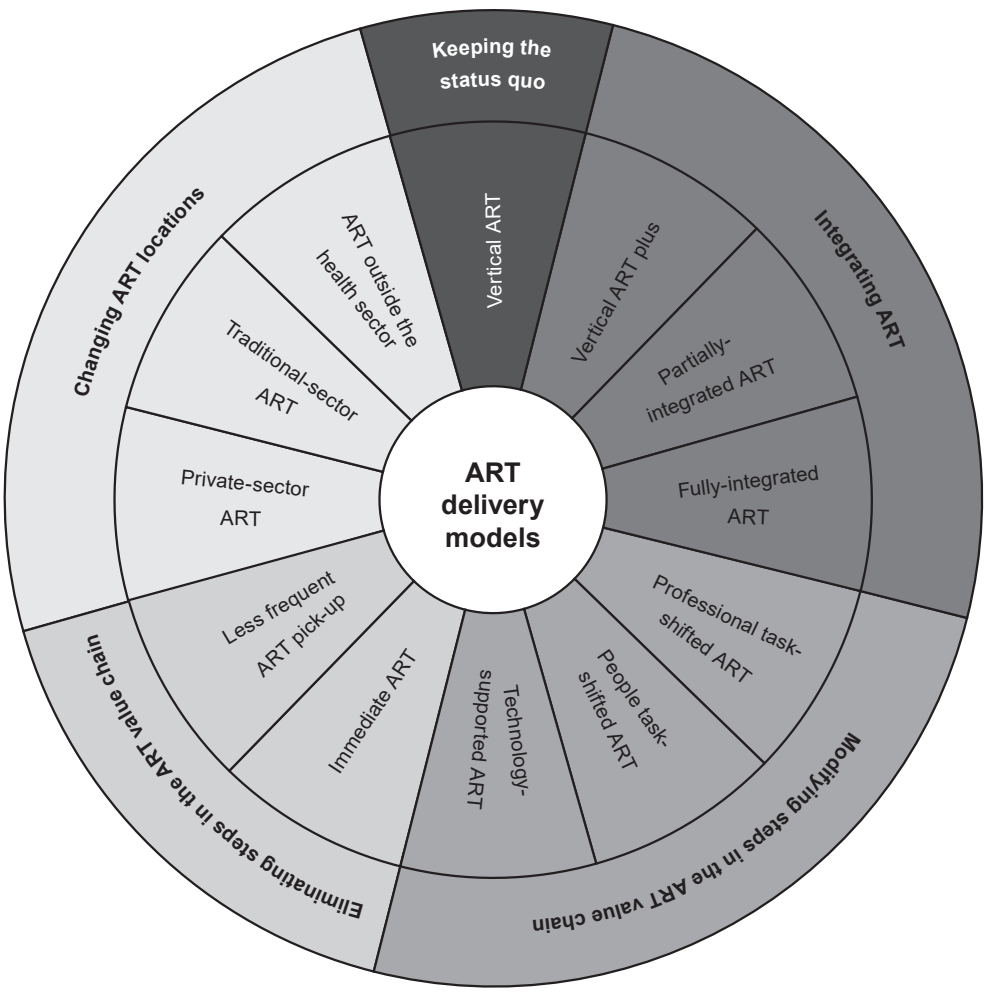

Figure 1: Wheel of ART delivery model innovations

Integrating ART

This delivery model innovation comprises models where ART delivery is offered together with other health services. This includes integrating care for other diseases with the care already available for HIV patients in the status quo delivery models (model 1 – "vertical ART plus"), combining different vertical systems like tuberculosis or maternal health with HIV care (model 2 – "partially-integrated ART"), or full integration of HIV care within the general primary healthcare system (model 3 – "fully-integrated ART"). These models have the potential to lead to efficiency gains for the healthcare system, due to shared use of staff and physical resources. Integrated models can also increase the efficiency of patients' healthcare utilisation: for comorbid HIV patients, care will be available in one clinic visit rather than several visits to different clinics. At the same time, it is plausible that integrated care increases average costs per treatment, because of diseconomies of scope. Vertical care ensures maximal learning and procedural efficiency because patients are very similar. Integrated care implies more dissimilar patients, which reduces learning effects and the potential to optimally prepare and organise the resources for care provision.

Model 1 – "vertical ART plus"

In the vertical ART plus model, ART delivery remains separate from the general health system, but other health services will be offered at the clinic alongside HIV services. Frequent comorbidities of people living with HIV are tuberculosis (Diedrich & Flynn, 2011; Oni et al., 2015), NCDs such as diabetes and hypertension (Oni et al., 2015), as well as depression and other mental health issues (Nanni, Caruso, Mitchell, Meggiolaro, & Grassi, 2015). With completely vertical HIV service provision, these comorbidities are often neglected, and people living with HIV need to visit multiple health facilities to access all the required care. Vertical ART plus services could capitalise on the foundations built with the HIV response to improve the efficiency and coverage of care and treatment of these comorbidities. Furthermore, screening might be offered along with HIV services, which is already done sometimes for cervical cancer in young female HIV patients and for the most common NCDs in older HIV patients (Duffy et al., 2017). Vertical ART plus may be more cost-effective than purely vertical services as resources are shared, translating to increased technical efficiency (i.e. minimalising staff and resources while maximising service delivery) (Duffy et al., 2017). However, the vertical ART plus model may result in inequalities in access to care, as HIV-negative people who require healthcare are not covered here and will need to seek services elsewhere.

Model 2 – "partially-integrated ART"

This model comprises partial integration of ART delivery with other existing vertical healthcare programmes, of which well-known examples are integration with programmes for tuberculosis (Howard & El-Sadr, 2010; Suthar et al., 2012), sexual and reproductive health (Warren et al., 2017), and NCDs (Duffy et al., 2017; Kemp et al., 2018). More recently, HIV service integration with mental health programmes has also been explored (Freeman, Patel, Collins, & Bertolote, 2005; Kaaya et al., 2013). Generally, this form of integration allows for operational efficiency gains (i.e. optimised service delivery due to specialised staff and well-functioning work flows, for example) and is most beneficial when target populations of both programmes largely overlap. In contrast to the vertical ART plus model, services are not exclusively available for people living with HIV. Partial integration of ART delivery with other health programmes can be realised at different levels, from complete integration of location, resources and personnel to solely linking both vertical programmes, through strengthened referral. The advantages of this model are highly dependent on the level of integration and context. Similar to the vertical ART plus model, this model has the potential for technical efficiency gains. Depending on the context, also allocative efficiency gains (i.e. optimal allocation of services based on the patients' needs) might be achieved. However, this model does not entail UHC and thus still produces inequalities in access to care.

Model 3 – "fully-integrated ART"

This integration model can be defined as ART service provision at the same location and with the same (human) resources as primary healthcare (Odeny et al., 2013). Decentralised ART delivery allows people to access all types of healthcare, regardless of their HIV status, thereby tackling issues of inequality and stigma associated with more vertical systems (Sweeney et al., 2012).

Whether efficiency is higher compared to more vertical systems will largely depend on the local context and disease burden. On the one hand, shared resources and shared workload among the staff could enhance technical efficiency and allocative efficiency of the general health system. Furthermore, due to easier referral and access to other health services, uptake of ART will likely increase, at a lower cost (Chan et al., 2010). On the other hand, diseconomies of scope may result in less efficient ART delivery, as heath workers and other personnel now need to shift focus between treating a wide variety of patients rather than specialising and optimising care for a specific group of patients. In addition, in high-burden areas, the high numbers of HIV infected people requiring care might overburden the health system and crowd-out other patients. Finally, a fully integrated ART delivery model might be detrimental for care and prevention for specific key populations, such as sex workers, injecting drug users, or men who have sex with men (MSM). In many cases these – often marginalised – populations have poorer access to general healthcare, and benefit greatly from specifically tailored services.

Modifying steps in the ART value chain

This delivery model innovation is aimed at modifying different essential steps of the value chain (Porter, 2001) of ART delivery to increase and improve delivery while ensuring low costs. This can be achieved by shifting the offered HIV services to lower health workers (model 4 – "professional

task-shifted ART"), other people or the patients themselves (model 5 – "people task-shifted ART"), or technology supported ART delivery (model 6 –"technology-supported ART"). By bringing services closer to the population, these models may increase ART coverage, and could bolster retention and adherence to ART at relatively low costs. When designed well, this type of innovation might alleviate pressure from the busy clinics providing HIV treatment. The effects on quality of care and patient satisfaction highly depend on the type of model and the specific content and context of modification.

Model 4 – "professional task-shifted ART"

Health workers have been one, or *the* "binding constraint", even early in the history of the ART scale-up in sub-Saharan Africa (Bärnighausen, Bloom, & Humair, 2007, 2010, 2016). Ever since the introduction of nurse-led treatment initiation (Samb et al., 2007), various task-shifting strategies have been explored to overcome this constraint and to increase the efficiency and sustainability of ART delivery. In the professional task-shifted ART model, HIV testing and ART delivery are partly shifted from nurses to health extension workers or community health workers (CHWs), for example through home-based testing or mobile testing (Asiimwe et al., 2017; Bemelmans et al., 2014) and CHW-led ART delivery (Geldsetzer et al., 2017). Clinics are often busy, and task-shifting and task-sharing can reduce the work load of highly trained health professionals, allowing them to provide other complex and essential care. In addition, costs will remain relatively low compared to fully centralised ART delivery. Community-based testing and service provision increases the number of people reached, that might otherwise not know their status or would not have access to sufficient treatment (Geldsetzer et al., 2018; Zachariah et al., 2009). Professional task-shifting can thus lead to higher ART coverage and operational efficiency gains. Shifting services to CHWs can be realised in both vertical and integrated systems, as CHWs can be associated with either specific HIV clinics or the general health system. In fact, community-based delivery does not need to be unique to HIV, and CHWs may also be able to provide pregnancy and maternal care (Geldsetzer et al., 2019; Larson et al., 2019; Lema et al., 2014), screening for hypertension, and distribute chronic medication to those in need, or provide counselling on where to access other required health services. Nevertheless, specialised HIV doctors and nurses will still be essential when dealing with more complex cases, such as people with poor viral suppression, resistance, or complex comorbidities.

Model 5 – "people task-shifted ART"

People task-shifted ART delivery involves the local community or even the patients themselves. For instance, HIV-positive peers within the community can bolster linkage, retention and adherence to ART through adherence clubs, community ART distribution points, or non-traditional community-oriented care for patients who are stable on treatment (Genberg et al., 2016; Holmes & Sanne, 2015). Peer educator-led ART refill groups in South Africa, community ART distribution points in the Democratic Republic of Congo and patient-led community ART groups in Mozambique are other examples of successful "people task-shifted ART" (Bemelmans et al., 2014). These initiatives enable patients to visit clinics less, saving time and travel costs, while peer-groups motivate each other to adhere to their medication. As international donor funding for HIV continues to decline and the number of HIV infected people on ART continues to grow, shifting care to the community or the individual is a logical consideration to improve efficiency and sustainability of the HIV response, while also freeing-up resources for other diseases. However, this model, like other task-shifting initiatives, comes with several disadvantages. Generally, shifting services away from the clinics will challenge quality-control. In addition, bringing care closer to home might affect privacy of patients and therewith discourage patients from seeking care due to HIV-related stigma.

Model 6 – "technology-supported ART"

Technology-supported ART can include a wide range of technologies, all aimed at reducing work, shifting work away from health workers or supporting patients or CHWs in their routines. Previously explored examples are drone delivery of HIV test kits and other medicines in Malawi (Reuters, 2016), and mobile fully-equipped ART clinics in Eswatini (MacKellar et al., 2018). Another example is the strategic placement of electronic pick-up machines, where patients can register with a patient-card to receive a tailored treatment package. Also, smartphone apps are increasingly developed to stimulate adherence and simplify monitoring, for example by providing laboratory test results, treatment schemes and information on side effects. However, active usage of these apps seems challenging, according to a randomised controlled trial among HIV patients registered at an urban clinic in South Africa (Venter et al., 2018). Tablet-based apps for patient registry and monitoring are an example for new technology-support initiatives for CHWs. Although new technologies generally seem promising, in many cases sufficient training is needed to use the technologies adequately. Moreover, the tools are generally costly, risking theft and damage.

Eliminating steps in the ART value chain

Eliminating steps in the ART value chain comprises of either providing immediate ART after diagnosis (model 7 – "immediate ART") or less frequent ART pick-ups for stable patients (model 8 – "less frequent ART pick-up"). Both models could be desirable for the patient, while also saving costs for the health system due to less frequent visits. The main challenge of this innovation lies in sustaining good quality of HIV care over time with less frequent patient-provider interaction.

Model 7 – "immediate ART"

It is important that people who test positive for HIV must contact care services in a timely manner. However, care-seeking behaviour is highly heterogeneous, leading to delay until receiving the first treatment (MacCarthy et al., 2015). For instance, if people test positive outside of

the central HIV services, for example, through community-based HIV testing, they are often referred to clinics that are busy, not well equipped, and far away. To overcome treatment delays, CHWs could be equipped with ART supply packages to offer to patients directly. Evidence from four trials conducted in African settings suggests that treatment outcomes are similar, compared to outcomes of linkage to care programmes (Kredo, Adeniyi, Bateganya, & Pienaar, 2014). A potential downside of this strategy is lack of adherence (Kredo et al., 2014), possibly due to insufficient counselling. Also, CHWs would need to have additional training to provide patients with all the information they need, for example on treatment schemes and important side effects. When people are tested in the health clinic, a follow-up appointment often needs to be scheduled to distribute ART. Here, same-day ART delivery could be a solution. A study conducted in an urban setting in Haiti showed that same-day ART delivery leads to an increase in adherence as well as better treatment outcomes (Koenig et al., 2017).

Model 8 –"less frequent ART pick-up"

Currently, many medical protocols require HIV patients to visit a clinic every one to three months. This is very time consuming and costly both for the patient and the health system. Alternative monitoring and ART pick-up schemes have been proposed, for example in Uganda, where patients are only required to visit their clinic once every six months (Nakiwogga-Muwanga et al., 2014). Although this model might save costs, the danger lies in the infrequent monitoring of patients. Therefore, this model is only suitable for patients who are stable on treatment.

Changing ART locations

This delivery model innovation is based on the use of new places for ART delivery, such as private health facilities (model 9 – "private-sector ART"), traditional healers (model 10 – "traditional-sector ART") or places outside of the healthcare system (model 11 – "ART outside the health sector"), including supermarkets, train stations and faith-based organisations. By offering ART at places that are easier to reach, these innovations can increase recruitment, adherence and retention to ART. Suitability of these models highly depends on the context. Primary challenges that should be taken into account when considering these models are ensuring quality of care and privacy of the patients.

Model 9 – "private-sector ART"

In the context of a well-developed private healthcare sector, the integration of ART delivery into the private sector can be considered. This could be the integration of ART delivery into the general health services provided by big privately-owned hospitals, but also ART distribution via private physicians or pharmacies. Although ART delivery might be improved for patients from higher socioeconomic classes, this distribution method would generally be relatively expensive. Unless treatment costs could be covered using alternative financing strategies, this model likely leads to increased inequality in access to ART, and therefore should not be implemented as a stand-alone solution.

Model 10 – "traditional-sector ART"

In some high burden countries, traditional medicine plays a central role in society. People infected with HIV might visit their traditional healer first, before seeking professional care. Traditional healers could be used to deliver ART, screen for HIV or do adherence counselling, therewith using their (often) trustworthy image and big network within the community. However, this model needs to be considered with caution. Community healers could have profit motives, and generally it would be challenging to guarantee the quality of the services being offered. In addition, traditional healers follow different believes compared to allopathic medicine: not all of them would be open to supporting allopathic medicine practices, and they provide care that may not be conductive to the clinical success of ART.

Model 11 – "ART outside the health sector"

Alternatively, ART could be delivered at places outside of the health sectors, at public or frequently visited places. Suitable places would be supermarkets, train stations and faith-based organisations, as well as other places that are easy to access for a vast majority of the population. However, this type of distribution strategy needs to be very well thought out in order to secure the privacy of patients and ensure good quality of care.

Keeping the status quo

Another option is to maintain the status quo, keeping ART delivery models as they currently are (model 12 – "vertical ART"). In this case, HIV services will continue to be provided apart from the general health systems. There are many good arguments for this choice. Generally, vertical delivery implies high operational efficiency, due to high levels of expertise and standardised work flows. Also, the current delivery models have proven to be successful, and the risk of adapting or changing this model must be considered carefully. Furthermore, the current models have already evolved and are often well-adapted to local contexts. However, solely maintaining this model may not be feasible in resource limited contexts.

Model 12 – "vertical ART"

In vertical systems, experienced doctors, nurses and other health workers work exclusively with HIV infected people, and therefore likely offer higher quality of care due to specialisation while doing their work more efficiently (i.e. economies of scale) in high-burden areas (Bärnighausen, Bloom, & Humair, 2011; Sweeney et al., 2012). In these contexts, this approach allows for possible cost reduction, as well as enhanced quality of ART delivery. In contrast, a disease-specific service provision model in low-burden areas will likely suffer from diseconomies of scale and scope due to excess capacity. Therefore – although operational efficiency might be high due to specialised personnel,

Table 1: Overview of the definitions and examples of models for ART delivery based on five delivery model innovations

Innovation	Delivery model	Definition	Examples
Integrate with other health services	Vertical-plus ART	Other services are provided within vertical ART services	• Anti-hypertensive care, diabetes prevention and other NCD services provided with ART services in Kenya, Uganda and Nigeria (Duffy et al., 2017) • Depression care offered with ART in the Unites States (Bengtson et al., 2016)
	Partially-integrated ART	Integration with other vertical health services	• Integration with tuberculosis services in sub-Saharan Africa, South America and Asia (Howard & El-Sadr, 2010; Suthar et al., 2012) • Integration with sexual and reproductive health (Warren et al., 2017) • Integration with NCD services in sub-Saharan Africa (Duffy et al., 2017; Kemp et al., 2018)
	Fully-integrated ART	Integration of ART services into the general primary healthcare system	• Integration of HIV care with primary healthcare services in rural Kenya (Odeny et al., 2013), and Malawi (Chan et al., 2010)
Modify steps in the value chain	Professional task-shifted ART	Shifting the delivery of ART from highly to less trained health professionals	• Community health workers delivering ART in Tanzania (Geldsetzer et al., 2018) • Community health workers delivering prevention of mother-to-child transmission services in Tanzania (Naburi et al., 2017) • Expanding testing and linkage to care through community health workers in Uganda (Asiimwe et al., 2017), Rwanda and Malawi (Zachariah et al., 2009)
	People task-shifted ART	Shifting the delivery of ART from healthcare professionals to lay people	• Improving adherence trough peer-support among pregnant women in South Africa (Richter et al., 2014). • Peer educator-led ART refill groups in South Africa, community ART distribution points in DRC and patient-led community ART groups in Mozambique are other examples of successful task-shifting models (Bemelmans et al., 2014)
	Technology-supported ART	ART delivery using technological innovations	• Drone delivery of HIV test kits in rural Malawi (Reuters, 2016) • Mobile fully-equipped ART clinics in Eswatini (MacKellar et al., 2018).
Eliminate steps in the value chain	Immediate ART	ART services provided immediately following a positive HIV test	• CHWs providing ART packages after HIV testing and counseling, in several African settings (Kredo et al., 2014) • Same-day delivery in urban clinics of Haiti (Koenig et al., 2017)
	Less frequent ART	Decreased frequency of ART provision	• Shift from 1-2 to 6 month clinic visits in Uganda (Nakiwogga-Muwanga et al., 2014)
Use new places	Private-sector ART	ART delivery in private healthcare facilities	• ART delivery at private hospitals, physician practices or pharmacies
	Traditional-sector ART	ART delivery supported by traditional healers	• ART delivery by traditional healers
	ART in places outside the health sectors	ART delivery outside of the healthcare system	• ART delivery at supermarkets, train stations or faith-based organisations
Status quo	Vertical ART	ART delivery remains separate from other health services, in current places, and using current technologies	

ART = antiretroviral treatment; CHWs = community health workers; NCDs = non-communicable diseases

referral chains, and logistics – the technical and allocative efficiency of disease-specific service delivery is highly dependent on the local disease burden. In addition, disease specific models may introduce inequalities in access to care, both in low and high-burden settings, as services for other diseases may remain inadequate (Bekker et al., 2018; Kim, Farmer, & Porter, 2013). HIV patients receiving care at the ART clinic might need to seek care for other conditions, such as hypertension or diabetes, elsewhere.

Discussion

We proposed five categories of “delivery model innovations” for ART, translated into twelve concrete ART delivery models. None of these proposed models will be a “silver bullet” for the world. Rather, suitability of the models will highly depend on the epidemic, health systems, political and cultural contexts (De Neve et al., 2017). For instance, countries with generalised epidemics may continue to benefit from a degree of “verticality” in the delivery of ART, because in many communities in these countries there are sufficiently large numbers of HIV patients to keep vertical

delivery structures fully and constantly occupied. In countries with more concentrated epidemics, among key populations such as sex workers and MSM for example, specific vertical services might be essential to be able to offer specialised care, tackle stigma, and promote easier access to health care for these vulnerable groups. In contrast, HIV care for the general population may be more efficiently provided as part of general internal medicine and family health services.

Moreover, even within regions or countries with similar epidemics and health systems contexts, multiple innovations might be needed to achieve near-universal ART coverage and optimised ART retention and adherence (Bärnighausen, Chaiyachati, et al., 2011). Communities living in remote areas would, for example, benefit from implementation of task-shifted and technology supported ART delivery, as this would increase test-and-treat coverage as well as decrease travel time and costs for people already receiving treatment. For patient groups that are mobile, such as truck drivers and seasonal migrants, less frequent ART delivery could be a solution to increase adherence. Other important facets that need to be taken into account while designing the best ART delivery strategies are: the available funding, previous successes in the HIV response (of which trends in HIV incidence and current ART coverage are important markers), burden of other diseases, HIV/AIDS-related stigma and political commitment.

Generally, while it is plausible that delivery model innovations can lead to major improvements in the effectiveness and efficiency of the HIV treatment cascade, we should keep in mind that it is also possible that such innovations fail and the envisioned improvements do not materialise. The status quo should not be hastily abandoned for innovations; careful vetting of novel models through implementation science and causal impact evaluations should come before any large-scale replacement of the current ART delivery programmes.

Optimally tailoring ART delivery to the current financial, epidemiological, and political context will likely not only require innovations in service delivery, but also in the methods used to determine resource allocation. Here science can play an important role. First, delivery models need to be identified and designed with beneficiaries, healthcare providers, and community stakeholders. Based on outcomes of ART delivery model comparisons and evaluations from various contexts, a framework can be designed to support evidence-based decision making. Complementary models for people-centred services can be developed for each context of the framework. Second, the proposed delivery models need to be tested in prototype and pilot studies – here science can support, by designing studies that allow for causal impact evaluations.

Also, mathematical modelling can be of value for optimising resource allocation for ART. However, these models are also largely disease specific, and generally ignore the general epidemiological and health system context of a specific area. Resource allocation within the UHC era will increasingly require multi-disease mathematical models that can also capture health system dynamics and constraints (Mikkelsen et al., 2017; Osetinsky et al., 2019). The proposed delivery model innovations can be utilised similarly to reshape other traditionally vertically delivered health services, e.g. tuberculosis or family planning services.

Conclusions and future perspectives

ART delivery model innovations need to be carefully vetted and evaluated for their potential to increase ART coverage and efficiency. The suitability of the proposed models will depend on local and national contexts. Thus, local design studies are required to determine the most promising delivery model innovations and their precise forms. Prototyping and pilot studies are needed to put these models to the test before large-scale implementation. The promise of ART delivery model innovations is large and implementation science, causal evaluation and mathematical modelling studies can ensure that it is fulfilled.

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