Using the HIV prevention cascade to integrate epidemiological, behavioural and social science theory into programme design and monitoring

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Abstract

Understanding of HIV prevention has matured over time influenced by theories from epidemiology, health behaviour and social science. The HIV prevention cascade is emerging as a new approach to guide the design and monitoring of HIV prevention programmes in a way that integrates these multiple perspectives. This approach recognises that translating the efficacy of the *direct mechanisms* mediating HIV prevention (including prevention products, procedures and risk-reduction behaviours) into population-level impact among *target populations* requires interventions that increase their coverage. An HIV prevention cascade approach suggests that high coverage can be achieved with: *demand-side interventions* that improve risk perception, and awareness and acceptability of the direct mechanisms of prevention; *supply-side interventions* that make prevention products and procedures more accessible and available; and, *adherence interventions* that support ongoing adoption of prevention behaviours, including those that do and do not involve prevention products. Programmes will need to: develop delivery platforms to ensure these interventions reach target populations; shape the policy environment to facilitate implementation at scale and with high quality and intensity; and, monitor the programme with indicators along the cascade.

Contributions

JH, TH, SJ, GD and GG contributed to discussions about the prevention cascade convened by GG that gave rise to this paper. JH, SD-M, PB and SK contributed to discussions around structural drivers of HIV prevention through their work together on the STRIVE Consortium. JH wrote the first draft of the paper. All authors contributed edits and agreed to the final draft of the paper.

Declaration

We declare no competing interests

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Introduction

HIV prevention remains a global priority. Thinking about HIV prevention has evolved over time within three major paradigms: epidemiology, health behaviour, and multi-level frameworks influenced by social science. Now a new approach is emerging: the HIV prevention cascade, which is similar but different in form to the HIV treatment cascade [1]. We show how this approach can integrate understanding of the multiple determinants of HIV incidence within programme design so as to translate the efficacy of HIV prevention tools and behaviours into population-level impact.

Understanding of HIV prevention has matured over time

Early work on clusters of AIDS cases focused on characterising the pathogen, developing models for diagnostic testing, identifying where cases were arising, investigating mechanisms of transmission and studying risk factors [2]. The late 1980s, with HIV transmission established throughout the world, saw epidemiological theory formalise the determinants of HIV incidence and targets for prevention [3]. The "direct mechanisms" of HIV prevention are to reduce the likelihood of transmission if an effective contact occurs and/or the rate of effective contacts. Epidemiological models also show that for most sexually transmitted infections R_0 is only greater than one in a subset of the population, motivating the need for targeted prevention [4]. Reducing transmission probabilities underlies the efficacy of prevention tools such as condoms [5], male circumcision [6], pre-exposure prophylaxis (PreP) [7-9] and treatment as prevention [10,11]. Reducing effective contact rates motivates the need for reducing sexual partner numbers or changing drug-use practices. Key populations that can incorporate those with a high risk of HIV include female sex workers (FSW), men who have sex with men (MSM), transgender people and people who inject drugs (PWID). Mathematical models can project the potential impact of increased coverage of prevention technologies and changes in risk behaviour [12], but do not explicitly incorporate the determinants of coverage or the behavioural or structural interventions that would increase this.

Behavioural HIV prevention has often incorporated insights from social cognitive theories [13]. These emphasise the importance of attitudes toward safer behaviours (do potential adopters of the behaviour believe it will have benefits?), perceived social norms (is it socially

acceptable to adopt the behaviour?), self-efficacy (do potential adopters feel able to undertake the behaviour?) and skills (can the behaviour successfully be undertaken?) [14-18]. Behavioural theories accommodate the idea that contextual dynamics are important determinants of risk but have also been criticised for focusing on individual-level factors [19,20]. Indeed, while behaviour change has influenced the trajectory of HIV epidemics among, for example, MSM in the US, PWID in Australia and the general population in Zimbabwe [21-23], the most effective aspects of behavioural prevention have been difficult to identify. Behaviour change will need to remain a core component if the coverage of HIV prevention products, procedures and behaviours is to increase in the coming years.

In sub-Saharan Africa, behavioural change strategies appeared to have little documented influence on patterns of infection in some well-funded research studies [24,25]. Multi-level theories emerged to explain how social and structural forces fuel the transmission of HIV and act as barriers to its control. Such factors include gender inequalities [26,27]; poverty, economic inequality and underdevelopment [28,29]; globalisation and economic migration [30]; and, social stigmatisation of HIV/AIDS [31]. These frameworks recognise that effective (sexual or blood) contacts are necessary for HIV transmission, but emphasise that contact patterns are shaped by the social and economic environment [32-35]. In response came calls for structural interventions to bolster HIV prevention [19,36]. Policy-level interventions were used to improve the availability and accessibility of prevention products, such as mass condom distribution/social marketing [37] or needle/syringe exchange programmes [38,39]. Major successes in HIV prevention among female sex workers in Thailand and Cambodia, and in Uganda, highlighted the importance of such policy-environment factors [40,41]. Another set of emerging interventions target social determinants of behaviour with cash transfers [42], livelihood programmes [43] and empowerment programmes for female sex workers[39].

The HIV prevention cascade as an integrating framework

Reflecting the many determinants of HIV incidence, countries have been encouraged to operationalise a multi-sectoral response and deliver combination HIV prevention. Jones et al. advocate data-informed targeting of intervention packages to support behaviour change, and expansion of HIV prevention technologies [44]. Chang et al suggest “combination

implementation" of biomedical, behavioural and structural interventions [45]. Vermund and Hayes see combination prevention requiring personal, societal and programmatic elements, "anchored" on expansion of testing and treatment [46]. The HIV strategic investment framework (2011) emphasises the need for programmes, social and programme "enablers" and attempts to maximise development synergies [47].

Yet despite this holistic view, combination HIV prevention does not yet provide an optimal framework to translate our understanding of the determinants of HIV risk into programme design. One problem has been a tendency to separate technologies (for example, condoms or oral PrEP), behaviours (for example, abstinence or reduced partners) or social factors (for example, gender inequality) and view them in isolation [48]. In some cases, this can unfortunately cast biomedical products, behaviour change and structural interventions as opposing approaches, with advocates from different disciplines. Further, the volume, type and quality of evidence differs across these interventions. This can lead to over-optimism about efficacious biomedical interventions and under-appreciation of the fact that behavioural and structural interventions are essential to translate their efficacy into an impact on population HIV incidence. In addition, some countries have struggled to integrate behavioural and structural interventions and guidance on bringing these perspectives together remains lacking [26] .

The HIV prevention cascade approach can help. The HIV prevention 2020 framework sets new ambitious goals: to reduce new infections below 500,000 by 2020 by increasing coverage of the direct mechanisms of HIV prevention including condoms, ART and PrEP, VMMC and clean needles[49]. This will require sustainable, accountable programmes that work at speed, scale and quality. Achieving coverage targets will require programmes to increase "demand" for HIV prevention, improve "supply" of prevention tools and support "adherence" to safe practices. These are key elements of the HIV prevention cascade.

The first step is to identify and characterise the *target population(s)* for HIV prevention which will differ from setting to setting. Next is to identify the *direct mechanisms* of prevention, defined as the technologies or risk reduction behaviours through which the programme directly seeks to prevent new HIV infections. These include products, behaviours and procedures that reduce the risk of HIV acquisition (Figure). The programme should seek to translate the efficacy of these direct mechanisms into population impact by

increasing their coverage. Increased coverage of the direct mechanisms can be achieved by addressing one or more of the three elements of the prevention cascade. *Demand-side interventions* should foster appropriate risk perception, and improve awareness and acceptability of the direct mechanisms of prevention. This category includes many of the classic behavioural interventions including information and education campaigns delivered in schools, health-settings, communities and through the media, and attempts to shift perceived norms through peer and social network driven interventions [50,51]. *Supply-side interventions* will make prevention products and procedures more accessible and available. This category includes some interventions that have been classified as structural in the literature such as mass-condom distribution programme and needle-syringe exchange programmes. *Adherence interventions* will seek to close the gap between behavioural intention and action by support ongoing adoption and use of prevention behaviours, including those that do and do not involve prevention products. Interventions include those that target the social determinants of behaviour, those based on incentives, and risk-reduction counselling to support ongoing prevention behaviour self-efficacy and skills (Figure).

For each type of intervention along the cascade, effective programmes will need to develop delivery platforms that ensure that these reach target populations. Existing delivery platforms include, for example, the media or the school education system (for demand-side interventions), the health system (for supply-side interventions) and community-based organisations (for adherence interventions). In other cases, it may be necessary to develop such platforms, as was the approach in the Avahan NGO-contracting based approach used to reach marginalised groups in India[52]. The programme must also influence policies that can support the delivery of the interventions with high intensity and quality and create an enabling environment in which these have the greatest chance of success. This might include shaping policies that monitor the quality of life-skills and HIV prevention education in schools (on the demand-side), establishing public-private partnerships that address issues to do with the price of prevention products (on the supply-side), or influencing police practices that undermine the agency of socially-stigmatised groups to enact HIV prevention behaviours (to support adherence).

Programmes should conduct a cascade analysis as outlined by Garnett et al to prioritise the need for action, and then implement evidence-informed interventions as required[53]. Krishnaratne et al appraise the evidence on biomedical, behavioural and structural HIV prevention interventions, mapping these interventions to the cascade framework [51]. Finally the programme must be monitored. Again, Garnett et al show how a prevention cascade analysis can be populated with data and adapted for this purpose [53].

Some simple examples illustrate the approach. An HIV prevention strategy might seek to improve awareness and acceptability of the direct mechanisms of HIV prevention among young people. Potential interventions include HIV prevention curricula based on sound behavioural theory, although evidence is still required on the best approaches. An appropriate delivery platform might be the school system. To support interventions being delivered with high quality, programmes might advocate for policies that mandate mechanisms to assess, monitor and improve quality of delivery, perhaps including through provider incentive schemes [54]. Alternatively a programme may seek to increase coverage of male circumcision, identifying that the greatest gains can be achieved by improving the supply of VMMC services. Delivery platforms include mobile or fixed-site health services. Policy-level interventions might include those that promote task-sharing allowing services to be mainstreamed within the public health system. Finally a programme may seek to maximise the impact of oral PrEP among female sex workers by supporting adherence. A range of interventions might be considered from ongoing risk-counselling provided by health workers or peer counsellors, financial or non-financial incentives, or community mobilisation programmes. Delivery platforms might include health, social welfare or non-governmental organisations. At the policy level, changing laws around female sex work, or locally adapting police-practice, might further facilitate adherence to PrEP.

These are simple illustrative examples only. In practice, countries wishing to adopt the HIV prevention cascade approach would need to conduct analyses and develop interventions relevant to their specific context.

Discussion

Understanding of the determinants of HIV incidence has matured over time influenced by epidemiology and the behavioural and social sciences. Prevention 2020 sets ambitious prevention goals anchored on increased coverage of the direct mechanisms of HIV prevention. An HIV prevention cascade framework can help integrate understanding from a range of disciplines to support better programme design to achieve these goals. The framework can help identify whether, for a given target population, the greatest gains in impact can be achieved through interventions on the demand-side, supply-side or by supporting adherence, or the most appropriate combination of these. Implicit in the cascade approach is a deliberate grouping together of well characterised direct mechanisms of HIV prevention as diverse as a tenofovir pill, a condom, a circumcision procedure, and not having sex at all. Each of these, though different in nature, share the characteristic of being the modifiable proximate determinants of HIV transmission risk through which a prevention programme exerts its effect. But they do not themselves constitute the programme: rather, this must comprise the interventions that will maximise population coverage of these direct mechanisms among those for whom transmission would otherwise occur, through a focus on demand, supply or adherence.

There are limitations to this way of thinking and further work is needed if it is to be used to strengthen programmes. We must avoid confusion since our use of the term cascade is different to the HIV treatment cascade. The treatment cascade describes individual-level steps necessary to achieve viral suppression, while in contrast our approach identifies population-level constraints to translating the efficacy of the direct mechanisms of HIV prevention into population-level impact. Another potential limitation is if the approach is seen to over-simplify HIV prevention. Our approach outlines logical steps in prevention and hopefully does simplify some aspects of programme design by providing a framework to guide this. We perceive that sometimes programmes need guidance on how to integrate biomedical, behavioural and structural intervention approaches: our framework aims to fill this gap. Nevertheless we recognise that there are many layers of complexity in this. A related problem is that our approach might be seen to undermine approaches based on broader development synergies. Our framework encourages HIV prevention programmers to be clear on how interventions that, for example, address social determinants of HIV, will influence HIV prevention specifically. However this is not to undermine the need for the

cross-sectoral benefits of interventions such as, for example, school cash-transfers to be considered in broader policy frameworks guiding resource allocation such as the co-financing agenda [55]. Finally, our framework does not explicitly deal with costing of HIV interventions, though other papers in this series bring in this dimension [12].

Primary HIV prevention programmes must be complemented by treatment for prevention, guided by the well-established treatment cascade. High population testing rates have important benefits for HIV prevention [56]. HIV testing provides an opportunity for risk-reduction counselling and to offer direct mechanisms of HIV prevention for those who test negative, enhanced by the potential for reflection on behaviour in light of an HIV-test result [57]. HIV-status awareness is a necessary component for risk reduction behaviours that rely on avoiding unprotected, sero-discordant contact behaviours, ie sero-sorting [57,58]. Finally, HIV testing acts as a gateway for those who test positive to care, treatment, and ultimately control of viral replication and thus reduced infectiousness [10]. The ongoing push towards universal testing and treatment in many populations will have critical benefits for HIV prevention. Together, treatment and prevention efforts guided by widespread adoption of a cascade approach have the potential rapidly accelerate HIV incidence decline using currently available tools.

Figure: Targets for prevention programmes along the HIV prevention cascade with examples of interventions, platforms for delivery and policies

Demand-side	Supply-side	Adherence	Direct mechanisms of HIV prevention
Targets for prevention programmes Risk perception Awareness and positive attitudes towards direct mechanisms of HIV prevention Social norms. **Interventions** For example: Information and Education Campaigns Peer-based prevention programmes **Platforms for delivery at scale** For example: Schools, Media, Community **Policies** For example: quality assurance programmes, policies that support age-appropriate sex education	**Targets for prevention programmes** Availability and accessibility of direct mechanisms of HIV prevention (especially products and procedures) **Interventions** For example: Mass condom distribution Needle-syringe exchange programmes Integrated health service delivery of HIV prevention **Platforms for deliver** For example: Health sector, private sector **Policies** For example: Overcoming legal barriers to supplying prevention products, mainstreaming, task sharing	**Targets for prevention programmes** Behavioural self-efficacy and agency **Interventions** For example: Longitudinal behavioural counselling. Interventions targeting social determinants of behaviour such as cash transfers, livelihood programmes, empowerment programmes. Incentives **Platforms** For example: Health sector, development sector partners **Policies** For example: Co-financing, monitoring of police treatment of key populations	**Prevention behaviours** For example: abstinence, sero-sorting **Prevention products** For example: PrEP, male and female condoms **Prevention procedures** For example: Voluntary medical male circumcision
Approaches to increasing coverage and translation of efficacy to population impact			**Direct mechanisms with prevention efficacy**

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