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A typology of structural approaches to HIV prevention

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Abstract

Renewed enthusiasm for biomedical HIV prevention strategies has followed the recent publication of several high-profile HIV antiretroviral therapy-based HIV prevention trials. In a recent article, Roberts & Matthews (2012) accurately note some of the shortcomings of these individually targeted approaches to HIV prevention and advocate for increased emphasis on structural interventions that have more fundamental effects on the population distribution of HIV. However, they make some implicit assumptions about the extent to which structural interventions are user-independent and more sustainable than biomedical or behavioral interventions. In this article, I elaborate a simple typology of structural interventions along these two axes and suggest that they may be neither user-independent nor sustainable and therefore subject to the same sustainability concerns, costs, and potential unintended consequences as biomedical and behavioral interventions.

Keywords

AIDS/HIV; behavioural interventions; biomedicine; developing countries; international health; social determinants

Despite recent progress, a vaccine against HIV infection remains a distant goal (Johnston & Fauci, 2008). As a result, the 33.3 million people living with HIV/AIDS worldwide (Joint United Nations Programme on HIV/AIDS, 2010b) are likely to see their ranks continue to increase for the foreseeable future. Compared to earlier stages of the epidemic, we now have a better understanding of the biological, behavioral, and social determinants of HIV infection, but much more work remains to be done to translate these findings into interventions to reduce the population incidence. No single “magic bullet” for prevention exists, although several candidates have been weighed on the scales and found wanting (Eaton & Kalichman, 2009; Hayes et al., 2010; Hearst & Chen, 2004; Hearst et al., 2012; Rerks-Ngarm et al., 2009). In such a milieu, thought provoking papers such as the one by Roberts & Matthews (2012), “HIV and chemoprophylaxis, the importance of considering social structures alongside biomedical and behavioral intervention,” deserve our careful attention.

Roberts & Matthews' article makes several important points. Biomedicine's approach to HIV prevention is relatively expensive because it emphasizes individually targeted biomedical or behavioral interventions and because the outcomes of these interventions are, by nature, user-dependent. Furthermore, these types of interventions do little to nothing to address the *prima causa* in the web of causation (Krieger, 1994). As a result, sustained prevention of HIV transmission through these strategies will require a lifetime of sustained HIV-

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preventive behaviors, and this may not be sustainable in the long run. Roberts & Matthews discuss the results of several recently published high-profile HIV antiretroviral therapy-based HIV prevention trials (e.g., Abdool Karim et al. [2010], Cohen et al. [2011], and Grant et al. [2010]), emphasizing the shortcomings of these individually targeted approaches to HIV prevention. They advocate for renewed efforts to train our collective gaze away from such palliative approaches to HIV prevention and towards structural interventions that have more fundamental effects on the population distribution of HIV.

Although I agree with many of their views about the limitations of biomedicine and the need for more research on structural interventions, I am puzzled by some of their initial arguments. At first glance, Roberts & Matthews seem to have strangely set themselves up to defend against claims that few in the field are making. For example, they motivate their discussion in part by arguing that biomedical and behavioral interventions are limited by suboptimal adherence and that there exists a structural bias against structural interventions. But to whom are they so strenuously arguing these points? Few, if any, in the field contend that biomedical and behavioral approaches are *not* limited by suboptimal adherence. The user-dependence of biomedical and behavioral interventions is well known and has always been a focal discussion point, especially with regards to findings from the most recently published set of biomedical prevention trials (Grobler & Abdool Karim, 2012; Kashuba et al., 2012; van der Straten et al., 2012). Behavioral scientists have also long held that “non-adherence” and “non-compliance” are regrettably imprecise terms when employed to describe deviations from prescribed dosing regimens that result from inability to overcome structural barriers (Bangsberg, 2008; Bangsberg et al., 2006; Crane et al., 2006).

In addition, few, if any, in the field contend that structural interventions are *not* deserving of further study and implementation. *Contra* Roberts & Matthews, the emerging consensus appears to be that effective HIV prevention will require a diverse portfolio of biomedical, behavioral, and structural interventions -- termed “highly active” (Vandenbruaene, 2007) or “combination” prevention (Coates et al., 2008). These sentiments have been echoed by journal editors (Horton & Das, 2008), biomedical HIV prevention experts (Abdool Karim et al., 2010; Padian et al., 2011), and individual HIV prevention experts working within the U.S. government (Shelton, 2011) and multilateral organizations (Hankins & de Zalduondo, 2010; Piot et al., 2008). The centrality of the combination approach has also been formally described in documents released directly by the Joint United Nations Programme on HIV/AIDS (Joint United Nations Programme on HIV/AIDS, 2010a, 2011). The big tent of combination prevention has been criticized for being too diffusely vague about the exact distribution of portfolio weights (Halperin, 2009; Potts et al., 2008), but there is plenty of room under the tent for now.

I would like focus specifically on Roberts & Matthews' implicit assumptions that structural interventions are user-independent and more sustainable than biomedical or behavioral interventions. (Indeed, at one point they argue that HIV prevention strategies based on structural interventions may mitigate risk compensation, a concern that has appropriately bedeviled many behavioral and biomedical interventions [Cassell et al., 2006; Lakdawalla et al., 2006].) It is hard for me to know exactly what they specifically mean when they laud structural solutions for being “sustainable” (p.2): are structural interventions sustainable because overcoming structural barriers will result in more durable changes in human behavior? Are they more sustainable because overcoming a particular structural barrier is a one-time event (that will inexpensively result in more durable changes in human behavior)? In the discussion below, I draw on insights from industrial hygiene, injury control, behavioral finance, economic development, and health services research to suggest that structural interventions may be neither user-independent nor sustainable and therefore subject to the same sustainability concerns, costs, and potential unintended consequences as

biomedical and behavioral interventions. The balance of cost and benefit may still favor structural interventions in certain contexts, but this will depend on the extent to which these factors differentially affect consideration of biomedical and behavioral vs. structural interventions.

The inevitability of user dependence

Roberts & Matthews highlight the waning dose-taking execution (i.e., lack of persistence [Tsai & Bangsberg, 2011]) observed during the course of follow-up in biomedical HIV prevention trials in order to caution readers "to be wary of how any meaningful population-level effect could be sustained" (p.3). Their critique of biomedical and behavioral interventions is accurate, but it is also important to explicitly recognize the extent to which the outcomes of structural interventions are also contingent upon human behavior. The earliest typologies of structural interventions have distinguished between structural interventions that are user-independent and those that are user-dependent. In the fields of industrial hygiene and injury control, user-independent interventions (such as the elimination of hazardous processes, substitution with less hazardous processes, and engineering controls that improve safety irrespective of worker interactions) are generally viewed as more effective and more desirable than user-dependent interventions (such as policies, procedures, training, and protective equipment) (Brandt, 1947; Office of Technology Assessment, 1985). William Haddon, Jr., the first director of the National Highway Traffic Safety Administration, initiated the term "active" to describe injury control measures that require some degree of volitional activity from individuals and recommended that higher priority be placed on the more effective "passive" strategies (Haddon, 1972; 1974; Haddon & Goddard, 1962). More recently, McLaren and colleagues (2010) invoked Rose (1985) while adopting the terms "agentic" and "structural" to draw the same distinctions. The latter category would include large-scale environmental control measures like the fluoridation of drinking water (McLaren et al., 2010), which achieves 100 percent dose-taking execution among all persons who drink water and which can be sustained for as long as the public taps do not run dry. Blankenship and colleagues (2000) recognized that many, but not all, structural interventions are aimed at individual behavior change -- and that there are few, if any, examples of the latter type of "structural" structural interventions in the field of HIV prevention.

In distinguishing structural interventions from biomedical and behavioral interventions that "rely on the individual to be successful" (p.3), Roberts & Matthews offer as an example the Intervention with Microfinance for AIDS and Gender Equity (IMAGE) (Pronyk et al., 2006). In the IMAGE study, Pronyk and colleagues (2006) pair-matched and randomized 8 villages in rural South Africa to receive access to microfinance services integrated with gender and HIV education. As a structural intervention, making microloans widely available to women may enhance their status within the household and subvert gender-inequitable norms, which could in turn improve the quality of their lives by reducing intimate partner violence (Pronyk et al., 2006), improving reproductive health (Hung et al., 2012), decreasing the risk of HIV acquisition (Shannon et al., 2012; Tsai, Hung, & Weiser, 2012; Tsai & Subramanian, 2012) and improving their children's health (Duflo, 2000; 2003; Thomas, 1990). However, it must be acknowledged that the population health effect is contingent upon a cascade of events, including loan uptake, fruitful entrepreneurial activity, negotiation of household obligations and entitlements, loan appropriation by male partners, and successful loan repayment (the distributions of which cannot necessarily be assumed to shift in the expected direction [Banerjee & Duflo, 2008; Chant, 2008; de Mel et al., 2008; Duflo, 2011; Goetz & Gupta, 1996; Kabeer, 2001; Macmillan & Gartner, 1999; Schuler et al., 1998]). Given that the outcomes of "agentic" structural interventions are contingent upon

human behavior, I believe this class of interventions is characterized by the same gap between efficacy and effectiveness as biomedical and behavioral interventions.

Energizer Bunny(R) or Tomy Rascal Robot(TM)?

In addition to user dependence, a second axis that can be employed to further categorize structural interventions is the intensity of activity involved in their implementation (see Figure 1). Comprehensive classification of structural interventions is a more complex undertaking (Blankenship et al., 2000; Glass & McAtee, 2006; Gupta et al., 2008; Sweat & Denison, 1995), but the simplified typology shown here will serve to focus our discussion. With regards to the examples described above, implementation can occur at a single point in time (e.g., adoption of gender quotas for elected political positions [Beaman et al., 2012]) or may require sustained, ongoing activity (e.g., public water fluoridation). Both public water fluoridation and microfinance programs may involve sustained, ongoing implementation activity, but they are mapped to separate quadrants because, of the two types, only microfinance programs require volitional activity from participants for maximal effectiveness.

Most biomedical and behavioral interventions entail both ongoing implementation and active participation and would therefore be mapped to the first quadrant. In comparison, Roberts & Matthews find structural interventions more attractive because these will facilitate health-promoting behaviors “among those individuals who want to engage in healthy behaviors but who live in a context where their choices are constrained (e.g., I want to exercise but there's nowhere to run), and also among individuals whose behaviors are largely dictated by convenience” (p.4). It is unclear whether they are referring specifically to one-time structural interventions such as community-scale urban design and land use policy changes aimed at increasing physical activity (Kahn et al., 2002), but these would be depicted in the fourth quadrant of Figure 1.

In general, achieving the ideal of sustainable HIV prevention seems to be based on the assumption that structural interventions and their attendant salubrious outcomes can be established for perpetuity with a single cash infusion or a single sweep of the legislative pen. Yet, as noted in Figure 1, many structural interventions require ongoing costs of maintenance in much the same manner as biomedical or behavioral interventions. These costs often may be sponsored by external donors, but these costs may also be sponsored locally. Sponsors of structural interventions might hope that local institutions would organically emerge during the intervention period, thereby creating the possibility for sustained behavior change over the long term without external subsidies (Scheirer, 2005), but there is a paucity of strong evidence to support this aspiration (Bennett et al., 2011; Campbell & Cornish, 2011; Jana et al., 2004). Some interventions may simply require “extensive and indefinite” external subsidies (Kremer & Miguel, 2007, p.1060). At present, perhaps the strongest evidence regarding the sustainability of HIV prevention is the need for sustained political will to fund it.

For one-time structural interventions such as policy changes, the assumption that these have a considerable cost advantage compared to individually targeted biomedical and behavioral interventions (Katz, 2009) is not necessarily correct (Tsai, 2009). Gordon Tullock, more than 40 years ago, formally noted how large amounts of resources are squandered (from a societal perspective) in the struggle to manipulate the political or social environment (Tullock, 1967), a phenomenon now known as rent-seeking. Although his theory was initially applied to the struggle over monopoly privileges, the application to the present context is straightforward. One-time structural HIV prevention interventions such as enactment of minimum drinking age legislation (Blankenship, Bray, & Merson, 2000), for

example, may be associated with few direct costs other than those of the political machinery, but diverse political actors may mobilize considerable resources to either enact or block such interventions. Tullock (1967) writes, “These expenditures, which may simply offset each other to some extent, are purely wasteful from the standpoint of society as a whole; they are spent not in increasing wealth, but in attempts to transfer or resist transfer of wealth” (p. 228). Our historical experience with protracted, socially costly political conflict over the distributional effects of structural interventions to reduce tobacco use and overconsumption of mildly nutritious foods suggests that these indirect costs may be substantial (Chopra & Darnton-Hill, 2004; Moore et al., 1994).

Moreover, the persistence of behaviors encouraged through the use of one-time structural interventions has not been adequately characterized. One example of failed persistence can be drawn from behavioral economics. Choi et al. (2004) studied employee savings behavior at three large unnamed firms in the U.S. When these companies implemented “nudge” policies of automatic enrollment in company-matched 401(k) retirement savings accounts, participation rates spiked. However, the fraction of participants at the automatic enrollment default declined steadily, such that only 54–76 percent of participants remained at 24-month follow-up relative to baseline. In this respect, one-time structural interventions, rather than lasting forever on a single battery like the Energizer Bunny(R), may prove to be more like a Tomy Rascal Robot(TM) that eventually winds down. New evidence from India and Sri Lanka suggests that one-time structural interventions such as adopting gender quotas for elected political positions and single infusions of capital for subsistence microenterprises may have had durable, long-term effects on girls' educational attainment (Beaman et al., 2012) and microenterprise profits and survival (de Mel et al., 2008, 2012). In the microenterprise study, however, the beneficial effects were observed only for microenterprises operated by men, and the research team did not report any other outcomes relevant to HIV prevention. These findings, while tantalizing, warrant further study. Whether people can be durably nudged, prodded, or shoved into abstinence, protected sexual intercourse, partner reduction, or adherence to HIV antiretroviral therapy-based prevention regimens remains to be seen.

Unintended consequences of the well intentioned

In considering the outcomes that may result from structural interventions, I am reminded of the Henry Wadsworth Longfellow poem as described by his son, Ernest: “When she was good, / She was very good indeed. / But when she was bad she was horrid” (Longfellow, 1922) (p.15). The unintended consequences of structural interventions can be disastrous if the central planner does not carefully anticipate individual responses to the intervention. Roberts & Matthews recognize this possibility (e.g., “structural interventions will almost always succumb to strong individual agency to do otherwise” [p.4]), but my concern here is not simply that structural interventions will lack effectiveness; the concern is that unintended consequences could actually result in harm. For example, the Cleveland Health Quality Choice program was an initiative that publicly reported data on risk-adjusted mortality for all 30 non-federal hospitals in the greater metropolitan Cleveland area between 1991 and 1997 (Neuhauser & Harper, 2002). As a structural intervention, Cleveland Health Quality Choice was aimed at improving regional quality of care by encouraging individuals to go to higher-quality hospitals for care, and by encouraging purchasers to engage in selective contracting with higher-quality hospitals or to create financial incentives for their employees to go to higher-quality hospitals for care. However, these intended effects did not materialize (Baker et al., 2003b). Rather, it appeared that deaths simply shifted: while in-hospital mortality declined, 30-day mortality remained unchanged -- suggesting that the in-hospital mortality trends were driven primarily by declining length of stay and that post-discharge mortality actually increased (Baker et al., 2003a; Baker et al., 2002). For a

particularly vulnerable subgroup of patients, those for whom a do-not-resuscitate order was written within two days of admission and whose length of stay was markedly shorter than expected, risk-adjusted mortality actually increased (Baker et al., 2004). The researchers cautioned that this specific type of structural intervention might have resulted in an increase in the number of patients discharged in unstable condition from hospitals under financial pressure to reduce length of stay.

Furthermore, there is considerable evidence to suggest that structural interventions may iatrogenically exacerbate socioeconomic differentials in health. Victora et al. (2000), restating Julian Tudor-Hart's “inverse care law” (Hart, 1971) as the “inverse equity hypothesis,” hypothesized that large-scale public health programs -- even if targeted towards the most disadvantaged -- could paradoxically reinforce social inequalities in health through selective advantage to persons who are most able to respond (Link et al., 1998). Victora et al.'s (2000) hypothesis was recently revisited by Frohlich & Potvin (2008) and renamed the “inequality paradox.” Although some structural interventions may reduce social inequalities (Sehgal, 2009), many other studies have shown that the least disadvantaged groups tend to adapt more quickly when responding to population-approach interventions. The “inverse equity hypothesis” has been vindicated in studies of such “agentic” structural interventions as universal insurance coverage of breast and cervical cancer screening in Canada (Katz & Hofer, 1994), anti-smoking educational campaigns in the U.S. (Escobedo & Peddicord, 1996; Gilpin & Pierce, 2002), federal folic acid fortification policy in the U.S. (Dowd & Aiello, 2008), and early scale-up of access to HIV antiretroviral therapy in South Africa (Tsai et al., 2009).

Conclusion

In summary, I agree with Roberts & Matthews' critique of individually targeted HIV prevention trials, as well as with their call for more research to adequately characterize the complex relationship between structures and individual behavior. However, it is already widely acknowledged that efforts to prevent new HIV infections will require a combined portfolio of biomedical, behavioral, and structural approaches. How to optimally assign these portfolio weights should remain an empirical (Halperin, 2009; Potts et al., 2008), not an ideological, question -- and I wonder whether Roberts & Matthews will as enthusiastically continue to privilege structural interventions once they have taken into account all of the heretofore unnamed sustainability concerns, costs, and potential unintended consequences.

Given the foothold that this wretched epidemic has acquired among the most marginalized populations of the world, HIV antiretroviral therapy will likely occupy a position of central prominence in most prevention strategies (Cohen et al., 2011; Das et al., 2010; Montaner et al., 2010). Treatment-based strategies are unlikely to be successful in isolation, however. Certainly it has already been anticipated that their effectiveness will vary according to the social context (El-Sadr et al., 2011). Discerning the optimal blend of biomedical, behavioral, and structural approaches with the highest portfolio probability of success will require an iterative process of undertaking trials and even making some errors (Cohen, 2011) that is pragmatic and data-driven. Roberts & Matthews criticize the biomedical establishment for “experimenting on vulnerable populations for 30 years” (p.5), but given the immense, frightening, and urgent need for action, I would argue for *more experimentation on vulnerable populations*, not less. The recent progress made in HIV prevention has taught us that there will be no single, or simple, strategy that will reduce the population incidence of HIV. Implementation of these complex multicomponent strategies will require that biomedical and behavioral experts work alongside social scientists (Imrie et al., 2007; Kippax, 2008) -- at best, synergistically (and at worst, in parallel). To those concerned about

the impending marginalization of social scientists and their structural approaches, I would counsel equanimity. There is plenty of work to go around.

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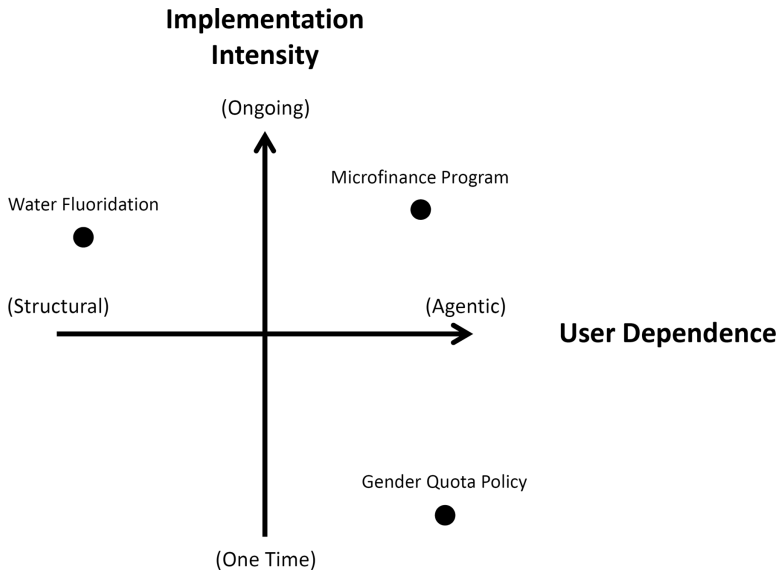

Figure 1.
In this simplified typology, structural interventions are classified along two axes: implementation intensity (ranging from one-time to ongoing) and user dependence (ranging from structural to agentic).