

Recruiting clients to a community-based HIV-prevention program: A dynamic model

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Abstract

We present results from a preliminary system dynamics model of problems in recruiting clients to a hypothetical HIV prevention program. Efforts in HIV prevention emphasize moving programs of demonstrated efficacy to community settings. However, little is known about how these programs interact with contextual elements of service delivery to determine the feasibility of implementation. The section of the model we present here focuses on the stocks and flows associated with attracting, enrolling, and graduating a steady flow of clients into small-group workshops and highlights paradoxes in providing this type of program in the community. We test two policies that either focus on monitoring the recruitment rate or monitoring the graduation rate. Despite its superiority in real-life experiments for producing behavioral change, our model suggests that small-group workshops are a highly inefficient means to change the behavior of a target population over a 10-year period of time.

KEY WORDS: HIV prevention programs; evidence-based programs; client recruitment.

INTRODUCTION

In 2004, AIDS was responsible for approximately 5 million deaths around the world (UNAIDS 2005). As of 2005, an estimated 45 million people are infected with HIV, the virus that causes AIDS (UNAIDS 2005). In many nations, AIDS is a leading cause of death and disability among young adult populations and a principal source of strain on existing medical, treatment, and health care resources. A cure for AIDS is not yet on the

horizon, nor is the promise of a vaccine. In the absence of curative or prophylactic medicines, prevention remains the most important means to reduce individual exposure to HIV and slow the spread of the epidemic.

Since the mid-1990s, social scientists have established through rigorous research the benefits of a select set of HIV prevention interventions. These interventions have been shown to increase condom use and improve skills to negotiate lower-risk sex in a variety of at-risk populations (e.g., Seeman and Sogolow 2002; Albaraccin, et al. 2005). Simultaneously, community-based service providers have developed and implemented their own preventive efforts, most of which have not undergone rigorous scientific study. The high economic and social costs of AIDS highlights the importance of providing high-quality and effective AIDS prevention programs to populations at risk of exposure to the virus.

Over the prior decade, interest in disseminating programs determined to be effective in scientific studies has dramatically increased. Indeed, the practice of imposing select evidence-based intervention programs on service providing agencies has become commonplace in many health and social service arenas in the United States (Weiss, et al. 2005). State and city departments of health often strongly encourage, if not require that organizations seeking funds select from a compendium of HIV prevention programs endorsed by the United States Centers for Disease Control and Prevention (CDC). These programs, often referred to colloquially as “DEBIs” (named after CDC’s Diffusion of Effective Behavioral Interventions Project), have been subject to at least one rigorous quasi-experimental or experimental test of efficacy.

As the pace at which DEBIs are being disseminated to community providers through imposed and voluntary adoption has accelerated, so has interest in better understanding the processes associated with successful dissemination and implementation of evidence-based programs. For instance, over the prior decade the CDC has conducted several dissemination trials and expanded its efforts to increase the capacity of organizations to provide these programs. As the field accumulates more experience of dissemination and implementation of HIV-related evidence-based programs in community settings, knowledge of the challenges associated with dissemination, adoption, and implementation of these programs has slowly begun to accumulate.

A growing body of anecdotal and empirical evidence suggests some success in transferring these programs into service delivery environments over the short term. At the same time, empirical and anecdotal evidence suggests that providers struggle to implement many of these programs over time and are not always able to offer these programs with acceptable levels of fidelity to the original program design (Cotton 2006). Many in the field express cautious optimism about the long-term success of current dissemination efforts. Yet, it is also clear that the field has much to learn about the process of long-term implementation of these programs if dissemination efforts are ultimately likely to succeed. In light of the importance of providing routine effective prevention programs to populations at risk, research specific to the context of community

service provision of HIV-related prevention programs is needed to understand problems in implementation and to identify solutions to address those problems.

The lack of a solid body of research on the context of service delivery in HIV prevention is a critical barrier to research progress in this area. To date, most organization-level and program-level research on HIV-related community-based service provision has focused on the complex array of issues associated with providing HIV testing and counseling services and to caring for those who are already infected. Only a very small body of work examines the issues associated with providing HIV prevention. Little of this work sheds light on the processes that are integral to delivering HIV prevention services on an ongoing basis, such as identifying and attracting at-risk populations for receipt of services, recruitment of those individuals into prevention services, and acquiring, allocating, and maintaining resources to the provision of HIV prevention services. In this sense, we know very little about how the service delivery context for HIV prevention programs and the characteristics of the various types of HIV prevention programs now being disseminated to providers might ultimately interact.

The present research represents one step in a broader program of research to contribute to filling gaps in our knowledge. Specifically, in the current effort we seek to build an exploratory system dynamics model to characterize the process of carrying out a community-based HIV preventive intervention program.

The Current Research

This paper describes the first stage of our exploratory work to build a model of the system that surrounds the delivery of an HIV prevention program implemented in a community setting. In this effort, we focus on the system that supports the delivery of a single prevention program in order to get at the core dynamics of program implementation. We developed a model of the process of implementing a single type of intervention - a small-group workshop - because the program represents a distinct and common approach to HIV prevention. Indeed, in a meta-analysis conducted by the CDC (Seeman and Sogolow 2002), 71% of interventions studied were of this type. The processes associated with implementing a small-group workshop are distinct from other interventions, such as one-on-one, face-to-face outreach programs, community-level social marketing, or normative change interventions. By building a model specific to a common intervention type, it is our hope to gain insight into the unique challenges of offering this specific form of HIV prevention in the dynamic context of a community.

Programs of the small-group workshop type require that an organization offering such a program enroll a relatively homogenous group of users who can come to a set location and participate in a group session of 1 or more hours in length. The number of program sessions may range from as few as one to as many as 24, according to data provided in a recent meta-analysis characterizing these types of programs (Albarracin, et al. 2005). Programs of this type typically include informational and skills-building sessions that are designed to accomplish aims such as promoting consistent condom use, improving partner communication and negotiation skills, and helping individuals to identify and

avoid situations that place them at high risk of exposure to HIV. It is also typically the case that, to be effective, participants must participate in most, if not all, sessions. Meta-analyses appear to suggest that programs that occur over multiple sessions produce better results than those that have few sessions and that good attendance is positively related to an individual accruing knowledge, attitudinal, and behavioral program benefits (Herbst, et al. 2005; Johnson, et al. 2005). Our base model assumes a program that meets weekly over a period of 8 weeks, the average number of sessions reported in meta-analyses by Albarracin and her colleagues (2005).

To begin developing our model, we took as our guide a framework describing the structural elements of an intervention developed by Gericke and colleagues (2005). In their work, Gericke et al. lay out a framework for indexing how complicated an intervention is to implement. The framework that Gericke and colleagues developed assumes a very different type of intervention from the one of interest to us, but provides a useful point of departure nonetheless.

Gericke et al. (2005) identify four components of an intervention that determine its delivery complexity. The first component identifies the nature and availability of resources to deliver the intervention, the basic system in place to carry out the intervention. This component includes the amount and quality of essential personnel and non-personnel resources, as well as how these elements relate to one another. The second component identifies features of the intervention itself, such as its degree of standardization, its coordination requirements, and its likelihood of producing adverse consequences. Gericke and colleagues (2005) reason that as interventions become more difficult to standardize or more likely to produce undesirable consequences, the management and resource requirements of the interventions change accordingly. A third component of the framework deals with the program's interface with external systems, such as those designed to insure programmatic accountability. The final component of the system includes the user interface and the process of maintaining a base of clients. In the present paper, we focus our attention on elaborating this last component of the intervention delivery system, the user interface.

Examining the user component of the intervention delivery system is of particular relevance to community service delivery. Anecdotal evidence from AIDS organizations suggests that recruitment to these types of programs is very difficult and that organizations have very few options, given limited resources, for how to influence recruitment. Further, many organizations' annual or biennial contracts with funding institutions are tied to recruitment or program completion rate goals. Finally, the scant literature on implementing these types of programs suggests that retention of clients in multiple-session programs can be challenging, whether because of drop out due to uncontrollable events in clients' lives (e.g., childcare falls through, becoming ill), or because some people will simply not care for the program or have a high enough quality experience to stay enrolled. In sum, given a reference mode that suggests that client recruitment and retention is a difficult part of HIV prevention service provision in the community, examining the dynamics of the user component seems particularly fruitful.

Reference Mode and Dynamic Hypotheses

A principal task for any program delivery system is to insure that there is a steady stream of appropriate clients accessing and using the programs (Levin and Roberts 1992). Programs must serve someone and processes must be in place to make sure that this is the case. In essence, for a program to have any hope of ameliorating the problem it is designed to effect, some set of mechanisms must exist to bring the program to the attention of its prospective audience, move its audience into the program and, once enrolled, maintain their enrollment long enough that at least some of them benefit in desired ways. Our model decomposes each of these major elements. It details the process by which a prospective client is recruited, enrolled, retained, and completes the program.

As we previously noted, many AIDS-related agencies have difficulty recruiting participants into small-group programs. This dearth of recruits can manifest at least two different behavioral patterns. Figure 1 shows a typical problematic pattern of recruitment. In this pattern, initially the recruitment advertising and outreach was adequate or more than adequate to recruit enough people to meet the program's target recruitment rate. Yet, over time recruitment rates fall to below the target level. The pattern of recruitment resembles a fatigue process, such as satiation of the effects of advertising and outreach in the target population. As recruitment falls below target levels, an agency, if monitored by its funding source, would become vulnerable to having its funds decrease or cut off. The exact time at which the recruitment rate for this program would go below the target level could vary. Presumably, an agency would like to prolong the drop in recruitment as long as possible or find policies that would prevent the recruitment rate from declining over time¹.

The key hypothesized loop processes are associated with a set of (a) positive loops that may underlie decreasing demand for the program and a set of (b) loops that are associated with two different policies to recruit and graduate participants. Figure 2 shows the proposed underlying structure that may account for these problems. Loop 1 could act as a reinforcing process if, for example, *Total Recruitment Rate* were to increase. However, this positive loop may be problematic if *Total Recruitment Rate* were to initially decrease. A decrease in *Total Recruitment Rate* leads to a decrease in the *Number People Finishing the Program*. A decrease in this variable decreases the effects of *Word of Mouth*, which would in turn decrease the *Total Recruitment Rate*, putting the system into collapse mode. Unfortunately, as we have indicated, a key problem in this sector is to account for the lack of demand for this kind of evidence-based program. Loop 1 may play an important role in understanding the problem.

¹ We should note that other reference modes, including one in which recruitment poses no difficulty, are possible. In analyses not presented here, we can reproduce these other reference modes.

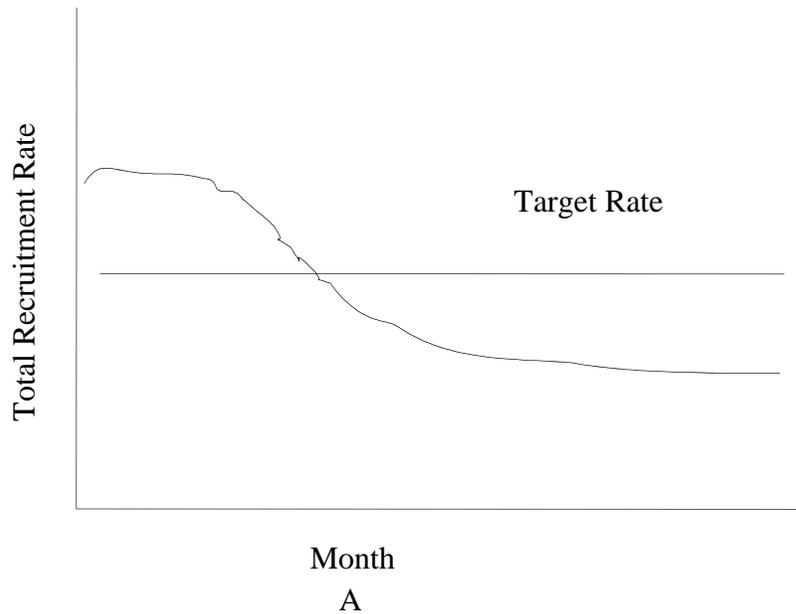


Fig. 1. Potential problematic pattern of low demand for the program over time

Loop 2 also could be problematic if the system is in collapse mode. This loop represents the effect of the “recycling” of people who had participated in the program and who at the moment are not practicing safer sex. A decrease in *Total Recruitment Rate* decreases the *Number of People Finishing the Program*, which in turn decreases the size of the *Target Population*. A decrease in *Target Population* would decrease the *Total Recruitment Rate*. The figure shows an additional set of loops that illustrates how an agency deals with the decrease in recruitment, as well as the problem of a low graduation rate.

Loops 3 and 4 focus on policies that agencies may follow to monitor and report to their funding sources that they are meeting the terms of their service provision contracts. “Recruitment monitoring” agencies are evaluated and funded for the number of new persons showing up to take the program. A recruitment monitoring agency monitors its recruitment rate and reports it to the funding agency as an indicator that they are providing the required amount of service. We hypothesize that if the agency fails to meet its goals, the agency’s main response is to put more emphasis and resources in advertising and outreach regarding the program in the target community (Loop 3). Advertising and recruitment outreach is about the only intervention or level of change under their control. Figure 2, Loop 3 describes a negative loop associated with reacting to not getting enough people through the door. A decrease in *Total Recruitment Rate* decreases the *Perceived Recruitment Ratio*, which in turn increases the intensity of the agency’s advertising and recruitment effort for the program. Finally an increase in the intensity of advertisements and recruitment outreach increases *Total Recruitment Rate*.

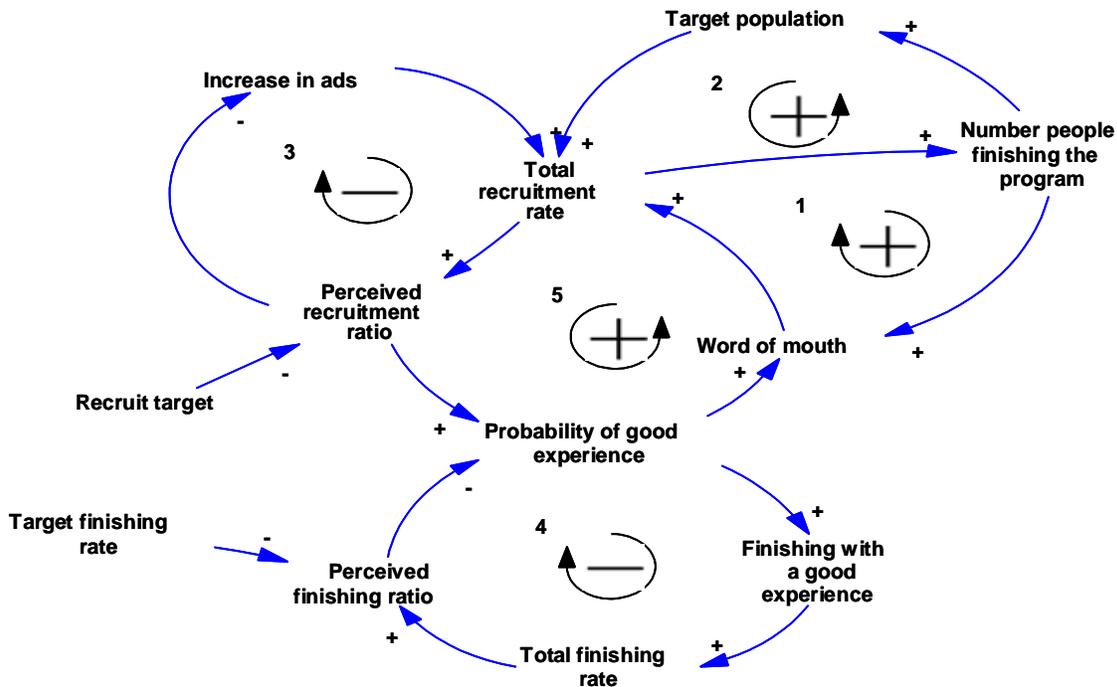


Fig 2. The hypothesized structure for low recruitment

Loop 4 deals with the actions of agencies that have contracts based on the number of people finishing the program. We call these “graduation monitoring” agencies because the agencies are focused on the rate of client output rather than the rate of client input. When monitoring the number of people completing the program, these agencies may try to increase the quality of the experience of the program to maintain participant satisfaction long enough to get them through the program.

Finally, our dynamic hypothesis includes a positive Loop 5 that affects the *Total Recruitment Rate*. Going into collapse mode is problematic and conforms to our prior description of the reference mode. A decrease in the *Total Recruitment Rate* decreases the *Perceived Recruitment Ratio*, which in turn decreases the *Probability of Good Experiences* by participants. A decrease in this probability decreases the impact of *Word of Mouth*, which in turn would decrease the *Total Recruitment Rate*, thus completing the loop.

Description of the Model

The model is composed of a chain of states in which people are either targeted for the program, currently in the program, or have left the program. The initial part of the chain is shown in Figure 3. This figure describes what happens prior to entering the program. The first two stocks in our model compose the program’s intended target population. Because research and theory (CDC Demonstration Group 1999; Prochaska and DiClemente 1992; Prochaska, DiClemente, and Norcross 1992) suggests that not all members of populations at risk are equally ready to pursue behavior change and access

formal assistance to pursue change, we have separated the target population into two pools, those who are at risk but not presently motivated to pursue behavior change *via our program* (“unmotivated”) and those who are at risk and who are presently motivated to pursue behavior change *via our program* (“motivated”). Presumably, those members of the population who are motivated to change would be easier to recruit into the program than those who are not similarly motivated. Note that we have also assumed that a number of factors can move people to become motivated to access our program. Specifically, we suggest that personal life events may make AIDS and the need to consider behavior change salient to an individual. For instance, a person may learn that someone they know is HIV positive or may have unprotected sex with a high risk partner. We also suggest that advertisements designed to recruit people to a program may have an impact on moving those who are unmotivated to change to become motivated. We reason that advertisements will be less effective for this purpose than the purpose for which they are intended – recruitment into the program, but may still have some effect on levels of motivation.

Other factors may influence motivated individuals to return to an unmotivated state and return those individuals back to the pool of unmotivated individuals. For example, hearing that some people have had a bad experience with a program may reduce an individual’s level of motivation to pursue it. Long delays or other difficulties in accessing a program may also encourage people to return to an unmotivated state. At our initial base run, we assume a steady rate of in- and out-migration from the motivated and unmotivated pools as part of a natural flow of migration in and out of the community².

We have also established another important source of leakage from the pool of motivated people. Motivated people might decide that they can accomplish change on their own or via some other program in the community. Individuals such as these become lost to our efforts at recruitment.

In Figure 3, there is a stock of unmotivated people and a stock of people motivated to enter the program. The stock, *Unmotivated Target Population (Unmots)*, is very resistant to change. Very little moves them to either consider changing current habits, much less enter this specific program. The second stock, *Motivated Target Population (Mots)* is composed of people who are considering changing their behavior via our program. They are much more likely to get into the program, to pursue practicing safe sex on their own, or to enroll in other programs than are the *Unmots*. In all of the runs reported here, we have assumed the *Unmots* are much more prevalent, indeed, by a ratio of 4:1, consistent with data collected by the CDC on the readiness of various community populations to change behavior (CDC Demonstration Group 1999). Those frequencies are unfortunately realistic.

In sum, our main assumption is that not all of the targeted population in a defined geographic service area is ready to go into the program. We assume that many in the

² In future analyses, we can explore whether communities that are attractive and have higher rates of in-migration than out-migration experience different recruitment dynamics than do communities in which population out-flow is higher than in-flow.

target population are not motivated to change the behaviors that place them at risk of exposure to HIV and that the number of people in our target population who are motivated and ready to enroll in our program is far fewer than the number of people in our target population who are unmotivated to pursue our program as a means to behavior change.

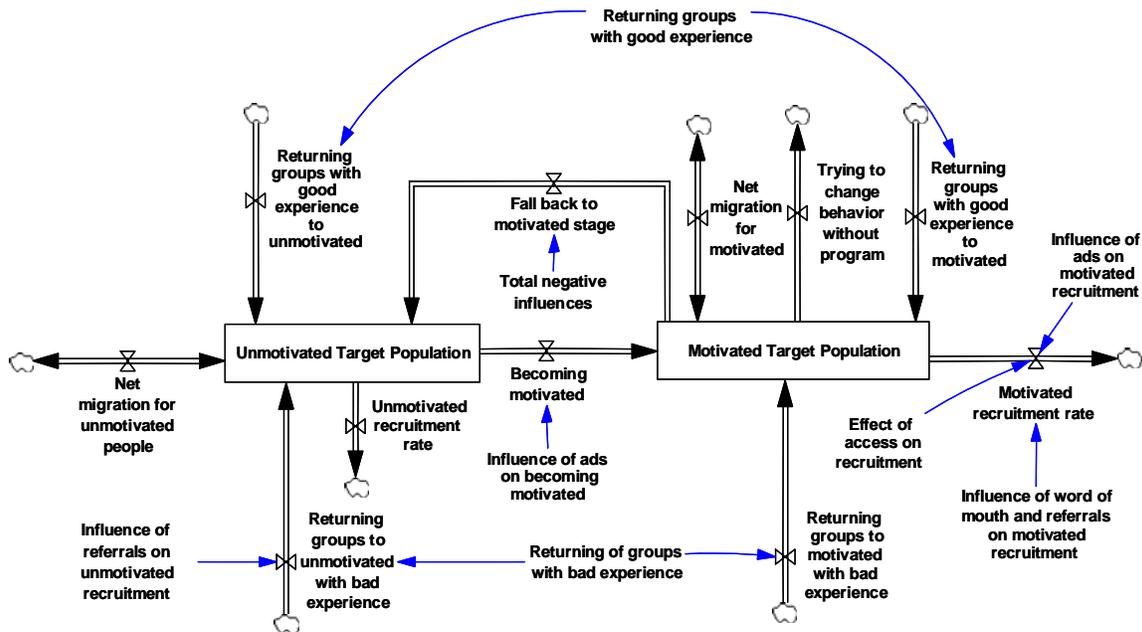


Fig 3. A simplified stock and flow diagram showing the early Stages of Change, the elements of the recruitment process, and some of the main flows in and out of the two target populations

The key flows in Figure 3 deal with (1) the recruitment process, (2) the transition from the *Unmotivated Target Population (Unmots)* to the *Motivated Target Population (Mots)*, and (3) the “falling back,” or return of the *Mots* to the *Unmot* group. Recruitment follows the logic of the Bass models of innovation (Bass 1969; Bass, Krishnam, and Jain 1994; Stermann 2000), so there is both stress on advertising that initially gets the recruits into the program and word of mouth from people currently or formerly in the program. We have also included one more element to the recruitment process, namely the influence of referrals to the program from outside agencies that is passed on to both *Unmots* and *Mots*. Finally, the recruitment process can be helped along through the formation of networks within the *Mot* population. Through processes of cooperation, *Mots* can help other *Mots* to, for example, get to the program if they do not have easy access to it.

Transitions between target populations. As explained above, the model assumes that *Unmots* move to the *Mots* category because they either experience a significant motivating event in their lives or are influenced by advertisements and outreach. We also assume that word of mouth has less positive influence on the *Unmots*’ likelihood of considering our program than it may have on those who are motivated, because the

Unmots are by definition less motivated to change their behavior via a program such as ours. We do assume, however, that *Unmots* could become motivated by word of mouth, though the probability of this occurring we have assumed is low in the absence of other motivating occurrences.

In most cases, the Bass model emphasizes that advertising and word of mouth move the target population in a positive direction into the program. In this context, however, people may also be influenced negatively by those groups that have had a bad experience with this particular program. The model includes the negative counterpart to the word of mouth feature of the Bass model. There is some evidence for the influence of negative word of mouth in the dissemination of innovation process (Leonard-Barton 1985). This may be one of the unique aspects of our model. We assume that negative reactions to the program from those currently in the program and those who had been in the program affect the rate of falling back from *Mots* to *Unmots*. Additionally, an increase in negative feelings about the program can decrease the generation of referrals by outside agencies, which in turn will slow the recruitment rate.

Figure 3 also shows a number of rate variables that flow in and out of the two stocks in the figure. Specifically, if the net in-migration into both stocks is positive (see Figure 2), perhaps representing a city or geographic region that is unattractive to the at-risk population, then it may set off loops in collapse mode. On the other hand, a surplus of people being attracted to the region may generate adequate numbers of people per month to run the program and to meet contractual obligations. In fact, according to the attraction principle, there could be excess demand for the program relative to the resources available to run it.

The other flows in Figure 3 deal with the return of people who have had some contact with the program and for one reason or another are returning to the *Unmot* or *Mot* groups. Figure 3 shows two aggregated return sources. The first is composed of those people who had a good experience with the program but who did not benefit from it. The second is composed of those who have not had a good experience with the program, but still want to try it over, perhaps because they are concerned about not consistently having safe sex. One of the key constraints of this situation is that funding sources may not permit the agency to count the returns as new recruits during any one funding cycle (e.g., a period of 12-24 months, depending on the length of the contract). This long lag may be key in slowing down the effects of the return process, as agencies may not perceive much advantage to allowing clients to repeat the program over short periods of time.

As mentioned previously, another flow process in the model concerns the action taken of people who are motivated to change, but do not necessarily want to go through the program. For the purposes of the model, they go out of the system, and are not part of the loop structure. However, if a large percentage of *Mots* decide to do it on their own or do it via some other program, then this process will have a significant impact on the size of the *Mot* population, ultimately decreasing the potential for recruitment.

Finally, the model includes an exogenous variable, *Access*, which might affect recruitment. In many settings, going to a program may interfere with other important activities, such as work or family obligations. Alternatively, a program may operate in a location or at a time that is convenient for only a fraction of the target population. We have quantified *Access* from 0.0, meaning no access to the program at all, to 1.0, perfect access. The model shows, as one would expect, that when *Access* is set to 0.0 as an extreme test, recruitment comes to a halt.

Program Dynamics

Figure 4 shows the dynamics of the program's participants. It is important to describe how the quality of experience was handled in the model. Normally continuous psychological variables like the *Quality of Experience in Program* could be easily handled in terms of a co-flow process (Sterman 2000). However, in conceptualizing the model, we were struck with the fact that the quality of experience varies considerably for those in the program. The co-flow structure focuses upon the average characteristic value, and has little to say about the distribution of quality of experience. For most purposes, focusing on the average is not problematic. However, in this situation people who are dissatisfied with the program may drop out. We conceived of this situation as a skimming process in which, when some people left the program, those that remained in the program would on the average be more satisfied. As the program goes on, fewer people would drop out because of having a bad experience than would probably occur during the initial sessions. Although one might modify the co-flow process to accommodate the skimming process, we chose an alternative approach, by disaggregating the recruits in the program into two satisfaction groups, namely those who are having a good experience and those who are having a bad experience.³

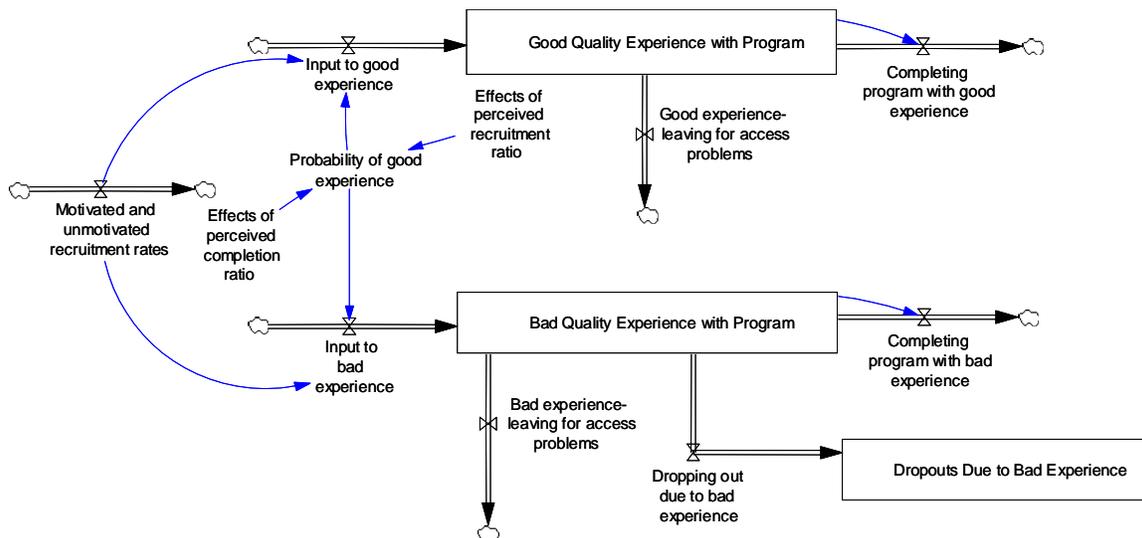


Fig 4. A simplified stock and flow diagram of the participant sub-sector

³ One might argue that it would be better to have at least three levels of satisfaction (quality of experience), and indeed that would be better. However, for combinatorial simplicity, we chose to have two groups.

Figure 4 indicates that the recruitment rates for *Unmots* and *Mots* are split into the two groups, *Good Quality of Experience with Program* and *Bad Quality of Experience with Program*. In both cases, a certain proportion of people leave the program because of a change in their situation, such as loss of a ride, child care problems or sudden illness. Otherwise, participants complete the program in the time prescribed by the program's operating procedures, which in our runs was 2 months, or the average length of an evidence-based small-group intervention. Note also that some of those participants who are having a bad experience with the program drop out and do not complete the program. These individuals may play an important role in passing on negative messages to the *Mots*, *Unmots*, and to the organizations that may refer people to the program. We have cumulated these individuals in a stock called, *Dropouts Due to Bad Experience*.

Recruitment and graduation monitoring policies. As described previously, recruitment monitoring policies focus on monitoring the recruitment rate, relative to the contracted recruitment target, a variable that we denote as *Relative Recruitment Ratio*. The key loop associated with the recruitment monitoring policy was shown as Loop 3 in Figure 2. We are hypothesizing that by focusing on front end recruitment matters, such as intensifying marketing and advertising, it is easy to let the quality of the experience erode. After all, the agency is rewarded by bringing people through the front door. There may be less perceived need for controlling satisfaction.

Now consider the effect of the relative completion rate on the *Probability of a Good Experience* with the program, as indicated in Figure 4. The graduation monitoring policy moves *Probability of a Good Experience* in the opposite direction to that of the recruitment monitoring policy. Agencies under this policy get rewarded for the number of people who complete the program. Loop 4 represents the feedback process associated with monitoring *Total Finishing Rate*, relative to the *Target Finishing Rate*, and reacting to increase the number of people having a good experience in the program. Our model assumes that a given agency utilizes either a recruitment or graduation monitoring policy. We use a switch to set the recruitment or graduation monitoring policy in any given simulation run.

The Dynamics of those who Finish

The third sub-sector of the model deals with the dynamics of those who finish the program and remain in the region to affect (1) the recruiting process, (2) the transition back from the *Mot* to *Unmot* states, and (3) the dynamics of the referral process, all through *Word of Mouth*. In addition, some of the groups that have completed the program, called, "finishers," eventually return back to either the *Mots* or the *Unmots* after a long delay.

Figure 5 is a simplified representation of the stocks and flows associated with the finishers. This figure introduces a new dimension into the model, namely the effectiveness of the program for those who have completed it and for those who left it for personal reasons due to changes in their lives, such as illness, time and location conflicts.

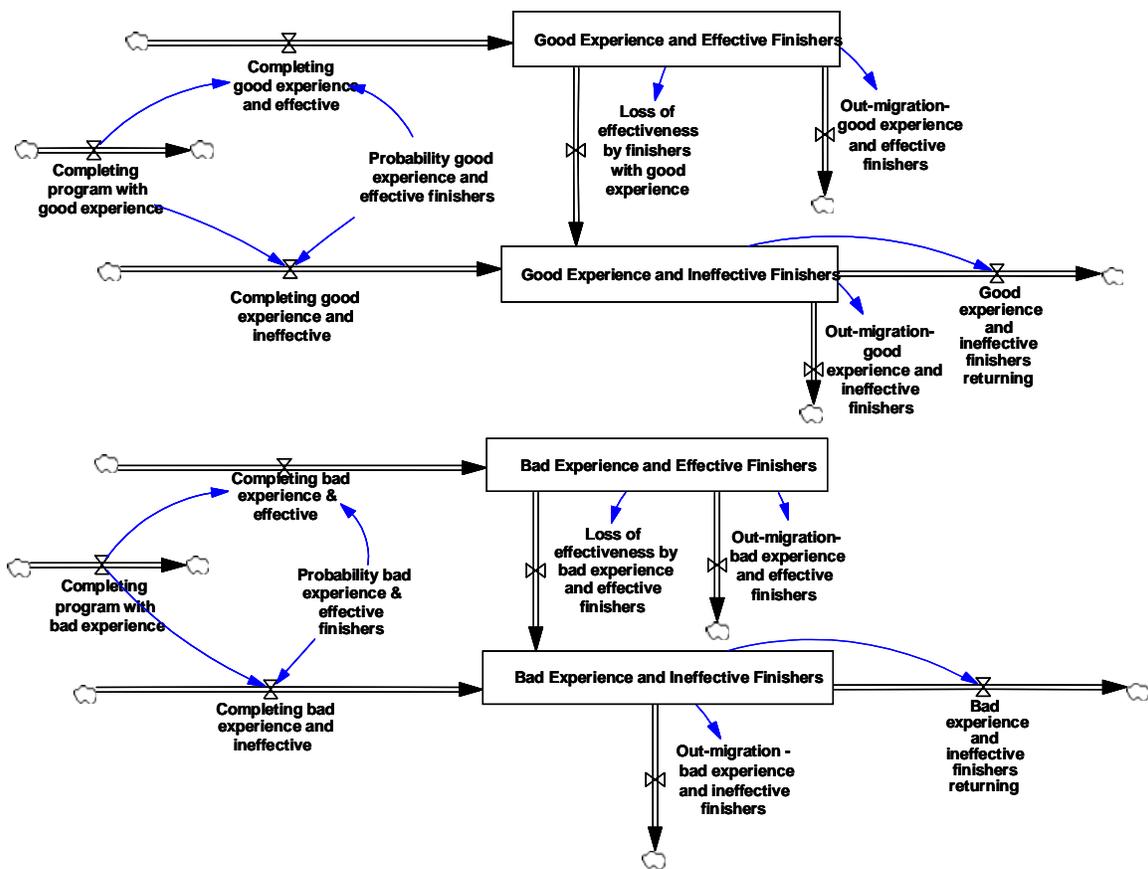


Fig 5. A simplified stock and flow diagram of those who finished the program

Previously, we have focused on how both recruitment and graduation monitoring agencies deal with problems getting enough people to keep their program going. Both policies affect the quality of experience with the program. Although many agencies view satisfaction as a proxy for effectiveness, we consider that effectiveness of the program is somewhat independent of the quality of the experience. *Quality of Experience* is relatively easy to measure and could be important in keeping people in the program. Also, the longer people are in the program, the more likely they are to change their behavior in the right direction. Nonetheless, people can enjoy a program without changing their behavior patterns on an immediate or long term basis. There are other reasons for enjoying a program, like being entertained at meetings and using the program as drop-in social center. Indeed, some program participants may be satisfied with how the program is run or the kindness and competence of the staff, attributing any lack of change in their own behavior to themselves rather than to the effectiveness of the program. By the same token, some small proportion of people may dislike the program and have a poor experience in it, but change nevertheless. Our model captures all four possibilities, as we show in Figure 5.

By definition, evidence-based programs have been evaluated for their effectiveness. One would think that a large proportion of finishers would apply what they have learned in the

program by having safer sex every time. This is not the case, even for these programs of demonstrated benefit. Meta-analytic studies have shown that, on the average, only about 25 to 35% of the finishers in the experimental studies increase their condom use or reduce their rates of unprotected sexual behavior following their participation in the program (cf. Johnson, et al. 2005). Moreover, some studies indicate that within a year, a proportion of those who were engaging in safer sex have slipped back to their old habits.

Program effectiveness is very important, so we have included it in the model (see Figure 5). As the participants complete the program they can be categorized into four major groups of finishers, as seen in the figure. In addition, Figure 5 represents the loss of people in stocks associated with finishers who at first consistently practiced safer sex and who then fall back in their level of adherence to safer behavioral practices. These stocks are named *Good Experience and Ineffective Finishers* and *Bad Experience and Ineffective Finishers*. One aim of those designing new interventions might be to attempt to slow down this loss by changing the program to be more permanently effective or to continue to be in contact with the finisher population through follow-up workshops. Unfortunately, policies that focus on effectiveness may not be easily carried out in HIV prevention community-based agencies because of inadequate resources and low program evaluation expertise. Even the graduation monitoring policy may not directly address this process. It may only focus on strengthening the quality of experience and graduating people, without attending to effectiveness of the program.

Recycling. As noted previously, the model also includes a recycling process. In this context, a recycling process is very adaptive, because it may help to provide an adequate stock of potential recruits. We assume that whether or not they enjoyed the program, participants who have changed their behavior would probably not feel the need to enter the program again. On the other hand, those people who have completed the program but have not successfully changed their behavior may want to take the program again in the future. In addition, some of the people who had to leave the program because of problems such as becoming ill or transportation may want to return to the program. Whether they have completed the program or dropped out from the program, agencies may allow former participants to repeat their participation in the program on ethical grounds. We assume that agencies have little financial incentive to allow repeat participation within any given contract year because repeat attendees may only once be counted toward the recruitment rate. We assume, therefore, that some people may enroll in the program on more than one occasion but that only repeat attendees who return after an 18 month or longer delay contribute to meeting the target recruitment rate.

RESULTS

In this section, we describe the result of our initial model runs. First, we will explore the effects of varying the size of the target population that an agency desires to recruit into its HIV prevention program. Next we will assess the similarities and differences between the recruitment and graduation monitoring policies. Finally, we consider the role that ease of access plays in creating the opportunity for recruitment.

Comparing the Size of the Target Populations

The first runs compared the responses of the model to varying the size of the at-risk community in any one region. Two population sizes were selected to represent moderate (4,000) and large (10,000) communities of the targeted at-risk group. The time horizon was set at 120 months, or 10 years. The degree of access to the program by the *Unmot* and *Mot* populations was set at 0.4. We again note that *Access* was quantified by an index that ranged from 0.0 to 1.0, where 0.0 means no access at all to the program and 1.0 means perfect access to the program. The value of 0.4 seems realistic in moderate to large target populations. In both settings, the *Unmots* outnumbered *Mots* by a ratio of 4 to 1, so that in the 4,000 person setting, initially there were 3,200 *Unmots* and 800 *Mots*. In the 10,000 person setting, initially there were 8,000 *Unmots* and 2,000 *Mots*. In all of the runs, the agencies mainly monitored the recruitment rate and followed the recruitment monitoring policy.

Duplicating the reference mode. Our first task was to ascertain if the model could duplicate the set of problematic recruitment patterns described earlier in which agencies are unable to maintain a steady rate of recruitment. Figure 6 shows the estimated yearly recruitment rate, relative to the *target recruitment rate*. This parameter was set at 200 people per year.

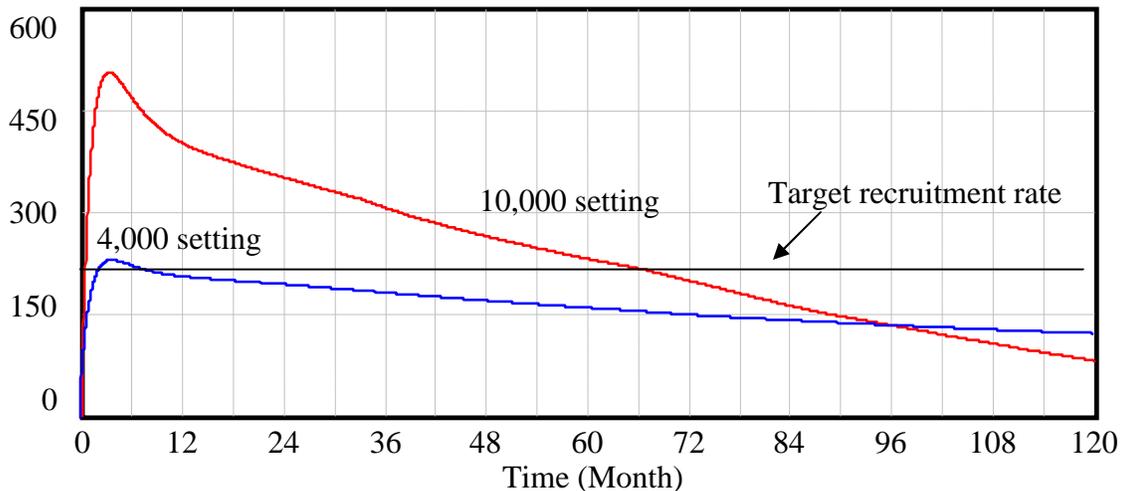


Fig. 6. Yearly recruitment rate as a function of the size of the community and target recruitment rate

Both populations show an initial overshoot and collapse mode of behavior. Relative to the yearly recruitment target, within the first year the recruitment rate is more than adequate for both settings. In fact, there may be too much demand for services in the 10,000 person situation. The model might have to be expanded to include a negative loop structure that would attempt to deal with excess demand, such as the formation of waiting lists, or multiple groups run simultaneously to accommodate participants.

Although the recruitment rate in both populations decreased over time, the 4,000 person community crossed the target rate of recruitment at about 18 months while the 10,000 community took up to 72 months or 6 years to begin to have a recruitment problem. There appears be enough people to prolong the crossing, but nevertheless even in the 10,000-person setting the 200 yearly recruitment rate that is required by the funding source cannot be sustained. Indeed, the agency working with the 4,000 person population may be in trouble fairly early because it fails to meet the target even before the second year the program is offered.

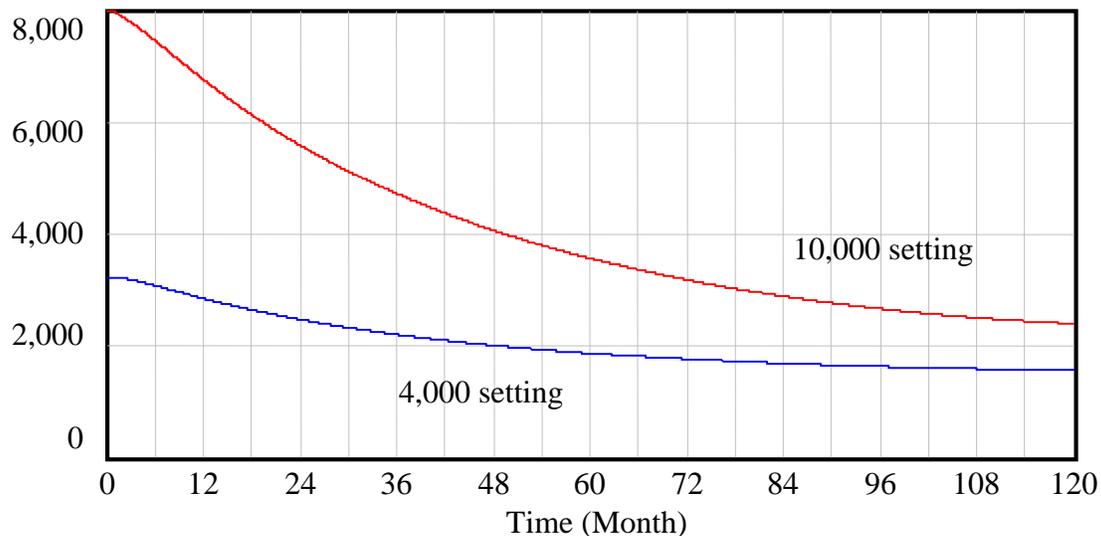


Fig. 7. Unmotivated Target Population as a function of the size of the community at risk

Why is recruitment unsustainable? Figure 7 shows the decline of the *Unmotivated Target Population*. We note that this decline is consistent with our hypothesis of a collapsing positive loop (#1) shown in Figure 2. The *Motivated Target Population* also declined over time. Thus, the model generated a problematic pattern that conforms qualitatively to the reference mode. Moreover, the model suggested quantitative differences between the 4,000-person and 10,000-person setting in terms of how long it would take to begin having a problem recruiting people into the program.

Analyzing major flows for unmotivated members of the target population. Because most of the patterns for the 10,000-person setting match those for the 4,000-person setting, we will only present the results of the smaller-sized community in the next few figures. The major outflow of the *Unmot* stock is the rate variable, *Becoming Motivated*. The major inflow of the stock is the rate variable, *Fall Back to Unmots from Mots*. Figure 8 shows that except for the first few months of program operation, the transition from being unmotivated to becoming motivated was higher than was the process of falling back to an unmotivated state. Falling back was a major input to the *Unmot* stock and may partially account for the observed decrease in the *Unmot* stock over time. Figure 9 shows how the input variable, *Becoming Motivated* stacks up with the key output rates, *Falling Back*,

Mot Recruitment, and Trying to Change without Program. One can see that the net flow would decrease the size of the motivated population over time.

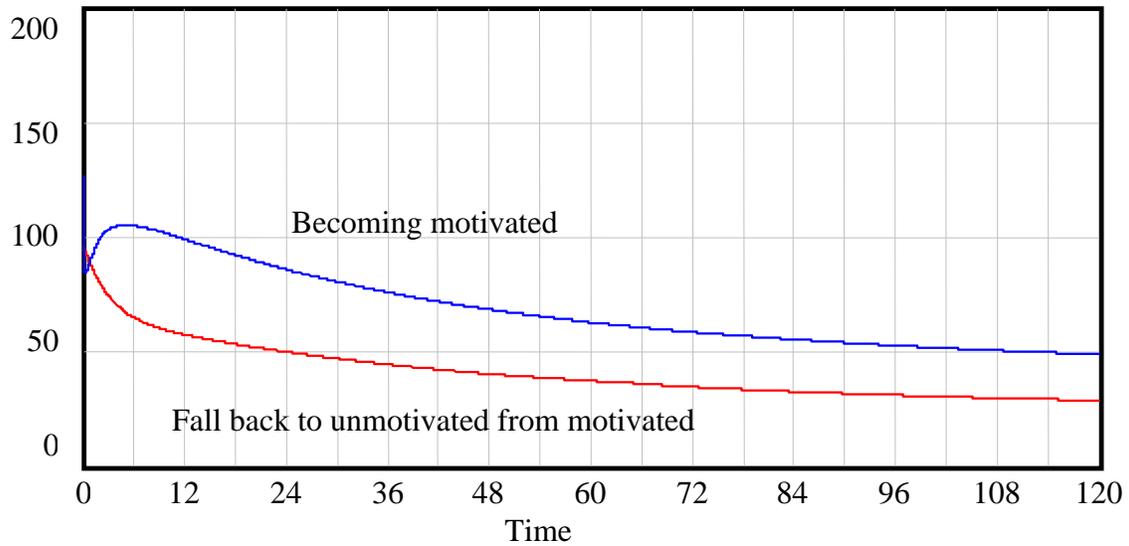


Fig. 8. Major flows in and out of the unmotivated stock

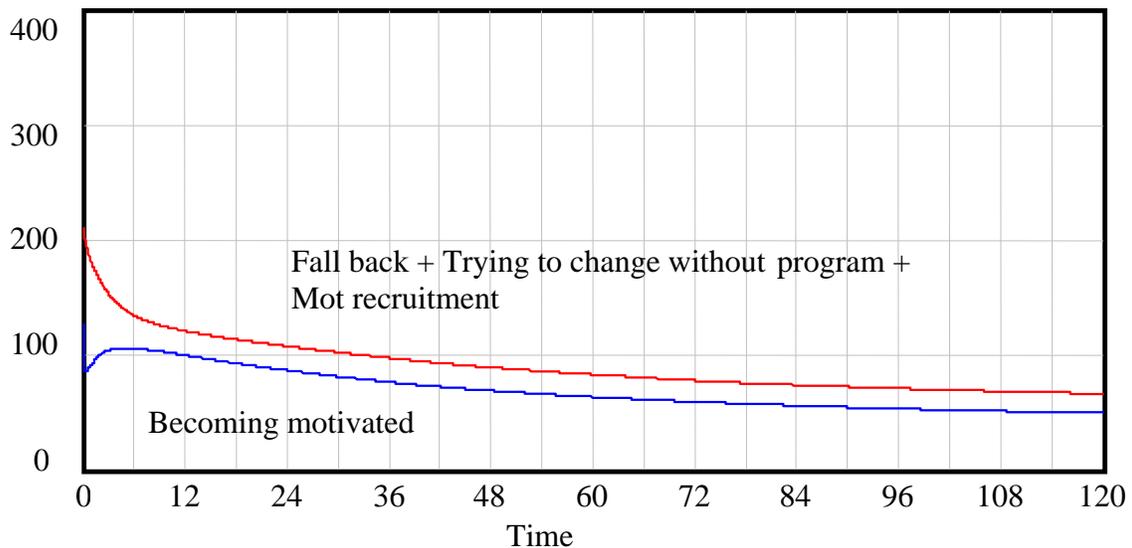


Fig. 9. The input variable Becoming Motivated compared to the major outputs from the motivated stock

Type of experience with the program. Figure 10 shows the time course of the quality of the experience of those currently participating in the program. Note the small number of participants overall. HIV-related agencies may only have the resources to offer one group at a time, which we assume to be the case, and therefore have a limit on how many people may be served by the program in any 2-month period. This constraint provides a bottleneck that is hard to overcome. The model also includes the return process we

described earlier in which some of the people who did not gain from the program the first time through may repeat the program. Our results show that the return mechanism is not adequate to deal with the gradual loss of people in the system. The success of those return flows depends on generating large numbers of people who have successfully completed the program. Assuming relatively high rates of good experience, moderate effectiveness rates, and typical real-world constraints on how many people can be served in any offering of the program, we find that there are simply not enough people to restock the population of unmotivated and motivated people.

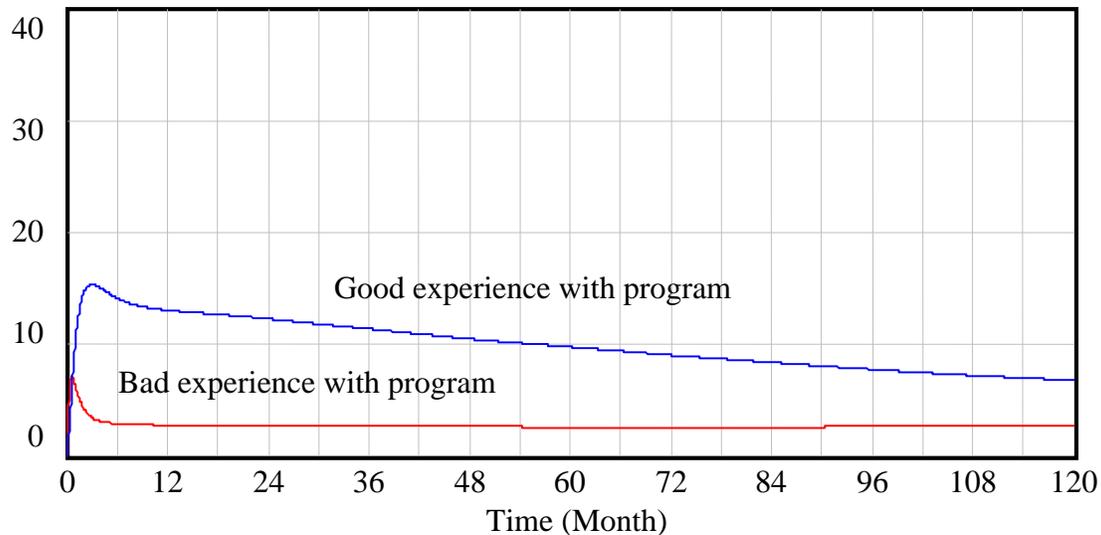


Fig.10. Participants' type of experience, with the base probability of a good experience set at 0.85

The last figure in this series of runs deals with the effects of ads, referrals, and the various types of word of mouth processes that underlie recruitment. This portion of our model encompassed the logic of the Bass model. Figure 11 shows the relative contributions of each of the separate processes that generate recruits.

By far advertisements contribute the most to *Mot* recruitment. It also should be remembered that the transition from being unmotivated to becoming motivated is also influenced by the effect of advertisements and recruitment outreach. Clearly, advertisements and recruitment outreach are the primary ways the agency can have some control over the recruitment process. At least for the 4,000-person and 10,000-person sized target populations, spending resources on recruitment advertising and outreach seems somewhat justified.

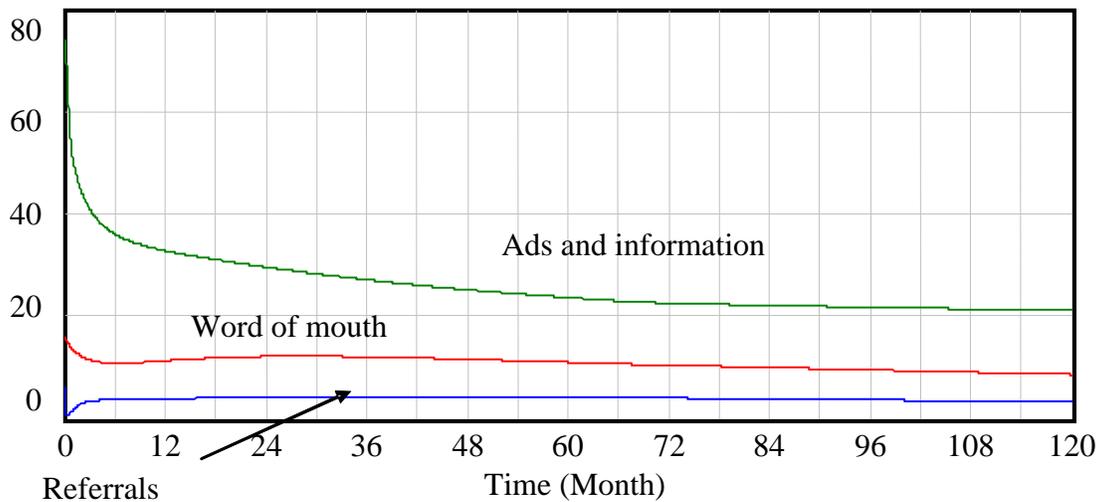


Fig. 11. The relative contribution of the ads, word of mouth, and referrals to recruitment

Comparing Recruitment and Graduation Monitoring Policies

The next series of simulation runs compares the recruitment and graduation monitoring policies on several dimensions. Again, recruitment monitoring agencies are contracted based on the number of program recruits coming in the door, while graduation monitoring agencies are contracted based on the number of people who complete the program. Loops 3 and 4 included in our dynamic hypothesis are most directly associated with the two policies.

To summarize briefly, the model indicated that the graduation monitoring policy lead to a slower decline of the target population’s recruitment. In general, the graduation monitoring policy was better in all of the output, but not by very much. For example, Figure 12 shows the output of key variables in the model dealing with the quality of the participants’ experience (top panel) and the number of “finishers” who had both a good experience and are currently practicing safe sex due to the program (bottom panel).

It appears that monitoring the rate of completing the program relative to a target leads to an increase in positive experiences of the program, but the effect was not large. Loop 4, which represents the essence of the graduation monitoring policy, is not powerful in this situation. The reason for this is that the base probability of having a good experience with small-group program is quite high to begin with. These runs were initiated with a value of 0.85, which is realistic given available data on satisfaction with similar programs. This base probability is affected by a multiplier that is a function of the *Perceived Finishing Ratio*. A graduation monitoring policy is associated with monitoring the completion rate, relative to the contracted target finishing rate. When there are not enough people finishing the program, the agency will then attempt to increase the quality of the participants’ experience with the program. The value of the multiplier starts above 1.0 and is a monotonic decreasing function of X. The problem with having such popular

programs with a probability of 0.85 is that there is a ceiling effect, because this probability is constrained to 1.0. The maximum value of the multiplier cannot be very high, because of this constraint. That may be why the graduation monitoring policy does not appear to be particularly effective in this situation. If there were more room to move, for instance if the base rate of good experiences was much lower (e.g., 0.65), the effectiveness of the graduation monitoring policy would be much more apparent.

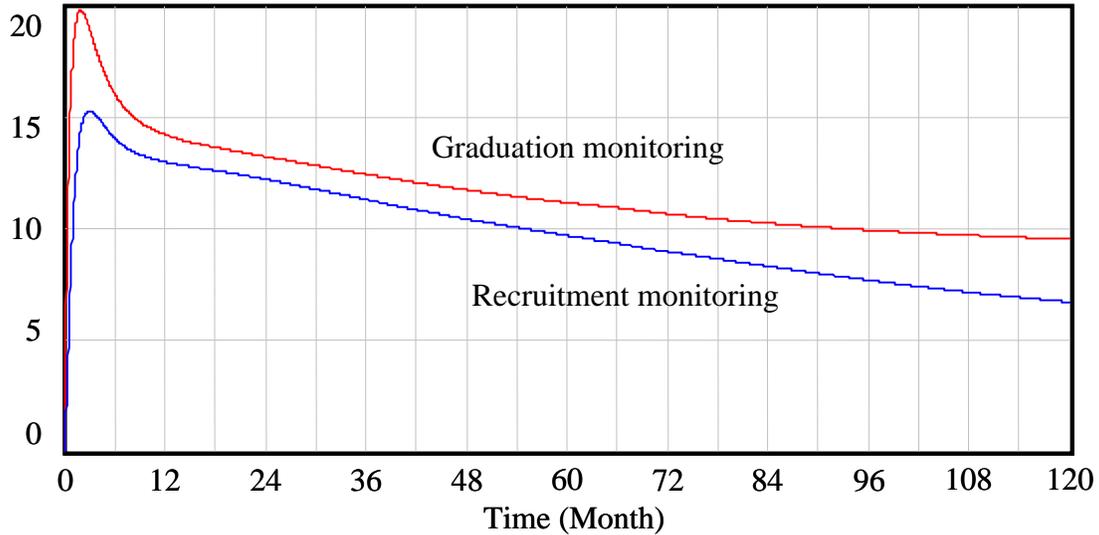


Fig. 12a. A comparison between recruitment and graduation monitoring policies with respect to quality of experience

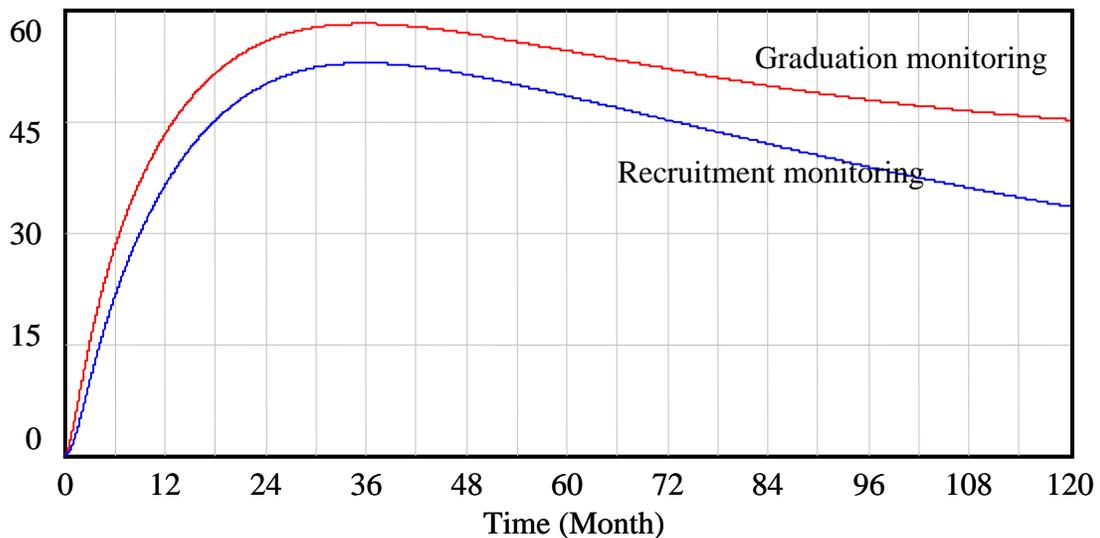


Fig. 12b. A comparison between recruitment and graduation monitoring policies with respect to ineffective finishers

Assessing the Effects of *Access*

To obtain a better idea about how target populations can be cut deeply, so much so that the agency may not reach their target recruitment or finishing rates, we present the results of a simulation run that varies the degree of access to the program prior to being recruited. Again, *Access* varies from 0.0 to 1.0. A realistic value for the 4K and 10K settings is 0.40, Fig. 13 shows what happens if and when *Access* is allowed to increase to 1.0, perfect access.

Figure 13 shows how easy it would be to get people into the program if somehow one could plan the time and location of the program to give the potential recruits access to the program.

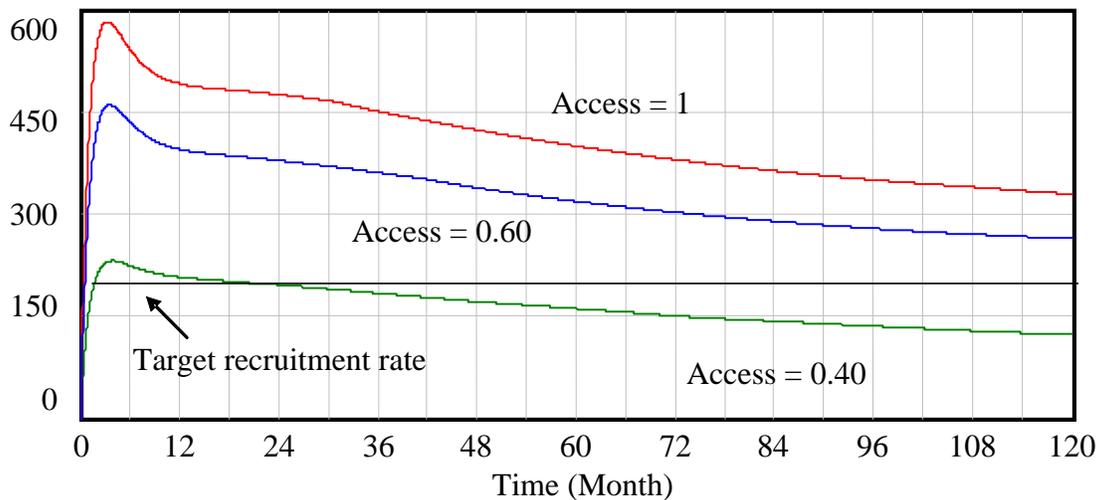


Fig. 13 Yearly estimate of recruitment rate at different degrees of access

DISCUSSION

We present a model developed in an attempt to understand why HIV prevention agencies may find that they have difficulty in recruiting people for small-group programs. HIV-related agencies are increasingly being required to adopt small-group programs such as those that are in the CDC's compendium of effective programs and are also expected to serve adequate numbers of people through these programs to meet contractual obligations. Understanding how recruitment might work and the problems of recruitment is therefore essential to understanding how to make the policy of disseminating small-group programs feasible and likely to succeed in the long run.

In our models, we set the size of the target populations at 4,000 and 10,000, which should be adequate to keep the program going for many years. Unfortunately, recruitment fails. Why is this so? We have described several characteristics of this situation and several loop processes that cut down the recruitment rate. First, not all of the target population is interested in dealing with changing sexual habits, let alone enrolling in the program. The

fact that only a small proportion of the target population is ready and willing to pursue the program cuts down the size of the potential recruits considerably. The problem of a small number of ready recruits is especially difficult when a high proportion of the total group at-risk and which a program aims to target is unmotivated to change via the program. This basic reality highlights the importance of motivating people to pursue behavior change as a precondition for enrolling them in more intensive small-group programs⁴.

A second mechanism that impedes recruitment is represented by the three positive loops shown in Figure 2 when the loops are in collapse mode. Decreasing recruitment affects the size of the stocks downstream, such as the number of people who finish the program, are positive about the program, and are consistently or not consistently practicing safe sex. This part of the model seems to suggest that smaller numbers of people completing the program who have a positive experience decreases the influence of positive word of mouth. Simply, agencies do appear to benefit from satisfying people and producing sufficient numbers of satisfied people to attract others by word of mouth. At the same time, making sure that people who do not change their behavior have a good experience also serves to bolster the flow of people who might recycle themselves through the program. Although providing participants a good experience is important, our model also points to the limits of providing a good experience. At some point, agencies will enjoy diminishing rates of recruitment return on increased program satisfaction.

An important characteristic of the system is the fact that access to the program is often limited for those in the target population. Thus, in our model runs, *Access* was set at 0.4. Setting access to this value means that the potential number of people who would enter the program is reduced by 60 percent. It is simply reality that some agencies are not conveniently situated or cannot offer programs at time or on a schedule that is convenient to everyone who might desire to attend. However, from a practical point of view, our runs of the model demonstrate that increasing levels of access can be a fairly effective lever to push to improve recruitment and, ultimately, the number of people who benefit from the program.

One might hypothesize that there is a fatigue effect among potential recruits with respect to the diminishing returns of prolonged exposure to advertising. Our model can generate a decrease in recruitment very easily without positing a fatigue effect to advertising. Indeed, our model allows for word of mouth processes to increase their influence relative to the effect of advertising's influence over time. Indeed, in a simulation not described in this paper, word of mouth overtakes advertising in its influence in a population of size 400. Thus, our model suggests that advertising may become less influential, not because people become immune to it, but rather because others with whom they interact ultimately become a more important influence on behavior.

⁴ In sensitivity analyses not presented here, we find that increasing the proportion of the population who are motivated, holding other conditions constant, produces a pattern in which initially the program experiences excess demand. By about 2 years, however, recruitment falls below target levels.

Perhaps the most important insight gained from our model concerns the prevention program bottleneck problem. This problem is represented by the agency's limited capacity to offer the program to only a few people at a time over the 10 year period. Small-group programs such as the one we model here generally run for a period of weeks and can accommodate only a small number of people at a time (e.g., 20-25 participants). No matter how large the target population of a single program may be, those individuals must still fit through the very small bottleneck of about 25 available program slots as these become available about every 8 weeks or so. This does not generate a lot of people downstream to say nice things about the program to improve recruitment. It also limits the number of people whose behavior could be changed. Indeed, the bottleneck highlights a conundrum for the field of HIV prevention: If the crème de la crème of prevention programs from an effectiveness standpoint appears to be fairly inefficient in its reach, what are we to do? It would take hundreds and hundreds of agencies offering multiple programs of this type over many years to ever affect enough people to turn the tide of the epidemic, or so our model suggests. Disseminating more efficient and equivalently effective programs seems to be an essential direction for AIDS prevention policy.

Limitations

Our work is not without limitations, three of which merit mention here. First, our model has not yet been verified. Although we are encouraged that we can reproduce patterns that are frequently observed in the field and that our results are logical, our model must clearly pass through more extensive verification tests before we can have complete confidence in its lessons.

A second limitation of our model concerns the fact that we have modeled what is a discrete process as if it were continuous. Clients entering HIV prevention programs of the type we are concerned with cannot begin the program and graduate from it on a continuous basis, as we have represented it here. Rather, a more typical pattern is that every 8 weeks or so, a new program starts and prospective clients must wait for several weeks for their program to begin. Although we do have a delay in our model to approximate a more discrete process, we ought to explore a more accurate representation of this part of the process. Of course, we should also note that representing this process is likely to make recruitment problems appear more severe than we have represented here.

A final limitation of note has to do with the fact that the size of our target populations – 4,000 and 10,000, is probably a great deal smaller than some agencies working in epicenter cities are likely to deal with. For instance, the size the sexually active gay male population or adult population of African-American heterosexual women in cities such as New York, San Francisco, Miami, Houston, Dallas, Chicago, Los Angeles, or Atlanta, to name but a few, are significantly larger than 10,000 in size. Clearly we must examine how our model behaves in the face of much larger target populations. However, we note that the bottleneck for many agencies will not open much wider, even in these larger environments. In this sense, the results we present here are still informative for larger communities.

Future Directions

Our model represents the dynamics of recruiting clients into a program and focuses on the lack of demand for these programs. In focusing on this process, we have not included mechanisms that have to come in to play when demand goes in the opposite direction, namely, when programs have too much demand. In future work, we will include these mechanisms, (e.g. having waiting lists, scheduling simultaneous session for multiple groups) in an extended version of the model. Additionally, as we said at the outset, the model we present here is just a small part of a larger model to examine the interrelationships among resources and program complexity. Our future work will consider interactions among these processes and client recruitment.

Another area for future investigation concerns our explicit consideration of the fact that recruitment can also be diminished if the program, originally developed as a research demonstration project on one group or population, is applied to a target population that is quite different from the population used in the study. We have such a variable in our model, but in the set of runs reported here, we assumed a perfect match between the target population for whom the program was originally designed and those who are being recruited. In the real world matches will not be so nearly perfect. Those who participate in research experiments may be different from those who seek services outside of a research context. This condition will also reduce the size of the potential recruits.

Finally, the sector of our model described in this paper focuses mainly on changing the quality of experience and says little about the process of changing effectiveness or acquisition of additional resources. For instance, fidelity is a critical notion. Fidelity refers to how well an agency applies all of the facets of the original evidence-based program. Deviating from the original program protocol may diminish the effectiveness of the program. So, an agency that follows the recruitment monitoring policy may try to deviate from the prescribed 8-week program by shortening it to 6 or fewer weeks, thus being able to bring in a larger number of people per year. Likewise, an agency that follows the graduation monitoring policy, which under some conditions can generate a good supply of finishers, as well as recruits, might try to shorten the program by reducing the number of sessions to get more potential finishers. Yet, shortening the program would reduce its fidelity and presumably its effectiveness. Exploring the linkages among fidelity processes, resources, and recruitment is a particularly fruitful avenue for future investigation and one we have already begun to pursue.

In conclusion, our model has helped us to clarify the difficulties of having a small-group workshop program. Indeed, it appears to be very inefficient from the standpoint of being able to reach sizeable numbers of people at risk over a span of 10 years and suggests recruitment outcomes that are counter to many agencies' hopes to reach as many people as possible as quickly as possible. The model teased apart and put together a number of processes that account for a reference mode in which recruitment is difficult. Indeed, the model helps to understand the formation of a bottleneck early in the recruitment chain, as well as the problems associated with high numbers of people who are unmotivated to use programs such as this one. Mechanisms to deal with the problem of low demand for the

program were proven ineffective in this parameterization of the model, the values of which match the parameter values found in agencies of this type. Most importantly, the model points out that the advantages of evidence-based small-group programs, which are disseminated because they are efficacious, may lose their advantages because contractual arrangements may distract agencies from monitoring effectiveness. Further, the constraints associated with the program's design may seriously limit its efficiency in even modestly sized communities.

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