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**UNDERSTANDING THE DYNAMICS OF PREVENTION, CARE, AND
EMPOWERMENT: A SYSTEMS APPROACH TO HIV/AIDS POLICY INNOVATION**

VOLUME I

By

David William Lounsbury

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ABSTRACT

UNDERSTANDING THE DYNAMICS OF PREVENTION, CARE, AND EMPOWERMENT: A SYSTEMS APPROACH TO HIV/AIDS POLICY INNOVATION

By

David William Lounsbury

A system dynamics model comprised of fifteen constructs was built for the purpose of fostering a greater understanding about the psychosocial dynamics of HIV/AIDS prevention and care in the community over a twenty-year time horizon, from the epidemic's inception (circa 1981) to the present (2001). In particular, the psychosocial dynamics of perceived stigma, complacency, and [dis]empowerment were studied in relation to the epidemiology of HIV/AIDS in Michigan. Applying a 'systems approach,' the study was informed by the results of an extensive qualitative research project that explored the current and emerging needs of persons living with HIV/AIDS (PLWHA) and by the insight and knowledge of a group of ten (N=10) core key informants from Michigan's HIV community.

The underlying dynamics of the problem focus in the study were expressed in a set of five key causal processes. These processes were named as follows: (1) the perceived stigma process; (2) the care complacency process; (3) the prevention complacency process; (4) the community empowerment process; and (5) the resource allocation process. Causal loop diagrams and descriptive narratives were used to explain the base case model's system of feedback structures. In addition, simulation output for selected constructs from these causal loop diagrams presented the model's behavior over time. Results of the model validation process were favorable. A comparative analysis of *simulated* to *empirically grounded* reference modes showed that the base case model

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effectively reproduced trends in HIV/AIDS prevalence and mortality, prevention and care funding, prevention and care service system quality, and HIV/AIDS-related stigma.

Questionable, yet plausible, model behavior was found for HIV incidence and complacency.

Interpretation of model behavior suggested a number potentially compelling policy studies, among them a need to promote greater *system change action* as a lever for *empowerment* of PLWHA. In particular, the model suggested a need for interventions that help undiagnosed persons learn about their serostatus and become engaged in a program of care as quickly as possible. Once within the care system, model behavior indicated that PLWHA appear to exhibit higher levels of system change action that, in turn, can improve the quality of both prevention and care services over time. However, the dynamic structure that facilitates system change action was dependent upon high levels of PLWHA *dissatisfaction*, or frustration, with the quality of available HIV/AIDS services. With respect to this finding, it is suggested that future policy analyses explore ways of sustaining PLWHA system change action that is not dependent upon high levels *dissatisfaction* with services.

Initial feedback from members of Michigan's HIV community affirmed that the base case model has provided deeper insight into the underlying challenges of HIV/AIDS prevention and care by generating an explicit picture of the dynamic complexity of particular psychosocial constructs. In addition, it was also affirmed that the 'systems approach' helped create space for the candid exchange of ideas about how to effectively intervene in the course of the epidemic in the near future.

To the Michigan PWA Task Force

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I would also like to acknowledge the support and guidance I received from my program's core faculty, namely Drs. Bill Davidson (dissertation co-chair), Debby Salem, Tom Reischl, Pennie Foster-Fishman, and Cris Sullivan. Their commitment to allowing students to 'learn to learn' in their own way and in their own time is a subtle application of 'empowerment theory' that I admittedly did not always understand or appreciate until now. Outside of Psychology, I would like to acknowledge Dr. Kim Chung (dissertation committee member) for all that she taught me about the process and the product of qualitative and participatory research methods; Dr. Dozier Thornton (dissertation

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committee member) for his steady, confident, and reflective manner of encouraging me in my work; Drs. Bertram Stöffelmayr and Brian Mavis for the learning opportunity they created for me on the Health Care Study Project, which introduced me to the complexities of conducting large scale community-wide program evaluations; and Dr. Nigel Paneth for his expert teaching of the fundamentals of epidemiology, which I applied in multiple ways in this study.

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INTRODUCTION

HIV/AIDS is a Complex Problem

Twenty years have passed since the Centers for Disease Control and Prevention (CDC) reported the unsettling news of five deaths in Los Angeles from Pneumocystis Carinii Pneumonia (PCP) (CDC, 1981), the event that marked the beginning of a worldwide battle against Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome (HIV/AIDS). Since then numerous, co-existing epidemics have emerged in throughout the globe – some of them highly volatile – all of them compromising the health and well-being of the communities they impact. *Sexual behaviors* (particularly unprotected sex between men) (Adib & Ostrow, 1991; Aggleton, 1998; CDC, 2000; CDC, 2001c; Katz, 1997; Schiltz & Sandfort, 2000), *substance use* (particularly injecting drug use) (Dennis, Fetterman, & Sechirest, 1994; Foege, 1983; Friedmann, D'Aunno, Jin, & Alexander, 2000; Hostetler & Fisher, 1997; Kretzschamar & Wiessing, 1998; Plumridge & Chetwynd, 1998), and distribution of *contaminated blood products* (particularly within the hemophilia community) (Feldman & Bayer, 1999; Setbon, 1993) are events that carry a substantial amount of explanatory power with respect to understanding the genesis and expansion of these epidemics over time.

Yet these reasons alone do not adequately explain current patterns of HIV/AIDS burden. An epidemic is a dynamic process that, as Doka (1997) explains in the following passage, involves time, place, biology, and society:

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Diseases are more than biological phenomena or individual catastrophes. They are profoundly social events. In many cases, the disease emerges and spreads because changing social conditions trouble the fragile balances that exist between humans and their diseases. In other situations, a disease is perceived or recognized in a distinct way, reflecting new social conditions and forces. In all cases, the ways in which a disease is spread and treated are strongly influenced by larger sociological considerations. And the emergence of new, or newly perceived, diseases is likely to change social institutions and perhaps society itself (p. xiv).

With respect to HIV/AIDS, *psychosocial* factors, namely *stigma*, *complacency*, and *[dis]empowerment*, need to be explicitly taken into consideration in the design of HIV/AIDS-related interventions (Aday, 1993; Doka, 1997; IOM, 2001; Mann & Tarantola, 1996). In particular, these factors have been associated with social context challenged by *racism* (Bayne-Smith, 1996; Chesler, 1981; Cohen & Northridge, 2000; Geronimus, 2000; Ostrow, 1999; Randolph & Banks, 1993), *homophobia/heterosexism* (Gayle, 2000; Herek & Greene, 1995; Perreault & Bourhis, 1999), *gender inequities* (Aranda-Naranjo, Portillo, Scheitinger, & Norgan, 2000; Bayne-Smith, 1996; Bond & Pyle, 1998; Campbell, 1995; Flaskerud & Nyamathi, 2000; Fullilove, Fullilove, Stevens, & Green, 2000; Gaston, Barrett, Johnson, & Epstein, 1998; Gómez & Meacham, 1998; O'Campo, Fogarty, & Gielen, 1999; Reagon, 1983; Wingood & DiClemente, 2000; Zierler & Krieger, 1997), *politics* (Altman, 1994; Cohen & Northridge, 2000; Dluhy, 1981; Ron & Rogers, 1989; Shilts, 1987; Weniger & Berkley, 1996), *religious intolerance* (Craigie, 1998; Kowalewski, 1990), and *poverty* (Altman, Reinhardt, & Shields, 1998; Flaskerud & Nyamathi, 2000; Gaston et al., 1998; Montoya, Trevino, & Kreitz, 1999; Wolfberg, 2000; Zierler et al., 2000). The point to be made here is that interventions intended to address the problem of HIV/AIDS are not likely to be effective if they do not address the complexities of the psychosocial context in which the epidemic

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HIV/AIDS is a Simple Problem

Despite these complexities, the actual nature, or character, of any given solution to the problem of HIV/AIDS, or any other epidemic for that matter, is simple. There are two general approaches, namely: (1) *prevention* and (2) *care*. Both have been proven to work if the right 'mix' is available (ACDP, 1999; CDC, 1997a; Jemmott, Jemmott, & Fong, 1992; Jemmott, Jemmott, & Fong, 1998; Kegeles, Hays, & Coates, 1996; Valdiserri, Lyter, & Leviton, 1989). In general, we want to prevent new cases of HIV infection and we want to develop and make accessible treatments that sustain quality of life for those who may already be positive. There is a need to strike a good balance, to integrate preventative measures into care services and *visa versa*, to foster HIV/AIDS *prevention through care*, and *care through prevention* (Altman, 1994; CDC, 1999a; Delor & Hubert, 2000; Doka, 1997; IOM, 2001; Labonte, 1994; Mann & Tarantola, 1996; Morin, Coates, & Shriver, 2000; Plumridge & Chetwynd, 1998). To begin to understand the challenge inferred by this statement, a review of the HIV/AIDS epidemic's *stages of intervention* is important to keep in mind. Reflecting on the relatively short history of HIV/AIDS, it appears that the norm for community intervention has been either prevention-focused or care-focused, but not an integration of both (CDC, 1993; CDC, 1997a; CDC, 1997b; CDC, 2000; Falck, Carlson, Price, & Turner, 1994; Morin et al., 2000; Schwartz, Dilley, & Sorensen, 1994).

Stages of Intervention

Although a critical understanding of the meaning of our collective response to the HIV/AIDS crisis is just now emerging in the social sciences, a number of retrospectives

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have already been offered. So far, an historical unfolding of HIV/AIDS has been viewed in terms of three to four 'phases,' or stages, of societal reaction spanning a twenty-year period (1981 to 2001). For example, Mann and Tarantola (1996) have labeled three periods, namely: (1) the 'period of discovery' (1981-1984), (2) the 'period of early response' (1985-1988), and (3) the 'current period' (1989 to 1996). More recently, Rosenbrock et al. (2000) have labeled four periods, the first three of which more or less correspond to Mann and Tarantola's. Rosenbrock et al.'s phases include the following: (1) 'emergence of exceptionalism' (1981-1986), (2) the 'consolidation and performance of exceptionalism' (1986-1991), (3) the 'exceptionalism crumbling, steps toward normalization' (1991-1996), and (4) 'normalization, normality' (since 1996).

To some extent, these stages can be seen as political in nature. Taking an historical perspective on health and healthcare, Levine and Levine (1970) would argue that, for example, the perceived need for deployment of preventative strategies over medical strategies to address the problem of HIV/AIDS could be explained largely in sociopolitical terms. In general, they have observed that there is a tendency to cycle between 'environmental' explanations and 'person' explanations of the causes of social problems and that these cycles typically coincide with current political sentiments.

In their review of a wide range of community health issues, Levine and Levine (1970) observed that when the climate of the times is *politically liberal*, the environment, or the system, is held at fault and interventions emphasize prevention over care. In contrast, when the climate of the times is *politically conservative*, the person, or the individual, is held at fault and interventions tend to emphasize care, or treatment, over prevention. The Kennedy-Johnson War on Poverty era is a case in point (Levitan, 1969).

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During the relatively liberal climate of the 1960s and the 1970s, considerable attention was given to prevention and the need to expand access to better health, education, and other community services (DHEW, 1979). In contrast, during the 1980s, with Ronald Reagan in Washington and Margaret Thatcher in London, it is generally agreed that public institutions were slow to address the needs of persons and communities affected by HIV/AIDS and that, in particular, the federal government had resisted implementing prevention and care programs that would have specifically benefited persons living with HIV/AIDS (PLWHA) (Perrow & Guillen, 1990; Shilts, 1987; Sundwall & Bailey, 1988). The following text elaborates further on the meaning of Mann and Tarantola's and Rosenbrock et al.'s proposed stages of intervention.

Discovery/Emergence of Exceptionalism

Until the appearance of HIV/AIDS, it appeared that medical science would continue to enjoy increased success in a variety of initiatives, such as: (1) elimination of the threat of infectious disease, (2) reduction of maternal and infant mortality rates, (3) improved quality of life, and (4) extended longevity for a larger proportion of the general population (Ashton & Seymour, 1988). 'Exceptionalism' emerged out of the quick realization that HIV/AIDS was a different kind of public health problem and therefore could not be effectively addressed through a traditional public health frame of reference (Rosenbrock et al., 2000; Rosenbrock, Friedrich, & Heckmann, 1995). At the start of the HIV/AIDS epidemic in the industrialized world, the attitude of the public health and medical establishment was that the age of infectious diseases had come to an end. The discovery of HIV/AIDS generated a climate of great uncertainty, which in turn motivated a very intensive period of exploratory research and development.

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Epidemiologists were the first to suggest that a new pathogen (i.e., HIV) existed and that particular behaviors were associated with increased risk of infection. This understanding facilitated the development and promotion of Knowledge, Attitudes, Beliefs, and Practices (KABP) toward AIDS and techniques for social marketing of 'safer sex' practices, including reducing the number of sexual partners and using condoms (Aggleton, O'Reilly, Slutkin, & Davies, 1994; Dearing et al., 1996). The main assumption of these interventions was that, to some extent, knowledge of risk would prompt behavior change.

Innovations from the 1960s, such as community mobilization and mass-media communication were used to guide KABP interventions (Altman, 1994). Towards the end of this period, and just one year after the official discovery of HIV, a set of guiding principles for primary prevention of HIV infection as well as for quality of care for PLWHA were established and declared in the Ottawa Charter for 'new public health,' which was proposed and adopted in 1986 at an international conference of thirty-eight countries (WHO, HWC, & CPHA, 1986). The Charter featured prevention and health promotion in conjunction medical treatment, and it called attention to the need for community-based health resources. At the heart of this process was the notion of empowerment of communities, which was to be operationalized as community ownership and control of the community's own endeavours and destinies.

Early Response/Consolidation and Performance of Exceptionalism

During the second period, the 'period of early response' (1985-1988), institutional responsiveness became the primary focus. Individual risk reduction initiatives remained a key objective, but they were now supported by selected health and social services. In

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many cases, these new services were the foundation upon which national AIDS programs were developed, many of them fostered by the guidance of the World Health Organization's Global Program on AIDS (WHO/GPA) (WHO, 1987). The Global Program on AIDS, in addition to promoting individual risk reduction strategies and 'institutionalization' of HIV/AIDS services, also called for non-discrimination towards HIV-infected people and people with AIDS, which may be attributed to the a general expectation that gay men and IDUs would remain the most affected by the epidemic. For the most part, substantial rates of increase in incidence and prevalence do not occur, although the urgency of the situation remains high and, as a result, exceptionalism is sustained (Rosenbrock et al., 2000).

Also during this period came the development of the earliest treatment protocols, but they were viewed as clearly separate and distinct from preventative activities (Chesney, Morin, & Sherr, 2000; Fenton & Peterman, 1997; Mann & Tarantola, 1996; NASTAD, 2001). AIDS care included development of programs that attempted to improve or sustain quality and availability of medical services and social support for individuals who were HIV-positive and their partners, families, and friends. In general, the needs of PLWHA during this period were of a palliative nature. Prevention interventions targeting PLWHA seemed unnecessary and risked being perceived as *victim-blaming* (Rosenbrock et al., 1995; Ryan, 1971).

Towards Normalization

According to Rosenbrock et al. (2000), during the period of normalization (1991-1996) HIV/AIDS turned into a 'chronic disease.' Among most industrialized countries, including the United States, epidemiological trends appeared stable and the infrastructure

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developed to provide prevention and care services underwent a process of consolidation. By the end of this period, what was once unfamiliar and very frightening seemed less so, which tended to cause the rate of HIV/AIDS innovation in both prevention and care to level off. Over time, public attention waned and began to shift to other priorities. A number of preceding processes explain how this occurred.

First, there was the renewed and increased pressure for tighter cost control in health care (WHO, 1996), which was to be promoted through market responsiveness and competition (Evans, 1997). The result of these forces was that PLWHA, particularly those of lower socioeconomic status, lost the attention that they had won during the earliest years of the epidemic (Gunn, Rolfs, Greenspan, Seidman, & Wasserheit, 1998; Mertens & Carael, 1997; Rosenbrock et al., 2000; Tarlach, 1998). However, funding was maintained or even increased as a result of commitment to ‘keep up the fight’ as well as increasing professionalization of services. Professionalization, or institutionalization, was the process whereby organizations ‘normalized’ themselves (Rosenbrock et al., 2000).

Also during this period the grassroots organizers who had stepped up in the early years began to leave due to burnout, which often took the form of serious health problems and death – given that many of these pioneers were themselves living with HIV/AIDS (Bayer & Oppenheimer, 1998; Kleiber, Enzmann, & Gusy, 1995). Overall, the effect was that an exceptional ‘activist’ zeitgeist dissipated in many locations. It was at this time, however, that Mann and Tarantola (1996), among others (Mane et al., 1996), stepped up initiatives to further extend care services to PLWHA and to renew commitment to the fight against HIV/AIDS. In particular, the Coalition began a campaign to call attention to the reality that current approaches were insufficient and that there was a need to go

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beyond traditional models of public health to address the societal dimensions of 'vulnerability' to HIV, such as poverty, stigma, and complacency.

In fact, it was various forms of complacency that Rosenbrock et al. (2000) argue impelled further normalization of the HIV/AIDS problem. They underscore that the 'horror scenarios' of rapidly spreading HIV that were originally forecast did not materialize. In general, epidemiological patterns of incidence and prevalence in the most affluent parts of the world remained constant. MSM and IDU continued to be the most affected populations, which strengthened the perception that prevention was 'working' because the impact on the larger, mainstream population remained small.

The most salient process contributing to the complacency was arguably initiated by widespread access to new, relatively effective anti-retroviral drugs in 1995. For the first time in the history of the epidemic the health of PLWHA was improved. Until this point, HIV/AIDS exceptionalism had been more or less preserved by the fact that the biomedical model was 'on the defensive.' The positive impact of anti-retroviral treatments was cause to relax a little. As new drugs became available and combination therapies were developed and shown to be ever more effective, HIV/AIDS began to be portrayed as a chronic illness. The dropping mortality rates as well as self-reports by PLWHA about the health benefits of the new treatments were taken as firm testimony of this fact (Patella et al., 1998).

Normalization

Rosenbrock et al. (2000) describe the period from 1996 to 2000 as revealing of two processes of normalization: (1) normalization in the form of cutbacks and (2) normalization as a generalization of exceptionalism. With respect to normalization in the

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form of cutbacks, AIDS-related task forces and specific agencies continued to be cut back or (re)integrated in normal hierarchic, bureaucratic organizations (Cattacin, 1998). For Michigan, a case in point would be the placement of the Michigan Department of Community Health's HIV/AIDS Intervention and Prevention Section (MDCH/HAPIS) into a sub-department of the MDCH's Sexually Transmitted Disease unit (MDCH/STD). The combined division is now referred to as 'MCDH/STD&HIV-AIDS/HAPIS.' What once stood alone, is now under the oversight of a larger, pre-existing division. Here, as in other locations, efforts to be more reflexive and cost efficient have translated into reduced or level funding for prevention, surveillance, and research (Foster, Gregory, Niederhausen, Rapallo, & Westmoreland, 1999).

With respect to normalization as a generalization of exceptionalism, some HIV/AIDS-related innovations have been widely adopted and, as a result, firmly institutionalized. The implications of these processes appear to have affected prevention more than care. In general, HIV/AIDS prevention programs within industrialized countries are held to be one of the most successful cases of broadbased behavior modification in the history of public health (Rosenbrock et al., 2000). The relative success of these prevention efforts is attributed to the dissemination of 'safer sex' and 'safe use' messages that were delivered through community-based approaches in a socially- and culturally-competent manner (CDC, 1997b; CDC, 1999a). This has been possible because of the interdisciplinary nature of HIV prevention science. Knowledge from a variety of fields, including biology, behavioral science, sociology, and program evaluation have contributed to the success of such programs during this period. This perception of success, as well as the re-encroachment of the medical model, which has

been facilitated by the relative success of HIV/AIDS anti-retroviral therapies over the last five years, are largest threats to the success of future HIV prevention innovations and interventions (Carpenter et al., 2000; Gallant, 2000; Harrington & Carpenter, 2000).

Overview of the Purpose and Methodology of the Study

Attending to the full period of time covered by these various stages of intervention (circa 1981 to 2001), the purpose of the study was to work in a participatory manner with a small group of HIV/AIDS prevention and care advocates from Michigan *to build a model for understanding the psychosocial dynamics of prevention and care in the community*. The need to create such a model was articulated in a preceding, qualitative research project that identified and described the current and emerging challenges facing PLWHA in Michigan (Lounsbury, 2001b). The small group of advocates involved in the study was comprised of persons who were familiar and active members of Michigan's HIV community (i.e., the community of persons involved in the design, delivery, consumption, and/or evaluation of HIV/AIDS prevention and care interventions in the state). The model that was build was intended to be of use as a policy analysis tool for Michigan's as well as other states' HIV communities. In general, the model was created to inform policy that could help achieve the following three overarching goals: (1) reduction of new HIV infections among all susceptible groups, (2) improved health and well-being among all PLWHA, and (3) increased efficiency and sustainability of HIV/AIDS-related services.

The study was qualitative in nature and applied a 'systems dynamics approach,' a research methodology explicitly intended to promote in-depth learning about dynamically complex problems (Ford, 1999; Forrester, 1961a; Forrester, 1961b; Forrester, 1971;

Forrester, 1987a; Sterman, 1994; Sterman, 2000). Essentially, system dynamics is about *building a model* that simulates *change* (i.e., decisions and/or actions) which are thought to be responsible thought to be causally related to a specified *problem*. The problem focus is typically defined in terms of trends in one or more constructs over a specified period of time. The dynamics of these trends can be represented by a set of *causal loop diagrams*, which can be translated into a system of *interdependent mathematical structures* (i.e., the system dynamics model).

The validity of any given system dynamics model can be assessed in terms of the extent to which it is accepted with confidence by members of the audience or population for which it was created. In a successful system dynamics study, confidence in the model accumulates gradually over time as its behavior “passes more tests and as new points of correspondence between the model and empirical reality are identified” (Forrester & Senge, 1980, p. 209). In this sense, system dynamics models are validated through the *participatory nature of the model-testing process*.

Once the model has been validated by its intended audience, it may be used to conduct any number of *virtual policy experiments*. Effective policy experiments are ones that organize a procedure for testing hypotheses, informed by insights gained from the system dynamics model itself, about *interventions* that might be used to correct or diminish the problematic trends of focus in the near future (Forrester, 1994b; Lane, 1992). In turn, the results of these policy experiments can be used to implement effective *policy innovation in the real world*. The system dynamics approach to policy innovation has been shown to enhance and make more productive the *cycle of learning and action* that takes place among members of work groups, organizations, and communities as

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problems of common concern or interest are addressed (Andersen, Richardson, & Vennix, 1997; Coyle, 1998; Forrester, 1994a; Law & Kelton, 1991 or 2001; Levine & Fitzgerald, 1992; Morecroft & Sterman, 1994; Vennix, 1996; Winch, 1993).

In summary, the purpose and methodology of the current study are inextricably linked together in a process of *modeling for understanding*. More detail about how the study's process of modeling for understanding was carried out will be presented in Chapter 3. Before getting to that, Chapter 1 provides a comprehensive description of the study's three conceptual domains of focus and Chapter 2 provides additional context about the 'systems approach.'

CHAPTER 1

DOMAINS OF FOCUS

The study calls attention to three conceptual domains, namely: (1) *epidemiological burden*, (2) *HIV/AIDS intervention*, and (3) *psychosocial vulnerability*. Drawing from the disciplines of public health, epidemiology, community psychology, and system dynamics, the remainder of Chapter 1 presents a review of recent literature and, in particular, salient findings from a qualitative research project that identified and described the current and emerging challenges facing PLWHA in Michigan (Lounsbury, 2001b).

Epidemiological Burden

The *epidemiological burden* domain calls attention to the dynamic relationship between the population of persons who are *HIV susceptible* (i.e., HIV-negative) and the population of those *living with HIV/AIDS* (i.e., HIV-positive). In general, as the number of PLWHA in any given community increases, the likelihood of exposure to HIV among those who are yet uninfected also increases. It is a truism that for every new case of HIV infection, at least one PLWHA was intimately involved, either through sexual behavior, needle sharing, or some other manner by which bodily fluids that carry HIV could be exchanged.

HIV/AIDS has already been affirmed as the latest entry on a relatively short list of ‘great epidemics.’ These have included the pandemics of bubonic plague (6th and 13th centuries, 1894-1919) and the various epidemics of yellow fever, typhus, typhoid, and

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cholera, all of which caused vast devastation. Winslow (1943), for example, estimated that mortality due to the bubonic plague from 1347-1350 affected no less than 25% and possibly as much as 75% of the population of Europe. The plague, like most epidemics, was self-limiting. Over time, the disease accounted for such a high rate of mortality that its ability to spread slowed. Among those who survived, a total or partial immunity was generated, which further restricted transmission. Some epidemiologists believe that sub-Saharan African, which has the highest prevalence of HIV/AIDS in the world, is beginning to manifest this effect. For the first time, there appears to be a leveling off, or decrease, in the number of PLWHA in that region (UNAIDS, 2000).

Comparing the dynamics of HIV/AIDS in various locations throughout the world, two prominent, or global, epidemiological trends appear to describe most, if not all, of today's HIV/AIDS epidemics. First, the number of PLWHA in any given region of the world continues to increase (Mann & Tarantola, 1996; UNAIDS, 2000). Second, the concentration of cases of HIV infection among populations that are socially most vulnerable has become ever more abject (Aranda-Naranjo et al., 2000; CDC, 1998b; Delor & Hubert, 2000; Finkelstein, Greenberg, & Lubinski, 2000; Fullilove et al., 2000; Mann & Tarantola, 1996). The following text provides an overview of current estimates of prevalence and incidence, disease progression, and trends in co-occurring conditions.

Current Estimates of HIV/AIDS Prevalence and Incidence

Worldwide HIV/AIDS estimates. Stepping back to examine the pandemic as a whole, current surveillance data indicate that HIV is spreading much faster than expected. According to recent assessments by the World Health Organization (WHO, 2001), the number of PLWHA today is more than 50% higher than was projected in 1991. It is now

estimated that approximately 51 million people have been infected with Human Immunodeficiency Virus (HIV) worldwide, 15 million (29%) of whom have already lost their lives due to complications associated with AIDS and 36 million (71%) of whom are currently living with HIV/AIDS. In terms of worldwide incidence, an average of 16,000 new cases are expected each day (i.e., approximately six million new cases per year) (AAWH, 2000).

United States HIV/AIDS estimates. In the United States, the cumulative number of reported AIDS cases in the United States as of December 2000 was 733,374 and the total reported AIDS-related deaths was 430,441 (59%). This included 425,357 adults and adolescents, and 5,084 children under age 13. Incidence in the U.S. remains flat for the fourth year in a row at approximately 40,000 new infections. Overall, there are more PLWHA in the United States today than ever before (CDC, 2001c; CDC, 2001d).

Michigan's HIV/AIDS profile. The Michigan Department of Community Health's (MDCH) Bureau of Epidemiology estimates that there are 13,000 persons currently living with HIV/AIDS, the majority of whom (69%) reside in the Detroit metropolitan area. Most of the remaining 31% live in or around other urban areas of the state (i.e., Lansing, Grand Rapids, Kalamazoo, Flint, Saginaw, Traverse City, and Ann Arbor), although PLWHA reside in each of Michigan's 83 counties. The number of new cases of HIV infection remained level from 1994 through 1998 at approximately 1,100 to 1,200 cases annually. More than 4,400 persons living with HIV are currently reported to have an AIDS diagnosis. The number of AIDS deaths decreased 67% between 1995 and 1998. The drop in mortality is attributed to greater access to earlier medical intervention and to more effective HIV/AIDS anti-retroviral therapies, first available in the U.S. in

1995. As a result of both flat HIV incidence and increasing longevity, the prevalence of HIV/AIDS among persons living in Michigan continues to rise each year. The following text provides a breakdown of Michigan's current epidemiology by risk, race, gender, age, and mortality (MDCH, 1999; MDCH, 2000a).

Risk. The majority of persons infected with HIV/AIDS (52%) continue to be men who have sex with men (MSM). Injecting drug users (IDUs) comprise 24% of total reported cases. Another 5% of reported cases are MSM who also inject drugs. These proportions have not changed since 1995. While IDU continues to be a significant risk, the number of cases of HIV attributable to injecting drug use decreased from 300 new infections in 1994 to 250 new infections in 1998. Heterosexual transmission is the sole mode of transmission with a definite upward trend. MDCH estimates that the annual number of new HIV diagnoses attributable to heterosexual transmission increased from 150 to 200 annually from 1994 to 1998 and the proportion of cases attributable to heterosexual transmission is increasing, from 14% in 1994 to 19% in 1999.

Race. Black persons comprise the majority of those living with HIV/AIDS in Michigan. They comprise 14% of Michigan's population yet make up over half (58%) of the cases of HIV/AIDS. MDCH estimates 7,560 blacks live with HIV/AIDS in Michigan and that the number of new HIV infections annually among blacks increased from 700 to 750 between 1994 and 1998. The rate of HIV infection among blacks is 589 per 100,000 population, nine times higher than the rate among whites. These increases are occurring in black women through heterosexual transmission, and in black men who report MSM. The marked declines in HIV-related deaths seen throughout the country since 1995 were also seen in Michigan. However, this decline was more rapid among whites (71%)

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compared with blacks (62%). The number of cases in Hispanics now accounts for 4% of total reported cases, up from 3%. Rates of infection among all other racial groups are too small to measure over time.

Gender. Men account for 78% of reported HIV/AIDS cases and women account for 22% of cases. The rate of infection for men is three-and-a-half times greater than that for women. However, the rate of infection among women is increasing faster than among men. Women account for over two-thirds of the cases attributable to heterosexual transmission. While women account for 22% of all reported HIV/AIDS cases in Michigan, they have consistently accounted for over two-thirds of heterosexually acquired infections – currently 70%.

Trends in new HIV diagnoses among men and women show different patterns. The number of men newly diagnosed with HIV each year is decreasing from about 900 new infections a year to 850. Among women, the number appears to have increased from 200 to 250. Among women reported with HIV/AIDS and a known risk, half (50%) of the cases are contracted heterosexually. In comparison, 45% were infected through IDU. Among women with a known risk, 22% are IDUs who also had high-risk heterosexual sex partners (i.e., persons whose partners had multiple sex partners, were IDU, had one or more sexually-transmitted diseases [STDs], or who were already known to be HIV-positive). These data underscore the point that these two modes of transmission are closely intertwined for women.

Age. The number of adults age 45 or older reported as HIV-positive in Michigan is increasing (from 200 to 250 reported cases each year). The number of persons newly diagnosed in the age group 25-34 is declining, with diagnoses in other age groups

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remaining level. Children and adolescents continue to account for 2% of reported cases. The number of vertical transmissions of HIV (i.e., mother to infant) has decreased from 25% in 1992 to 3% in 1998. As of April 1, 2000, two of the 62 children born to HIV-infected women in 1998 in Michigan have been diagnosed with HIV infection. These decreases are directly attributable to an increase in the use of Zidovudine (ZDU) prophylaxis during pregnancy, delivery, and/or to the newborn shortly after birth.

Mortality. The number of HIV-related deaths in Michigan declined 67% between 1995 and 1998. The decline occurred among whites (71%), blacks (62%), men (68%) and women (51%). Although mortality dropped throughout this period, the greatest decreases occurred in 1996 and 1997. The marked decline in HIV-related deaths seen throughout the country (as in Michigan) since 1995 was greater among men (68%) than women (51%).

Disease Progression and Mortality

Pre-HAART. Before the introduction of HAART (Highly Active Anti-retroviral Therapy) studies indicated that, in the absence of treatment, half of all HIV-infected people will develop AIDS within nine years after infection (Hendriks et al., 1993). Few, however, will develop AIDS during the first two years of infection. Thereafter, the annual rate of developing AIDS was estimated to increase from about 3% in third year to 9% in seventh year (Lifson et al., 1991). Early studies on the progression from HIV infection to AIDS showed rates of approximately 5% to 6% per year (Aalen, Farewell, De Angelis, Day, & Gill, 1997; Goedert et al., 1989; Lee et al., 1989; Mulder, 1996). These rates suggested a median AIDS-free period of approximately 11 years among reported cases of HIV infection (Mulder, 1996). Some infected individuals have, however, remained

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apparently healthy for more than 15 years with little or no clinical therapy. In general, studies of AIDS among adults in more industrialized countries suggest that survival rates have gradually improved (Mulder, 1996).

Post-HAART. By the late 1980s the median survival after AIDS diagnosis was approximately 18 months (Lemp, Payne, Neal, & Rutherford, 1990; Whitman-Overton, Tillett, Evans, & Alladice, 1993). The slowing of disease progression and mortality was attributed to increased availability and use of new anti-retroviral treatments, such as AZT, and to more effective means of preventing and controlling PCP (Gardner et al., 1992; Lemp et al., 1990). HAART came into widespread use in North America, Europe, and Australia during late 1996 and early 1997. Since then mortality rates from AIDS have fallen dramatically in these locations (Carpenter et al., 2000; Gallant, 2000; Patella et al., 1998). Long-term health impact of HAART has not yet been established (Kelly, Otto-Salaj, Sikkema, Pinkerton, & Bloom, 1998). However, based on known risks and benefits, it is believed that if CD4-cell counts and viral load are monitored carefully, and if HAART is started when the CD4-cell count drops below 350 cells/mU/l, then damage to the immune system and progression to AIDS and death can be greatly delayed or prevented (Gallant, 2000; Harrington & Carpenter, 2000). In general, there is a need for careful balance in use of HAART. If HAART is started too early, the cumulative side-effects of the drugs used, including the development of multi-drug resistance, may outweigh the net benefits of the lengthening of life (Chesney et al., 2000; Harrington & Carpenter, 2000).

Trends in Co-occurring Conditions

A variety of co-morbid and co-occurring conditions have complicated the

treatment of HIV/AIDS. HIV/AIDS co-morbidities include *physical diseases* such as Tuberculosis (TB), viral hepatitis, STDs [e.g., herpes, syphilis, human papillomavirus, crabs, chlamydia, gonorrhea], *mental health problems* (both severe and moderate) (Anderson, 1998; Farley, Kahn, Johnson, & Cohen, 2000; Gunn et al., 1998; Meredith et al., 1998; Mertens & Carael, 1997; Pettifor, Wilkins, & Raghunathan, 2000; Rietmeijer, Bull, Ortiz, Leroux, & Douglas, 1998; Rothenberg, Wassweheit, St. Louis, & Douglas, 2000; Tarlach, 1998), *behavioral problems*, such as substance abuse (including alcohol problems (AED, 1997; Diamond & Buskin, 2000; Finkelstein et al., 2000; Garnett & Anderson, 1996; Hostetler & Fisher, 1997; Marks, Bingham, & Duval, 1998; Morris & Dean, 1994; Plumridge & Chetwynd, 1998), and *social conditions* such as unemployment (Geronimus, 2000; Henderson, 1998) and incarceration (Braithewaite, Hammett, & Mayberry, 1996; Gani, Yakowitz, & Blount, 1997; Hammett, Rhodes, & Harmon, 1999; Rotily & Weilandt, 2000). The three most challenging co-morbidity conditions found among PLWHA in Michigan, as in most other states, are Hepatitis C (HVC), substance abuse, and mental health problems (Lounsbury, 2001b).

Hepatitis C. Nationwide, Hepatitis C (HCV) is now four times more common than HIV/AIDS, which has increased the likelihood of HCV exposure among PLWHA (CDC, 2001c). Because it is usually transmitted percutaneously, often through sharing equipment between drug users, most new infections of HCV are among young adults age 20-39. PLWHA and HCV often face accelerated progression of liver disease and cirrhosis and may have a more limited tolerance for anti-retroviral therapies, given that many of the treatments have hepatic side effects (Ostrow, 1999).

Substance abuse and mental health challenges. A growing number of newly

diagnosed clients present with substance abuse and/or mental health problems (IOM, 1997; NRC & IOM, 1995). IDU are primarily infected through sharing of contaminated injection equipment. Use of non-injectable drugs, such as alcohol, crack cocaine, methamphetamines, and inhalants impair decision-making, thereby increasing the potential for HIV-related risk behaviors (IOM, 1997). For persons who are substance users or who have mental health problems, the physical as well as the psychosocial stress of managing HIV disease can be overwhelming (Collins & Reed, 1994; Friedmann et al., 2000; Meyerson, 1999). Substance abuse, such as excessive consumption of alcohol, may be one way to attempt to cope with the extenuating life circumstances presented by HIV disease. However, the immunosuppression effect of using can accelerate disease progression (Acuff et al., 1999). HIV infection among IDU also presents a threat to their sexual partners (NRC & IOM, 1995).

Recent studies have indicated that mental health challenges increase individual vulnerability to HIV-infection and that, post-infection, depression and anxiety are commonly reactions among newly diagnosed persons (Diamond & Buskin, 2000; Marks et al., 1998). Other studies have found that depression among PLWHA, for example, affects ability to adhere to treatment protocol and to adhere to risk reduction guidelines that may prevent transmission of HIV to sex or drug use partners (Rabkin & Chesney, 1999; Susser, Betne, Valencia, Goldfinger, & Lehman, 1997a; Susser et al., 1997b).

Poverty. It is increasingly clear that poverty is the most common 'co-factor' of newly diagnosed HIV cases in both rural and urban locations (Gopal, 2000; Lounsbury, 2001b; Montoya et al., 1999; Zierler et al., 2000). In general, persons living in poverty do not have access to adequate health care, which in turn allows many treatable conditions to

go without attention. Over time, such health problems directly contribute to the likelihood of contracting HIV (Altman et al., 1998; Brennan, 1994; Gaston et al., 1998; Gemignani, 1999; Gopal, 2000; Kronick & Gilmer, 1999; Mosen, Wenger, Shapiro, Anderson, & Cunningham, 1998; Stroupe, Eleanor, & Kniesner, 2000).

A consumer/community advocate from Michigan stated that poverty among PLWHA “creates significant barriers to care because it effects every aspect of life, beginning with lack of health insurance, transportation to medical care, extending to poor nutrition, inadequate housing, and generally poor health practices due to lack of resources.” Moreover, Trotter and Needle (1999) called attention to the relationship between racism and high HIV incidence among African Americans in cities such as Detroit: “Poverty, discrimination, homelessness, racism, and low self-esteem rooted in race emerged as conditions that created high-risk environments and situations” (p. 21). In general, socioeconomic instability has been associated with higher rates of prostitution, drug use, incarceration, family disruption, and homelessness, all of which have also been associated with the spread of HIV (Bangsberg et al., 2000; Fournier & Carmichael, 1998).

Prevention and Care Interventions

The *intervention* domain represents a community’s formal public health response to the problem of HIV/AIDS. Two broad, dynamically related strategies are identified: *prevention* and *care*. Generally, strategies of prevention have focused on education and lifestyle changes and on development of a vaccine, while strategies of care have focused on development of a cure, improved treatments, and easier access to treatment-related services (Altman, 1994; Ashton & Seymour, 1988; IOM, 2001).

Prevention interventions are typically intended to impact the community as a whole and has been described as ‘community-oriented, collectivistic, and holistic’ (AED, 1999; Altman, 1994; Bellah, 1985; Butterfoss, Goodman, & Wandersman, 1993; Dearing, Larson, Randall, & Pope, 1998; Eng, Salmon, & Mullan, 1992; Guenther-Grey, Noroian, Fonseka, & Higgins, 1996; Kegeles et al., 1996; Kelly, 1999; Sikkema et al., 2000). Focusing on the benefits to the community as a whole is conceptually important when attempting to assess the utility of any given prevention program. In fact, when the potential benefit to any given individual is considered, the notion of a *prevention paradox* has often been invoked (Rose, 1992). The paradox noted is that preventive measures can bring large benefits to the community but may offer little to the majority of persons who access, or take up, the protective innovation. Considering the context of HIV/AIDS, many hundreds of sexually active people may need to consistently practice ‘safer sex’ in order to prevent just one new case of HIV infection.

Interestingly, this way of thinking appears to be the complement of the notion of *herd immunity*, or the extent to which an entire group or community is protected from an infectious agent, such as HIV. In theory, 100% of a group or community need not be protected. Instead, everyone may enjoy full protection if a sufficiently high proportion of the group or community members are, for example, consistent in their practice of ‘safer sex’ (Fine, 1993; Last, 1995). In summary, given that people can be protected from a particular infection or affliction, primary prevention – the protection of good health – is generally considered to be the most viable approach. Levine and Perkins (1987) note that, with respect to prevention, “. . . no disease has ever been truly conquered by treatment. The greatest advances have been made when we have been able to prevent disease” (p.

5).

In contrast to prevention, care interventions are typically intended to impact the individual and can be described as ‘person-oriented, individualistic, and biomedical’ (Aday, Moses, Marconi, & Bowen, 1994; Holman, 2000; Lawson, Katzenstein, & Vermund, 1999; McKinney & Bragg, 1994; Meredith et al., 1998; Rothenberg et al., 2000; Rundall, Kwait, Maconi, Bender-Kitz, & Celentano, 1999; Weissman et al., 1994). Underlying the concept of care is the medical model, which views health problems as *disorders* and professional services as *treatments* (Levine & Perkins, 1987; Rappaport, 1977). Although increasingly well-equipped to address illness or injuries that are specific and acute in nature, problems that are more general and chronic can pose profound difficulties for medical services. Chronic conditions, such as diabetes, arthritis, hemophilia, heart disease, as well as HIV/AIDS, require a diverse and flexible set of health-related services, some of which may only be needed from time to time, and others that may be needed regularly for an extended period (Bould, 1999; MDCH, 2000b). For chronic illnesses, delivery of effective care essentially becomes a ‘systems problem’ (Bringewatt, 1998a; Bringewatt, 1998b). The great challenge for care is efficient service delivery as Bringewatt (1998b) noted below:

While we must preserve the pieces of healthcare, our success [in meeting chronic care needs] depends upon our ability to make whole cloth out of stray threads. It means bringing together the components of healthcare that serve a common population to integrate care as a person’s chronic conditions evolve across time, place, and profession (p. 24).

Considering the complicated context that surrounds the problem of HIV/AIDS, both prevention and care have been valued and needed, yet despite remarkable and rapid knowledge growth and resource mobilization, we are still losing the battle against

HIV/AIDS. Our relative ‘failure’ may be explained as a general outcome of *partial success* (i.e., partially successful prevention interventions combined with partially successful treatment interventions). If either a vaccine (100% effective individual prevention) or a cure (100% effective individual care) were successfully developed, it would be plausible to imagine that eradication of HIV/AIDS, like polio or the measles, could be feasible in the near future.

HIV Prevention

If no new cases of HIV infection developed, the pandemic could conceivably end for lack of hosts in less than two decades. Yet previous experience suggests that that is unlikely to occur. Doka (1997) offers the example of other STDs, noting that:

Other sexually-transmitted diseases have continued to infect the population for hundreds of years. Syphilis, in particular, should have been eradicated. After all, it is spread in ways even more limited than AIDS. Infection can also be determined through medical testing. Syphilis can even be cured. Still the disease has proved surprisingly prevalent (p. 87).

Notwithstanding the magnitude of the challenge, a range of HIV prevention strategies have been developed and applied, often with notable success.

Based on reports by the CDC (1999a) and the National Institutes of Health [(NIH, 1997), the Institute of Medicine (IOM, 2001) has described four types of prevention interventions: (1) behavioral interventions, (2) co-occurring conditions interventions, (3) biomedical and technological interventions, and (4) social interventions. Each of these categories of intervention will be briefly discussed in terms of their capacity – either independently or in combination – to address primary prevention needs.

Behavioral interventions. Most HIV prevention strategies attempt to modify individual behavior regarding sexual activity and drug use. Such interventions have been

most effective when designed to address the needs of either a *special population* [e.g., MSM (ACDP, 1999; Kegeles et al., 1996; Valdiserri et al., 1989); IDU (Booth & Watters, 1994); youth (Jemmott et al., 1992; Jemmott et al., 1998; Rotheram-Borus, Gillis, Reid, Fernandez, & Gwadz, 1997; St. Lawrence et al., 1995; Stanton et al., 1996); heterosexual men (Exner, Gardos, Seal, & Ehrhardt, 1999); and women (DiClemente & Wingood, 1995; Exner, Seal, & Ehrhardt, 1997; Sikkema et al., 2000)] or a *special setting*, such as an AIDS service organizations and public health clinics (Boyer, Barrett, Peterman, & Bolan, 1997), schools (Main et al., 1994), or jails (Magura, Kang, & Shapiro, 1994) where persons who may be in need of prevention services can be reached (NIMH, 1998; Sikkema et al., 2000).

A variety of challenges can impact the long-term effectiveness of behavioral interventions. Generally, the vigilance on the part of any single individual will wane over time (Marquis, 2000; Pettifor et al., 2000), particularly when there is a strong perception that new treatments, such as HAART, act as a prophylactic (CDC, 1999b; Lehman et al., 2000). In addition, the nature of the progression of HIV disease inhibits prevention because it can have a relatively long asymptomatic period. During this time neither the HIV-positive individual nor his or her partners may be aware of the risk of transmission. Finally, the fact that HIV is transmitted primarily through shared needles or sexual contact further frustrates prevention. The pleasure of sex and of drug use makes abstinence (or consistently 'safe sex' or 'safe use') difficult to adhere to (Anderson, 1998).

Co-occurring conditions interventions. Treatment of conditions that are recognized as commonly co-occurring with HIV can be leveraged as opportunities for

primary prevention that can reduce susceptibility among HIV-negative persons as well as reduce level of infectivity among HIV-positive persons (CDC, 1998a). For example, adding behavioral counseling to STD treatment can help encourage risk-reducing behavior change (CDC, 1993b; Cohen, 1995). There is also growing evidence that treating substance abuse can reduce HIV infections caused by substance use-related behavior (Iguchi, 1998; Moss et al., 1994; Shoptaw, Reback, Frosch, & Rawson, 1998). Similarly, treatment of mood disturbances has also shown promise with respect to decreasing the likelihood of engaging in risky sexual behavior (Folkman & Chesney, 1992; Marks et al., 1998) and/or substance use (Drake & Osher, 1997; Regier et al., 1993).

Biomedical and technological interventions. Recent advances in anti-retroviral therapies have resulted in the development of several highly effective prevention strategies. For example, there is strong evidence that use of Zidovudine or Nevirapine by pregnant women who are HIV-positive can greatly reduce the risk of perinatal HIV transmission (Conner et al., 1994). Similarly, recent evidence suggests that PLWHA with low or undetectable viral loads are substantially less infectious to their HIV-negative sexual partners (Quinn et al., 2000). However, more evidence is needed to confirm these findings. The development of more sensitive HIV antibody screening assays have functioned as an important technological prevention intervention. In general, they have provided an effective way to check blood supplies for HIV infection (Feldman & Bayer, 1999; IOM, 1995).

The biomedical intervention that arguably holds the most promise – an HIV vaccine – is still far from becoming an accessible reality despite the fact that it has been a

primary goal since the beginning of the HIV/AIDS epidemic (Cohen, 2001). In general, science is challenged by the fact that the virus is high mutability, is passed from person to person via a variety of transmission modes, and is already prevalent in multiple different strains. With respect to economics, incentives to encourage private investment in research to develop an HIV vaccine are lacking because of the great liability of developing 'bad' vaccines. Moreover, even the vaccine were truly efficacious, it is assumed that the market for the product would 'dry up' once all (or most) susceptible persons are inoculated (Berkley, In press; Cohen, 2001).

These fundamental scientific and economic barriers have hindered the development of a viable HIV vaccine (Kimball, Berkley, Ngugi, & Gayle, 1995; Lawson et al., 1999). What progress has been made has come from publicly funded initiatives (IAVI, 2000). It is worth noting that some vaccine trials have shown limited protection (Berman et al., 1997; Schwartz et al., 1993). Dissemination of partially effective vaccine, particularly in high prevalence locations in less industrialized nations, could prove to be an effective prevention strategy. On the other hand, it may lead to a more relaxed attitude about risk reduction practices, just as the use of ART has relaxed 'safer sex' and 'safer use' behaviors (Kravcik et al., 1998).

Social interventions. Societal prevention interventions, such as the promotion of condom use, public service announcements about 'safer sex,' privately-funded needle-exchange programs, and upgraded surveillance procedures, have been shown to be relatively inexpensive and effective (Holtgrave, Pinkerton, Jones, Lurie, & Vlahov, 1998; Luboobi, 1994; Pinkerton & Holtgrave, 1998). 'Social marketing' of condom use and other interventions that increase individuals' access to prevention services and tools have

been demonstrated to be highly successful at HIV prevention, particularly in less industrialized parts of the world (Bhave et al., 1995; Ford & Norris, 1993; Ford et al., 1996; Ngugi et al., 1988). Through advertising and mass media, as well as through direct product distribution, the demand and use of condoms has increased, which in turn has functioned to diminish HIV incidence as well as other STD incidence (Andreasen, 1995).

Interestingly, a nationwide condom advertising program has never occurred in the U. S. (Bedimo, Pinkerton, Cohen, Gray, & Farley, in review). Regional studies of condom social marketing in the U.S., however, have been well-received by their target communities, very cost effective, and easy to implement (Cohen, Scribner, Bedimo, & Farley, 1999). Also slow to be developed – despite strong evidence in support of their effectiveness – have been needle-exchange programs. In general, social and political climates have inhibited broad-based implementation of such programs and have disregarded findings that show that such interventions do not increase the overall prevalence of substance use in either adults or youth (IOM, 1995; Valleroy et al., 1995). In Michigan, the Michigan AIDS Fund (MAF, 1999b) has allocated funds for this purpose in selected parts of the state.

With respect to public service announcements (PSAs), only one national campaign has been conducted in the United States to date. It was titled “America Responds to AIDS” (ARTA) and it ran from October 1987 to July 1990. Multiple types of media were employed (e.g., multilingual mailings, public service announcements on television and radio stations, and posters), each designed to increase public awareness of and knowledge about HIV/AIDS. Smaller-scale PSAs have been successfully implemented by the CDC. One initiative, for example, obtained positive behavioral risk-

reduction outcomes among adolescents – which was its target population – such as increases in the likelihood of carrying condoms and therefore a reduction in the number of unprotected sexual encounters (Kennedy, Mizuno, Hoffman, Baume, & Strand, 2000; U. S. Conference of Mayors, 1994). Considering these findings, (IOM, 2001) states that:

Broader implementation of such programs [PSAs] in the United States could potentially reach those risk populations who have limited or sporadic access to HIV prevention messages. Further, educational components of such campaigns can help to reduce the stigma and negative attitudes associated with HIV/AIDS, substance abuse, and sexuality (p. 158).

In summary, these types of social interventions hold great promise, but they should not replace more intensive individual and community-level risk reduction interventions. Ideally they would complement a variety of other on-going prevention initiatives targeting a variety of ecological levels and audiences (Kelly, 1999).

HIV/AIDS Care

In general, an effective system of care services for PLWHA depends upon the development of a comprehensive continuum of medical and social support services (Rundall et al., 1999). It is estimated that 350,000 to 528,000 PLWHA now make use of the clinical care delivery system and receive regular HIV/AIDS care in the United States (Bozzette et al., 1998). As the number of PLWHA grows, the need for care services will increase. This trend, by itself, will be a great challenge to care services. Michigan's latest Statewide Coordinated Statement of Need [SCSN] (Lounsbury, 2001b) identified a number of important themes regarding the delivery of quality HIV/AIDS care. Among those considered most important were (1) access to primary care, (2) access to specialists and special medical treatments, and (3) access to a mechanism to pay for health care. An overview of these particular care needs is provided below.

Establishing and maintaining a single primary care doctor-patient relationship. The ability to build a professional care relationship with a selected physician who is knowledgeable about HIV/AIDS treatments is considered to be paramount to effective control of this disease (Bodenheimer, 2000; Carpenter et al., 2000; Friedmann et al., 2000; Gallant, 2000; Holman, 2000; Luboobi, 1994; Wholey, Burns, & Lavizzo-Mourey, 1998). When such a relationship is created as soon as possible after learning about one's HIV-positive status, a greater number of treatment options and strategies are more likely to be available. Moreover, because HIV disease does not manifest the same way in all individuals, which options to pursue at any given time are best informed by a doctor's keen understanding of his or her patients' healthcare history. The more often an HIV client is compelled to switch their primary care doctor, the less likely such an historical perspective is possible.

Access to HIV specialists and special medical treatments. The character of medical treatment for PLWHA has become increasingly specialized and complex (Aday et al., 1994; Bellandi, 1999; Bodenheimer, 2000; Bozzette et al., 1998; Brennan, 1994; Coile & Trusko, 1999; Crystal & Sambamoorthi, 1998; Friedmann et al., 2000; Gallant, 2000; Gunn et al., 1998; Kelly et al., 1998; Lawson et al., 1999; Meredith et al., 1998; Milton & Benjamin, 1998; NASTAD, 2001; Pettifor et al., 2000; Rundall et al., 1999). The process of HIV specialization appears to be affecting where and how clients access HIV/AIDS care. Not all care settings can offer expert care for HIV/AIDS, which has increased demand for access to selected care settings.

In general, clients need access to infectious disease doctors with HIV expertise. However, particular combinations of expertise may be needed. For example, meeting the

specialized needs of women, relative to men, is one area for which additional medical capacity is also warranted. In general, as more women are infected, there is a growing demand for doctors who can provide expert gynecological and pregnancy-related services for HIV positive women. Further, for PLWHA who also have mental health challenges, psychological and/or psychiatric treatment may represent an important need, particularly when adherence to ARTs is a concern (NIMH, 1998; Richmond, 1999).

Mechanisms to pay for health care. Health insurance or having access to financial coverage by a payer of last resort is a necessity for all PLWHA (Altman et al., 1998; Kronick & Gilmer, 1999; Rajan, 1998; Stroupe et al., 2000; Wolfberg, 2000). Without these coverages, access to any form of regular care may not be possible. In Michigan, helping clients obtain and maintain coverage is an on-going challenge. The percentage of PLWHA in the state who are uninsured is estimated to be as low as 9% and as high as 30% (Lydia Meyers, personal communication, September 6, 2000). Insurance status often depends upon income level (Altman et al., 1998; Kronick & Gilmer, 1999; Rajan, 1998). Many PLWHA have stopped working due to AIDS-related illness or other extenuating circumstances, which often results in a loss of private insurance (Stroupe et al., 2000). If clients have been diagnosed with AIDS and if they meet current low income guidelines, they are generally eligible for Medicaid insurance.

In Michigan, as in a growing number of other states, Medicaid services are provided via a managed care system (Moore & Chaisson, 1997). There are benefits and costs associated with managed care models. Although there is an incentive to keep clients as healthy as possible, which may facilitate greater access to preventative services, most managed care programs operate under carefully specified capitation rates. Ceilings on the

amount paid for particular care services may limit access to needed services.

Approximately one-third of all insured PLWHA are covered through Michigan's managed care Medicaid program. The Supplemental HIV/AIDS Surveillance project (SHAS, 2000) in Detroit found Medicaid was the most common insurance coverage (47%), with women substantially more likely to use Medicaid (67%) than any other type of coverage. Men were typically using Medicaid (41%) or private-employer insurance (36%). A common frustration for many of these clients in Michigan has come from delays in processing Medicaid applications and from changes in policy coverage or eligible location of service without being informed. Moreover, due to a variety of frustrations with the Medicaid system, a number of providers have recently decided to drop their setting's qualified health plan status, which restricted access care, at least temporarily, for their Medicaid clients. In general, these types of service interruptions are viewed as salient barriers to important health care services for PLWHA (PWA Task Force, 1999).

Psychosocial Vulnerability

Doka (1997), among others [e.g., Shilts, (1987)], poignantly underscores that the problem of HIV/AIDS cannot be understood without affirming how, as a dreaded disease, it elicits 'deep primal fear' in the people and communities it affects. He underscores, however, that there are two types of dreaded diseases: (1) those that cause mass devastation and loss of life (e.g., bubonic plague) and (2) those that stigmatize (e.g., syphilis, leprosy, and cancer). Of the stigmatizing type, Doka writes: "These diseases did not cause the collective devastation of the epidemic plagues, but they did condemn individuals to death characterized by agony, pain, and isolation" (p. xv).

HIV/AIDS may be classified as a *super* pandemic because it is a clear example of both vast devastation and intense stigmatization. As a result, HIV/AIDS has generated great psychosocial vulnerability within affected communities. This vulnerability has affected how communities attempted to prevent and control HIV/AIDS. Doka (1997) notes that “in both types of dreaded diseases, the very actions intended to halt or slow the spread of disease frequently exacerbated the spread” (p. xv). In the current study, HIV/AIDS stigma is hypothesized to be the most salient dimension of what is conceptualized to be a three-dimensional (i.e., stigma, complacency, and [dis]-empowerment), interactive psychosocial vulnerability domain. The following text provides additional description and context about each of the three dimensions of psychosocial vulnerability.

HIV/AIDS Stigma

In general, HIV/AIDS stigma is due to fear of contagion, moral blame, or to other attitudes that generate social isolation of persons who are known or perceived to be HIV-positive or to have AIDS (Gilmore & Somerville, 1994; Herek & Capitanio, 1993; Herek & Glunt, 1988; Kowalewski, 1990; Letine et al., 2000; Pierret, 2000; Randolph & Banks, 1993; Schag, Ganz, Kahn, & Peterson, 1992). Although disparaging attitudes about PLWHA may have decreased somewhat since the early days of the epidemic (Herek & Glunt, 1988), HIV/AIDS-related stigma remains a salient negative force in many communities. A recent survey of U.S. households (N = 5,641) found that the majority of persons do not hold stigmatizing views of PLWHA (Letine et al., 2000). Nonetheless, when asked to evaluate the statement “People who got AIDS through sex or drug use have gotten what they deserve,” 18.7% stated that they believed they did. Those

respondents who endorsed this statement were more likely to be men (21.5%), white (20.8%), over 54 years of age (30.0%), have less than a high school education (22.1%), have less than a \$30,000 a year income (23.4%), and to have poorer health status (23.6%).

Negative attitudes about PLWHA and their associates. HIV/AIDS stigma may be directed against groups of people perceived to be likely to be infected and against those individuals, groups, and communities with whom these individuals interact (Herek & Greene, 1995; Perreault & Bourhis, 1999). For example, in a study of HIV/AIDS caregivers (i.e., physicians, nurses, case managers, etc.), Lounsbury (1997) found two types of perceived ‘associational’ stigma: *judgment of depravity* and *sense of disempathy*. Depravity was defined as perceptions of HIV/AIDS workers as morally bad, corrupt, infectious and perverted (because they attended to the needs of persons who have HIV/AIDS). Disempathy was defined as perceptions of HIV/AIDS workers as persons who ought not be admired and who were not worthy of compassion (because they attended to the needs of persons who have HIV/AIDS). More generally, Lounsbury found that perceived associational stigma manifests as a subtle, but influential construct among HIV/AIDS workers, underscoring the notion that people do not readily expose personal beliefs of discrimination and fear to others. At the community level, inhibited communication about important health-related topics may be viewed as a potentially serious barrier for prevention. Detection of an associational stigma among health service providers, such as HIV/AIDS workers, may be particularly indicative that this type of barrier is at work.

HIV/AIDS-related stigma goes beyond attitudes about the disease itself. It also

involves attitudes about, for example, sexual behavior, drug using behavior, poverty, gender, and race (Chesler, 1981; Kowalewski, 1990; Randolph & Banks, 1993; Trotter & Needle, 1999). The most pervasive notions of HIV/AIDS stigma take the form of homophobia, a social discomfort or judgement about same-sex intimacy, particularly about men who have sex with men and the worthiness or place of PLWHA as members of the community (Adib & Ostrow, 1991; Aggleton, 1998; Herek & Greene, 1995; Lounsbury, 2001b).

Impact on access to services. Stigma impacts the way that services are sought out as well as how they are offered or delivered. For example, it may surface as overt harassment in the work place or as diminished self-esteem or self-efficacy. It may dissuade persons from seeking out HIV counseling and testing (Letine et al., 2000), and it may discourage community members from becoming more involved in HIV/AIDS-related events and activities (CDC, 2001d; Doka, 1997; Herek & Capitanio, 1993). It can also affect how the media covers matters related to HIV/AIDS prevention and care (Dearing et al., 1998; Dearing et al., 1996; NASTAD, 2001).

Assuring confidentiality is an important part of managing the challenges that stigma presents to PLWHA. Until the stigmatizing attitudes and the behaviors they elicit are eliminated, the assurance of confidentiality will be necessary. Helping people understand more about what HIV is and how it can be treated is key to changing negative attitudes about PLWHA. Part of helping the community understand more about HIV may come from helping PLWHA to be 'out' and open about their HIV positive status (Herek & Capitanio, 1993; Herek & Greene, 1995).

HIV/AIDS Complacency

With respect to HIV/AIDS, complacency may be described as a general attitude of individuals and organizations that HIV/AIDS is no longer an important problem, that HIV cannot touch them, and that – even if infected – treatments which are as good as a cure are readily available. For example, complacency is the individual who stops practicing ‘protected’ sex, the organization that reallocates funding to other diseases, the society that reprioritizes, excluding HIV/AIDS as in need of policy development (e.g., Hall & Keen, 2001).

More generally, complacency can be thought of as a particular way of adjusting or adapting to one’s environment over time. It has been offered by Raup (1930) as the ‘foundation of human behavior,’ which he theoretically described in terms of a four-phase process as follows:

(1) a *formative* phase, in which the new relation came into being as a step in the making of other adjustments; (2) a *quiescent* phase, in which the relationship moved smoothly, in the character of habits (this I have chosen to call the “complacency” stage); (3) a *disturbed* phase, which is characterized by a great variety of activities having a decided trend and drive towards the restoring of the complacency that had been disturbed; (4) and . . . a *resumptive* phase, in which there are two subphases (a) that wherein the activities become set, or definitely directed, towards the establishment of the relationship which is forefelt to be satisfactory, and (b) that wherein the adjustment relationship comes into the fullness of its being (p. 4).

What Raup proposed is that complacency is essentially the tendency to re-establish a particular status quo over time. Put another way, from time to time a disturbance, or interruption, may impact the status quo. This then generates a period of uncertainty that eventually resolves itself, making way for re-emergence of the previous status quo, or at least circumstances that are equally comfortable.

Although Raup's (1930) theory of complacency was developed to address the individual (i.e., the person), it may be applied to higher units of analysis as well, such as the small group, the organization, the institution, the community, and/or society. Applying the theory to the context of HIV/AIDS, and jumping up to the level of either the community or society, it becomes immediately apparent that the third phase – the disturbed phase – could be likened to Mann and Tarantola's (1996) first two periods (i.e., 'discovery' and 'early response') or, similarly, to Rosenbrock et al. (2000) first three periods (i.e., 'emergence of exceptionalism,' 'exceptionalism,' and 'towards normalization').

In terms of this theory, the discovery of the first cases of HIV/AIDS in the United States and the activities that ensued fit the description of a period of 'disturbance,' which broke a period of relative quiescence, or complacency about the problem of dreaded infectious diseases. The phase of quiescence, then, would be our general tendency to rely upon (or at least take for granted) the ability of public health to prevent illness or to provide treatment or cure for disease as it manifests. In particular, this phase would be marked by an increasingly strong faith in the power of science and the medical model to meet all of our health needs, including sexually transmitted diseases.

It follows that the formative phase, the period before the period of complacency, was the gradual development of a modern public health infrastructure in industrialized countries such as the United States, which functioned to generally reduce exposure to infections as a result of improved standards for food, water, housing and a subsequently reduced disease prevalence (Levine & Perkins, 1987; Levitan, 1969; McKeown, 1976). The resumptive phase, then, would be the process of recovering the status quo and the re-

the emergence of complacency phase, which appears to be much like what Mann and Tarantola (1996) and Rosenbrock et al. (2000) have described as a period of ‘normalization.’

Misperceptions. Increases in complacency about HIV/AIDS may be attributable to broad-based misperceptions that HIV disease is no longer an immediate threat to life (CDC, 1997b; CDC, 2001d; HRSA, 1998; Tarlach, 1998). In particular, the perception of success of HAART and a sustained emphasis on vaccine development appears to have allowed some people to rationalize that they no longer need to take precautions against either transmitting or acquiring HIV (Chesney et al., 2000; Cohen, 2001; Gallant, 2000; Kravcik et al., 1998; Rabkin & Chesney, 1999). In general, the risk of contracting (or re-contracting) HIV may now be perceived as lower, since reports are that PLWHA on HAART often enjoy very low viral loads and substantial increases in T-cells (Musicco et al., 1994; Ragni, Faruki, & Kingsley, 1998; Royce, Sena, Cates, & Cohen, 1997).

Information such as this appears to be driving an increased willingness to engage in higher risk activities. For example, in a study of HIV-negative or untested persons, 17% reported that they were not as concerned about practicing ‘safer sex’ and ‘safer drug use’ and 31% were less concerned about testing HIV-positive because of the efficacy of new treatments (Lehman et al., 2000). Other recent studies affirm that unprotected sex and other high-risk behaviors among MSM have resurged, as evidenced by the increased incidence of STDs in major urban areas, such as San Francisco (CDC, 1999b), Seattle (CDC, 1999c; Williams et al., 1999), Los Angeles, and Philadelphia (Marquis, 2000).

Leadership. Part of what appears to be driving these misperceptions of risk can be attributed to a lack of leadership and a lack of community involvement in the fight

against HIV/AIDS. The Institute of Medicine (IOM, 2001) notes that “concerted efforts by politicians and national leaders to openly discuss HIV and engage the public in HIV prevention efforts can set the stage for a national-level mobilization against the epidemic” (p. 104). However, difficulties in fostering collaborative efforts among federal agencies and competition for keeping HIV/AIDS as a ‘top priority’ of the current administration have limited the development of a clear, cohesive national strategy for HIV/AIDS prevention and care (CDC Advisory Committee, 1999; PACHA, 2000).

In general, efforts to foster community mobilization have been successful, but only on a more localized scale. For example, community mobilization in the gay community during the early 1980s generated significant changes in sexual behavior and declines in HIV incidence among MSM in large cities, such as San Francisco and New York (Katz, 1997). Notably, these initiatives came before the development of any official federal programs for HIV/AIDS prevention or care (NCR & IOM, 1993). As one AIDS activist put it: “It is the gay community that has invented and disseminated the idea of ‘safe sex,’ trained hundreds of volunteers to staff information lines, set up local AIDS libraries, used direct action to influence the Food and Drug Administration’s slowness to make available experimental drugs, held forums on varieties of alternative treatment” (Miller, 1993, p. 8). Given that newly diagnosed persons are increasingly likely to also present with challenges related to mental illness, substance abuse, etc., as well as with needs for higher levels of key support services, such as housing and transportation, effective interventions will require renewed and greater involvement from the community (IOM, 2001; Lounsbury, 2001b).

Media. The pervasiveness of misperceptions about HIV/AIDS risks and about the

efficacy of treatments are also linked to incomplete or inaccurate media coverage. Since the advent of ART, media reports have tended to overstate the extent to which HIV/AIDS is 'in-check,' giving the impression that needs have been met and that circumstances are less urgent (MAF, 1999a; Trotter & Needle, 1999). Although such messages are not completely false, there is a need to work more effectively with electronic and print journalists to ensure that information delivered to the public does not reinforce a sense of complacency. Recently, however, greater awareness of the impact of how reporting and public service announcements may inadvertently add to the complacency surrounding HIV/AIDS issues has been recognized by the media itself (*Los Angeles Times*, Jan 29, 2001; "Anti-HIV Drugs Not 'Miracle Cures'").

[dis]Empowerment of PLWHA

Empowerment has served as an important theoretical principle for action-oriented social science since the early 1980s (Rappaport, 1981; Rappaport, 1987; Rappaport, Swift, & Hess, 1984; Rissel, 1994). It is a concept that emerged from the collective experience of the civil rights movement of the 1960s and from the women's movement and the self-help initiatives of the 1970s (Eng et al., 1992; Kieffer, 1984). Anderson (1996), who wrote "empowerment is an outcome of changes in fundamental structures and relations of power, rather than through individual actions alone" (p. 698). These words point to the importance of the subtle interdependencies between person and environment, or context, that shape the design and implementation of any social program or community intervention. From the empowerment perspective, social problems are defined as "conditions [in the community or society] that place individuals in a vulnerable position" (Prilleltensky, 1997, p. 527).

Empowerment is a complex construct. Its common definition includes two versions: (1) to *authorize* a person to do something and (2) to *give power* to person to do something. The former implies the need for some action of enablement, whereas the latter implies a surrender of control from one to another (Jack, 1995). In addition, empowerment has meaning at multiple levels (i.e., individual, group, organizational, or community), as a process (i.e., an empowering course of action), and as an outcome (i.e., the state of being empowered) (Perkins & Zimmerman, 1995; Zimmerman, 1995).

At the individual level, empowerment aims “to enhance the possibility for people to control their own lives” (Rappaport, 1981, p. 15). Zimmerman (1995) writes that, for the individual, empowerment brings together “perceptions of personal control, a proactive approach to life, and a critical understanding of the sociopolitical environment” (p. 581). At the community level, empowerment may be defined as the removal of social barriers within a community that, for example, restrict access to better housing (Fawcett et al., 1996).

Valuing self-determination. According to Mann and Tarantola’s (1996), empowerment “is the extent to which individuals are capable of making and effecting free and informed decisions about their life” (p. 441). This definition is consistent with the definition offered by Prilleltensky (1997) and others (Aday, 1993; Bellah, 1985; Rappaport, 1981), who view the overarching theme of empowerment as *a valuing of self-determination*, given a particular ecology of personal-versus-collective power dynamics.

In an excerpt from Michigan’s SCSN (Lounsbury, 2001b), self-determination is indicated through peer-led interventions for PLWHA, which have strengthened a sense of individual control and achievement in the community. The excerpt reads as follows:

[In Michigan] Peer-led interventions are gaining popularity and are beginning to be integrated into a variety of types of services, including case management, medication adherence, HIV/AIDS prevention and risk reduction, youth outreach, substance abuse treatment, women's advocacy, and statewide planning. There needs to be more training opportunities that are inclusive of PLWHA to train PLWHA to be effective peer advocates. Developing the capacity among PLWHA to implement peer-led interventions, however, will take time and resources.

Perhaps the most notable example of a peer-led intervention is Michigan's PWA Task Force. The mission of this task force is "to express the regional and statewide needs of the PLWHA community; to facilitate a system which gives recommendations to decision making bodies; to provide advocacy and encourage continued support to meet the evolving needs of persons living with HIV/AIDS." The Task Force membership has nearly doubled in the last two years, and members have become involved in a greater variety of projects and activities that have helped identify critical HIV/AIDS issues at the state and regional levels. *The Positive Quarterly*, a newsletter produced by the Task Force and disseminated statewide, is an example of their growth, as are the *Statewide Community Forum Project* and the recent prevention and care survey projects.

These descriptions of peer-led intervention may serve as examples of what Mann and Tarantola (1996) state is necessary to foster empowerment within communities of persons who are vulnerable to HIV/AIDS: (1) the realization that the status quo is not immutable and that change is possible, (2) that empowerment can only develop from within each individual, organization, or society – it must be elicited from within, but (3) that empowerment can be facilitated by providing information, linking people with others, and by supporting efforts that are initiated by individuals, organizations, or society towards change.

Psychological empowerment. The notion of realizing the possibility of change is consistent with Zimmerman's (1995) construct of psychological empowerment (PE), which – although conceptualized as the individual level of analysis – also works with higher levels of analysis, such a family or a community of persons. PE, Zimmerman

(1995) warns, is not easy to measure (either quantitatively or qualitatively) because: “(a) PE manifests itself in different perceptions, skills, and behaviors across people; (b) different beliefs, competencies, and actions may be required to master various settings; and (c) PE may fluctuate over time” (p. 583). Although Zimmerman underscores that development of a global measure of PE is not an appropriate goal, he nonetheless presents a useful “nomological network” comprised of three general components: (1) intrapersonal, (2) interactional, and (3) behavioral.

The intrapersonal component includes perceived control, self-efficacy, and control. The interactional component includes processes that develop or facilitate critical awareness, causal understanding, skill development, skill transfer, and/or ability to mobilize resources for action. The behavioral component includes experiences with community involvement, organizational participation, and/or coping behaviors. Taken together, Zimmerman writes that:

. . . these three components of PE merge to form a picture of a person who believes that he or she has the capability to influence a given context (intrapersonal component), understands how the system works in that context (interactional component), and engages in behaviors to exert control in the context (behavioral component) (p. 590).

For example, consider the intrapersonal matter of ‘safer sex self-efficacy,’ which is a person’s ability to adhere to ‘safer sex’ practices, such as consistently using a condom or other protective ‘barrier’ during sexual activity. The associated interactional component could be represented as ‘knowledge of HIV epi trends and services,’ such as the fact that epidemiological surveillance reports in Michigan show that African Americans comprise 14% of Michigan’s population yet make up over half (58%) of the cases of HIV/AIDS (MDCH, 2000a). The associated behavioral component could be

represented as involvement in regional HIV prevention initiatives, Michigan's PLWHA Task Force, and/or other community groups that are actively addressing the problem of HIV/AIDS. Over time, these intrapersonal, interactional, and behavioral components of PE would reinforce each other.

According to PE theory, it is plausible that an individual who comes across basic epidemiological information published on the Internet would develop a sense of concern for himself, as black man living with Michigan. This, in turn, functions to persuade him to discuss HIV with his girlfriend, who suggests that they should both be tested for HIV-antibodies. Upon agreeing to this, both persons learn about a series of community forums that are on-going in their neighborhood through a flyer that is passed to them by the HIV-antibody testing counselor during their appointment. Although neither of them can make the next scheduled forum, they are available to attend the one after that. They attend and learn more about the severity of the problem, and so on, and so on.

It is in this fashion that individuals gain PE. For PLWHA, a similar dynamic is possible. However, it appears that HIV/AIDS care services, for a variety of reasons, tend to [dis]empower, as opposed to empower, clients over time. For example, Medicaid insurance is available only to persons who have limited financial resources and inadequate access to private health insurance (i.e., Medicaid is a payer of last resort). Qualifying for Medicaid implies spending personal resources down to a level that may be much lower than an individual is accustomed to. In most cases, it limits, if not completely rules out, the possibility of working full-time (Fish, Izzo, Karoulis, & Growick, 1997; Moore & Chaisson, 1997; Schag et al., 1992). Over time, PLWHA are financially disempowered. Many other examples of living with HIV/AIDS and disempowerment

exist. At minimum the goal of empowerment for PLWHA should be to help clients develop a confident sense about how to optimally navigate and make use of the service system to achieve personal goals for health and well-being.

Community empowerment. Empowerment at the community level was identified as an important need in Michigan's SCSN (Lounsbury, 2001b). In the document empowerment was defined as a process through which individuals, groups, and entire communities can gain the knowledge, skills, and resources needed to achieve one or more goals. With direct reference to PLWHA, it was noted in the SCSN that, like everyone else, PLWHA have diverse needs and diverse goals such as personal health, relationships and community involvement, financial security, and educational development. In general, the SCSN called for an allocation of resources that would allow PLWHA – as individuals and as a community – to pursue through their own voice and action what they designate to be most important for quality of life and general well-being.

Applying the notion of empowerment to public health requires a focus on the level of the community. For all intents and purposes, a framework for public health as *community empowerment* is conceptualized in the 'Ottawa Charter for Health Promotion' (WHO et al., 1986). This charter was derived from an earlier government report entitled 'A New Perspective on the Health of Canadians' that was published by then Canadian Minister of Health, Marc Lalonde. In general, it laid out an agenda for a new era of preventative medicine (i.e., primary care) that sought to bring together environmental change and preventative measures with appropriate clinical interventions, especially for the disabled and the elderly. Moreover, it was the first doctrine of public health that went beyond human biology to affirm the importance of social determinants of health

problems. Ashton and Seymour (1988) write that:

In this way it seeks to avoid the trap of blaming the victim. Many contemporary health problems are therefore seen as being social rather than solely individual problems; underlying them are concrete issues of local and national public policy, and what are needed to address these problems are 'Healthy Public Policies' – policies in many fields which support the promotion of health. In the New Public Health the environment is social and psychological as well as physical (p. 21).

Over a number of years, a variety of countries – including the United States – have sought to adopt these ideas and to develop the field of preventative medicine and health promotion (DHEW, 1979; St. George & Draper, 1981). Calling further attention to this new strategy, the WHO (1981) incorporated the concepts of the 'New Public Health' in its policy statement for the 34th World Health Assembly ('Global Strategy of Health for All by the Year 2000'). The essence of the goal was summarized as follows: 'All people in all countries should have at least such a level of health that they are capable of working productively and of participating actively in the social life of the community in which they live.' Such an objective mirrors the meaning and sentiment of the need for empowerment at the community level that was firmly declared in the text of the SCSN for Michigan, written exactly twenty years later.

CHAPTER 2

APPLYING A SYSTEMS APPROACH

The system dynamics ‘systems approach’ is like conducting an experiment in a *virtual world*, the results of which can be used to inform the design and execution of experiments, or policy actions, in the *real world*. According to Sterman (2000), “there is no cookbook recipe for successful modeling, no procedure you can follow to guarantee a useful model. Modeling is inherently creative. Individual modelers have different styles and approaches” (p. 87). Nonetheless, system dynamicists have developed a general work process by which many good models have been developed and applied. As stated previously in the introduction, the overarching objective of this process is *to learn about*, or *to better understand*, the dynamics of interaction among agents (or components) of the context that is perceived to surround, or define, a specified ‘problem’ or ‘dilemma’ (Forrester, 1994b; Lane, 1992).

Figure 2.1 places the three conceptual domains featured in Chapter 1 (i.e., *epidemiological burden*, *HIV/AIDS intervention*, and *psychosocial vulnerability*) in an interdependent and dynamic context. The arrows linking the domains (and the sub-domains within each) indicate *dynamic interdependency* (i.e., behavior of one domain affects the behavior of others, either directly or indirectly, over time). Of particular focus is the *dynamic mediation* of psychosocial vulnerability as it interacts with prevention and care interventions and with epidemiological trends.

The general design of this conceptual framework represented in Figure 2.1 was

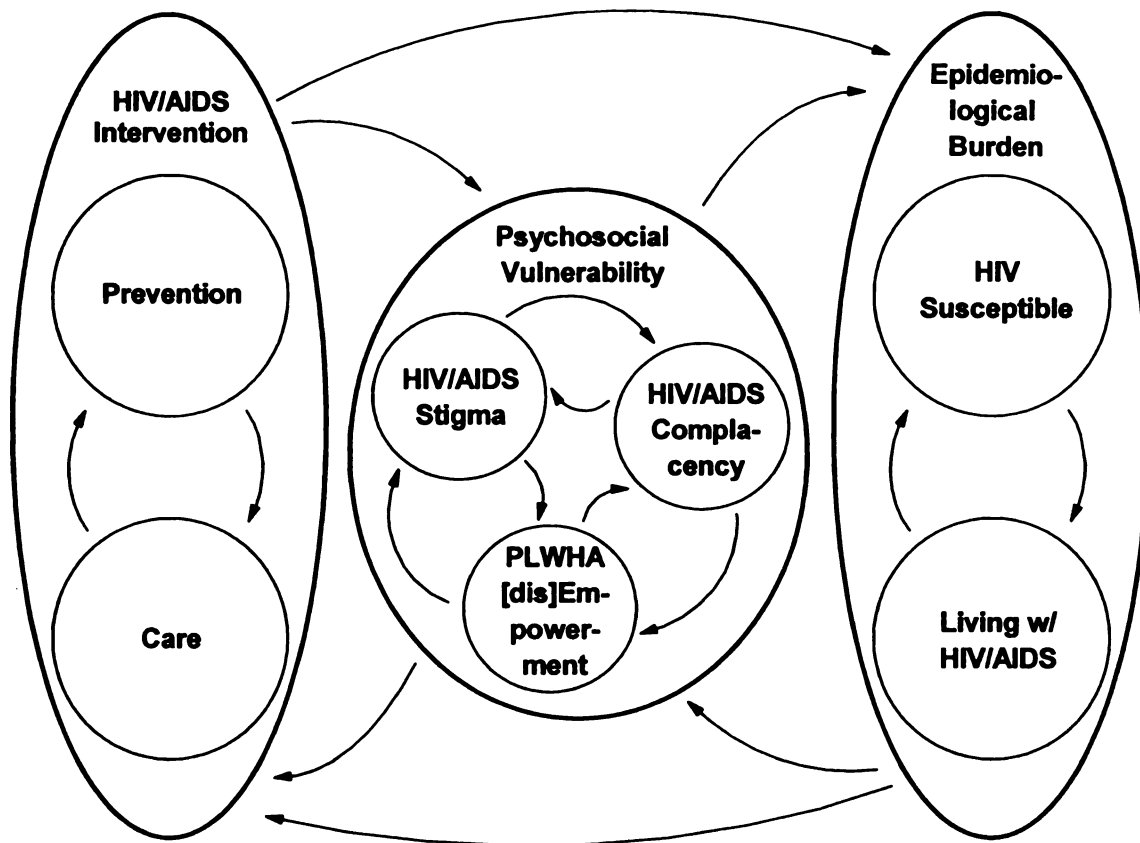


Figure 2.1 - Conceptual framework for the current study

adapted from Levin and Roberts' (1976) theory of the dynamics of human service delivery (which will be discussed further in this chapter). The general implications of this framework are easy to grasp because the complex relationships within and between its domains are presented in a highly symbolic and aggregated manner. However, as one begins to think more deeply about Figure 2.1's implied interactions among these domains, the need for a more powerful analytical tool becomes obvious. In particular, a methodology that allows specification and display of relationships that are (1) dynamic, (2) non-linear, (3) hierarchical, and (4) interdependent would be most appropriate. System dynamics is a methodology that provides capacity to work with all four of these

types of relationships. In general, system dynamics models use mathematics (mainly calculus) to simulate the structure and behavior of economic, technological, social, and environmental systems.

System Dynamics versus Other Schools of Mathematical Modeling

Mathematical simulation models are, simply put, models that express relationships among elements, or variables, in mathematical terms. A simulation model may use one or more of the following fundamental types of mathematical relationships: (1) stochastic or deterministic, (2) continuous or discrete, (3) linear or non-linear, and (4) simultaneous or lagged [see Meadows and Robinson (1985) for more depth on these types of mathematical relationships]. System dynamics differs from other schools of mathematical simulation, such as operations research (Churchman, Ackoff, & Arnoff, 1957) and basic epidemiological modeling (Flanders & Klienbaum, 1995), in that it allows explicit focus on one or more processes of continual change over time. In contrast to most other techniques of mathematical modeling, system dynamics easily incorporates variable relationships that are continuous, non-linear, and lagged.

The development of system dynamics as a scientific discipline is attributed to Jay W. Forrester (Forrester, 1961a; Forrester, 1961b; Forrester, 1971), professor emeritus at the Massachusetts Institute of Technology (MIT). At MIT, he and his colleagues began to apply principles of feedback control theory (how systems are regulated), cybernetics (how information is used in systems for the purpose of regulation), and organizational theory (how human organizations are structured and how decisions about their development are made) to the study of industrial dynamics in the early 1960s. Many of the findings derived from his early modeling work were controversial because the

dynamics they generated suggested policy changes that refuted a number of strategies of development commonly endorsed at the time. For example, Forrester's (1971) urban dynamics model showed that:

The fundamental cause of depressed areas in cities comes from excess housing in the low-income category rather than the commonly presumed housing shortage. The legal and tax structures combine to give incentives for keeping old buildings in place. As industrial buildings age, the employment opportunities decline. As residential buildings age, they are used by lower-income groups who are forced to use them at a higher population density. Therefore, jobs decline and population rises while buildings age. Housing, at the higher population densities, accommodates more low-income urban population than can find jobs. A social trap is created where excess low-cost housing beckons low-income people inward . . . [etc.]. (p. 57).

What Forrester describes here is essentially the process of building a ghetto. The model allowed him to explain how a seemingly logical response to a social problem was, in fact, the problem itself.

In general, the system dynamics approach starts with the concepts and information on which people and organizations are already acting. It then packages, or structures, these concepts and information in a computer model which displays, or simulates, the behavior of the system of interest. As the example showed, the output of the model is usually counterintuitive to what was originally anticipated. Forrester contends that this is a benefit of the systems approach because it forced a reevaluation of the system from a different vantage point that often allowed for substantive improvements in strategic operations (Forrester, 1971). In this sense system dynamics is a formalized technique for what many in the field refer to as 'systems thinking' (Cavaleri & Sterman, 1997; Huz, Andersen, Richardson, & Boothroyd, 1997; Senge, 1990).

General Assumptions of System Dynamics

There are at least three general assumptions upon which the discipline of system dynamics rests. These include the assumption that: (1) natural and human systems have dynamic complexity, (2) systems are goal-seeking, and that (3) systems can be changed [for the better] by human action. The meaning and implications of each of these is developed further in the following text.

Natural and Human Systems have Dynamic Complexity

The most general assumption underlying system dynamics is that natural systems (e.g., the behavioral system that enables the transmission of HIV from one person to another) and human systems (e.g., the service delivery system for HIV/AIDS services) have high levels of dynamic complexity, which arises from their internal causal structure. The components that comprise the structure may be human or material resources (e.g., the number of practicing primary care doctors or the amount of affordable housing stock within a community) or informational (e.g., knowledge about HIV/AIDS prevention guidelines as well as internalized notions of norms, roles, and values that are perceived to influence crucial aspects of the environment). The causal structure itself is “the pattern of physical constraints and social goals, rewards, and pressures that cause people to behave the way they do and to generate cumulatively the dominant dynamic tendencies of the total system” (Meadows & Robinson, 1985, p. 34).

Systems are Goal-seeking

System dynamicists assume that the behavior of a system is ‘goal-seeking.’ As such, system dynamicists look for a solution, or resolution, to a problem by changing the goals and the kinds of information that influence decisions. Goals may either be

conscious or unconscious, singular or multi-dimensional (Levine & Fitzgerald, 1992). Goal-seeking is dependent on the receipt and processing of feedback, or two-way causation. Feedback is information about change. Without receiving feedback, achievement of any individual or collective goal would be unlikely (Forrester, 1971; Forrester, 1987a; Levine & Fitzgerald, 1992).

Goal-seeking systems achieve their objective via the principle of 'negative feedback' (Richardson, 1991). Within in the social and health sciences, the concept of negative feedback is essentially equivalent to homeostasis. Homeostasis describes the ability of individual living organisms to maintain physiological stability despite sharp changes in external or internal conditions. It is the process of 'automatic adjustment' to various environmental stimuli. The notion of homeostasis can be traced back to the ancient Greeks. The term itself was coined by Walter Cannon (1932; 1926; 1929).

The concept of a goal-seeking system applies at the group and community levels as well. L. J. Henderson (1913), for example, in his book *The Fitness of the Environment*, discussed the remarkable stability of physical and chemical conditions in the biosphere that are life-supporting. A precursor to Kurt Lewin's (1935) ecological formula $B = f(P, E)$ [Behavior is a function of Person and Environment], Henderson defined fitness as the "as the mutual or reciprocal relationship between the organism and the environment" (Henderson, 1913, p. 31). The homeostasis of the community as a collective system was, according to Henderson, essential to all life.

Despite this long-standing and keen understanding of the importance of systems and negative feedback within the social and health sciences, the methodology of system dynamics is only now beginning to gather critical interest within disciplines such as

psychology, sociology, and public health (Levine, 2000). One explanation for this delay is that modeling software and other tools for ‘systems thinking’ and system dynamics application development have only recently (i.e., within the last 10 to 15 years) become widely available (Morecroft & Sterman, 1994; Senge, 1990).

Systems can be Changed by Human Action

Another major assumption of system dynamics is that human action, or intervention, can have an impact on the social system of interest. Forrester (1968) observed that there are, of course, forces that cannot be affected by human action. These he labeled as *exogenous*, calling attention to the need to focus instead on understanding what can be affected by human action. These he labeled *endogenous*. Hovmand and Levine (2000) write:

Forrester started with the idea that to the extent that problems could be solved by human interaction, they involved human decisions. That is, human decision making is an essential ingredient for understanding both the cause and the solution of social problems. If human action has no impact on a problem or on our ability to cope with a problem, then there is nothing to be done [about it] (p. 11).

In general, the need for methods that help explain the impact of human actions and human decision-making are becoming more acute. There is a growing recognition about the effects of rapid change and the increasing complexity of contemporary society, particularly where it has been observed that many of the problems we now face developed as unanticipated outcomes of our own past actions (Ford, 1999; Sarason, 1972; Sarason, 1978; Senge, 1990). For example, the tragic events of September 11th, in a variety of ways, can be viewed as a case in point. What societal dynamics (i.e., collective human actions) might explain how such a level of malevolence came to be? It is asserted here that system

dynamics is a potentially effective tool for exploration of such a question.

Applicable Works from the System Dynamics Literature

A search of the systems literature located a number of HIV/AIDS-related modeling projects, essentially all of which focused on epidemiological trend analyses and on the dissemination or adoption of a specific prevention or care technology (e.g., Bernstein, Sokal, Seitz, Stover, & Naamara, 1998; Caulkins, Kaplan, Lurie, O'Connor, & Ahn, 1998; DeAngelis, 1998; Edwards, Shachter, & Owens, 1998; Garnett & Anderson, 1996; Heidenberger & Roth, 1998; Kahn, Brandeau, & Dunn-Mortimer, 1998; Korenromp et al., 2000; Luboobi, 1994; Owens, Brandeau, & Sox, 1998; Paltiel & Freedberg, 1998; Porco & Blower, 1998; Rossi & Schinala, 1998; Van der Ploeg et al., 1998). In addition, Taylor and Lane (1998) provided a useful review of more than 50 simulation studies in the area of health care.

Only two studies of HIV/AIDS epidemiology addressed the integration of the dynamics of care with the dynamics of prevention. In the first of these studies, Korenromp et al. (2000), simulated the effects of a “single-round mass treatment” of STDs to explore the potential impact on HIV incidence. In the second, Luboobi (1994), simulated the effects of providing increased medical care and health awareness interventions to sexually active, mature adults in Uganda.

Notably, the work of Levin and Roberts (1976), who built a model of the dynamics of human service delivery, and Dangerfield, Fang, and Roberts (2001), who built a model of the epidemiology of HIV/AIDS and the consequences of HAART, were found to be substantively and technically useful to the study’s focus. Both are summarized below.

Levin and Roberts' General Theory of the Dynamics of Human Service Delivery

In Levin and Roberts' (1976) book, *The Dynamics of Human Service Delivery*, a general theory about the process of providing services to people is presented. The theory is based upon the premise that the delivery of human services is a dynamic process that unfolds in a changing environment and that the interaction between a service program and its clients is "the essence of human service delivery" (Levin & Roberts, 1976, p. 17). It may be applied to the study of the integration, or interdependency, between 'service providers' (i.e., programs) and 'service receivers' (i.e., clients) in the domains of health, education, housing, or any other area of human service. Figure 2.2 shows Levin and Roberts' theory in its most simple and aggregated form. In their fully developed

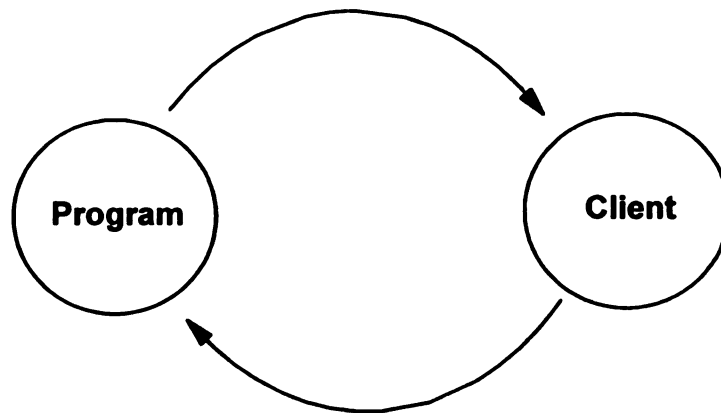


Figure 2.2 - Simplified version of Levin and Roberts' conceptual framework of the dynamics of human service delivery

system dynamics model, these domains comprise many different variables that affect client demand for and program supply of services over time. It can be easily observed how the current study's conceptual framework was derived from their theory.

Intervention is equivalent to *program*; *epidemiological burden* is equivalent to *client*.

Psychosocial vulnerability is, then, added as a dynamic mediator between the other two domains.

According to Levin and Roberts' (1976) theory (which was designed to simulate the behavior of a single person, not an entire community of people), the human service system can lay dormant for an indefinite amount of time, depending upon the particular circumstances facing a potential client. For example, an individual may never require HIV care services because he or she may never be infected with HIV. In such a case the program is not activated and services are not delivered. More generally, different client circumstances will produce different levels of demand for service over time. When the demand for client services exceeds the current capacity of the program, additional resources can be allocated. In this way the program is responsive to client needs over time. Ultimately, when the client is satisfied, the demand for service is 'turned off.'

Thus, a service program is represented as a negative feedback system directed by the process of satisfying client need. The primary assumption here is that the delivery of services is an interactive process. In other words, Levin and Roberts (1976) are simulating a process of 'cooperation' between a client and a program. If the client and program cannot come to some level of mutual agreement, then the program will not be activated on behalf of the client. For example, applying the context of HIV/AIDS, a PLWHA may initiate an agreement to receive case management services from a community-based organization. To the extent that the client needs services and to the extent that the terms by which the client receives services are acceptable to the program, the client-program relationship will remain active.

Dangerfield, Fang, and Roberts' Model of the Epidemiology of HIV/AIDS and the Consequences of HAART

Dangerfield et al. (2001) have developed an extensive system dynamics model of HIV/AIDS epidemiology and the consequences of HAART. Their model is informed by data about incidence, morbidity, and mortality for a cohort of homosexual men in the United Kingdom (U.K.) from 1981 (i.e., the inception of the epidemic) through 1998 and from previous modeling efforts over the past 12 years (Dangerfield, 1999; Dangerfield & Roberts, 1989).

Dangerfield et al.'s (2001) system dynamics model is particularly relevant to the current study because of its focus on care (i.e., HAART) and how care treatments may impact primary prevention of HIV infection. Most models of HIV/AIDS epidemiology have focused exclusively on the dynamics of prevention and infectivity, stopping short of an examination of how access to efficacious treatments may also impact prevention and infectivity. The purpose of Dangerfield et al. (2001) model is summarized as follows:

The change in therapy not only changes the effects of treatment, but also influences the nature of the epidemic and the corresponding resource use. This will cause new and different impacts on the health care system and for planning purposes it is necessary to understand what these impacts might be (p. 2).

The general structure of their model includes a flow of cases from a population of persons who are at risk of HIV infection through six stages of disease, culminating in death. The structure explicitly captures different patterns of treatment (including mono-drug treatments that may precede HAART treatments). Dangerfield et al.'s model includes other structures that account for HIV infectivity and changes in sexual behavior. In addition, there are flows out of each stage of HIV disease to account for non-HIV-

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Of particular relevance to the current study's purpose is the effect of perceived and actual infectivity of PLWHA on HAART. Based on computer simulations, Dangerfield et al. (2000) estimate the infectivity of patients on HAART to be very low (approximately 0.0005). They caution, however, that "this belief cannot, as yet, be confirmed but it is an opinion which is gaining increasing prominence and it is a central aspect of [their] simulated scenarios" (p. 3).

Research Questions

Recall that the purpose of the study was to build a model for understanding the psychosocial dynamics of HIV/AIDS prevention and care in the community. Considering this purpose in the context of the complexity of the on-going HIV/AIDS epidemic in Michigan, the system dynamics 'systems approach' was used to research the following questions:

1. How does *stigma* caused by HIV/AIDS affect the dynamics of prevention and care in the community?
2. How does *complacency* caused by HIV/AIDS affect the dynamics of prevention and care in the community?
3. How does *[dis]empowerment* of PLWHA affect the dynamics of prevention and care in the community?
4. How does *care* affect the dynamics of prevention? [and/or] How does *prevention* affect the dynamics of care?

Next, Chapter 3 presents the method used to build and validate the system dynamics model that was used to address the above questions.

CHAPTER 3

METHOD

Fundamentally, system dynamics is a method of modeling *decision processes* that are hypothesized to describe the dynamics of a specified *problem focus*. The objective of the modeler(s) is to explicitly specify “the decision process whereby information is converted to action” (Forrester, 1992, p. 54). Here Forrester is referring to the nature of the causal structure, or causal relationships, among *constructs* (i.e., variables) that make up a system dynamics model.

Overview of Method

In the study, the problem focus was undesirable trends associated with the dynamic interaction of the three conceptual domains that were used to define the conceptual framework (i.e., *epidemiological burden*, *HIV/AIDS intervention*, and *psychosocial vulnerability*). In particular, the study was intended to promote critical thinking and deeper understanding about ways of addressing the detrimental effects of HIV/AIDS-related stigma, complacency, and [dis]empowerment on HIV/AIDS prevention and care interventions and on HIV incidence and AIDS mortality. To clarify the nature of these dynamic interactions, a number of important constructs were identified and defined by study participants from the HIV community in Michigan. These constructs were then structured into a set of *causal loops* that explicitly defined a given decision process over time. The ordering of the constructs that comprise each causal loop

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were also informed by the opinions and insight of study participants and by qualitative analysis of other sources of data that were accessible to the system dynamicist. In turn, the causal loops were then translated into a system of *interdependent mathematical structures* (i.e., the formal, base case system dynamics model).

Although there are many important technical details to learn and to attend to in order to develop a viable base case system dynamics model, the objective of the system dynamics method is to discover, or *uncover*, a set of causal loops that describe the decision processes that have led to the problematic outcomes of concern in the study. In the study, a total of 13 causal loops were identified. In qualitative terms, each causal loop communicates a story, or *narrative*, about a substantive dynamic process related to the problem focus. In quantitative terms, each causal loop represents a set of stock-and-flow equations. Particular pairs of these casual loops share one or more of the same constructs.

Where constructs are shared between loops there is dynamic interdependency or *feedback*. As explained in Chapter 2, searching for and understanding feedback mechanisms is an important hallmark of the system dynamics approach. Causal loops diagrams, sometimes referred to as influence diagrams or directed graphs, are a commonly used tool for representing feedback structures (Richardson & Pugh III, 1981). To fully appreciate the method used in the study, the reader will need to know how to read causal loop diagrams.

Interpreting Causal Loop Diagrams

Causal loop diagrams are comprised of words, arrows, and plus (+) and negative (-) signs. An example of a generic causal loop diagram is shown in Figure 3.1. The arrows show the causal pathway(s) between variables. Positive (+) and negative (-) signs

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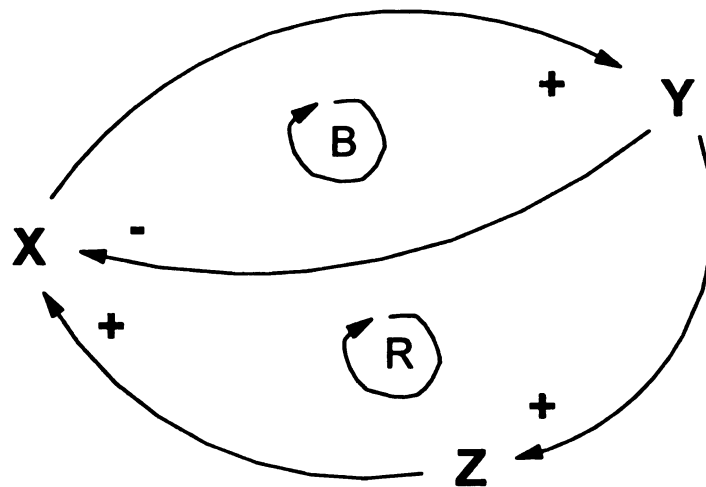


Figure 3.1 - Example causal loop diagram of a two-loop process comprised of three variables

are used to indicate the nature of the causal association between two variables. Positive signs indicate that two variables change in the same direction. That is, as X (i.e., the cause) increases over time, Y (i.e., the effect) increases over time, too. Similarly, if as X decreases over time, Y will also decrease. Sterman (2000) defines a positive link this way: “A positive link means that if the cause **increases**, the effect **increases above what it otherwise would have been**, and if it **decreases**, the effect **decreases below what it would otherwise have been**” (p. 139). In comparison, negative signs indicate that the two variables change in opposite directions. For example, as X increases, Y will decrease, and visa versa. Borrowing Sterman’s words again here: “A negative link means that if the cause **increases**, the effect **decreases below what it would otherwise have been**, and if the cause **decreases**, the effect **increases above what it otherwise would have been**” (p. 139).

It is important to note that the causal relationship between two variables can represent either a change in rate (i.e., increase or decrease):

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(the derivative)

or a change in accumulation:

$$Y = \int_{(t_0 \rightarrow t)} ([+ | -] X + \dots) ds + Y_{t_0}$$

(the integral)

over a specified unit of time. It is also important to note that causal loop diagrams represent *causality*, not *correlation*. By definition, two linked variables are correlated, but they are only causally related when a change in X occurs before an associated change in Y.

When two or more variables form a closed loop, the polarity of the loop itself can be signed. Loops with an even number of negative links are dynamically *reinforcing* (R) or growing. Loops with an odd number of negative links are dynamically goal-seeking or *balancing* (B). When the dynamics of two or more loops are considered simultaneously, one loop's impact may dominate the effect of the other loop over a particular period of time. One loop will dominate the another loop if the rate of change generated within the first loop is greater than the rate of change generated within the other. The reverse is true if the rate of change within the second loop is greater than the rate of change within the first. However, without building a formal model and testing its dynamics, loop dominance becomes very difficult, if not impossible to assess.

In the current study, for the sake of understandability, the 13 causal loops were further organized into 5 *causal loop diagrams*. Although a single causal loop diagram with all 13 loops represented could have been drawn, it would have been difficult to understand. The five diagrams have been labeled, or titled, in a manner that references substantive, overarching processes of interest in the current study. Each of these diagrams is comprised of at least 2 of the 13 loops. Although these diagrams share some of the

same constructs, none of them share the same loops. Simulation output was used to explore the dynamics of these overarching processes as well as to affirm the extent to which the base case model adheres to model validation guidelines. The five causal loop diagrams will be presented in detail in Chapter 5, however it is useful to keep in mind that the essence of the system dynamics method is to identify and model causal processes.

Modeling for Understanding

The work of identifying causal loop processes that capture the dynamics of a given problem focus is the second of five steps that constitute the full system dynamics methodology (see Figure 3.2). The methodology has been referred to as the process of *modeling for understanding* (Forrester, 1987b). The five steps are as follows: (1) *describe empirical reference modes*, or trends, that are related to a specified problem focus, (2) *identify causal loops* (sometimes referred to as cybernetic mechanisms, information feedback loops, dynamic processes, or dynamic hypotheses) that are hypothesized to explain the interdependent structure of the observed reference modes, (3) *convert causal loops into stock-and-flow equations* (i.e., mathematical statements about rates of change and accumulations over time), (4) *conduct model tests* to confirm the validity of the stock-and-flow equations over a specified time horizon, and (5) *conduct policy analyses* by changing the model's structure and/or parameter values at the point of time that represents the present such that new 'modes of behavior' simulated over the near future can be observed and evaluated by system stakeholders (e.g., affected members of a community or organization).

The process of *modeling for understanding* is inherently inductive in nature. As

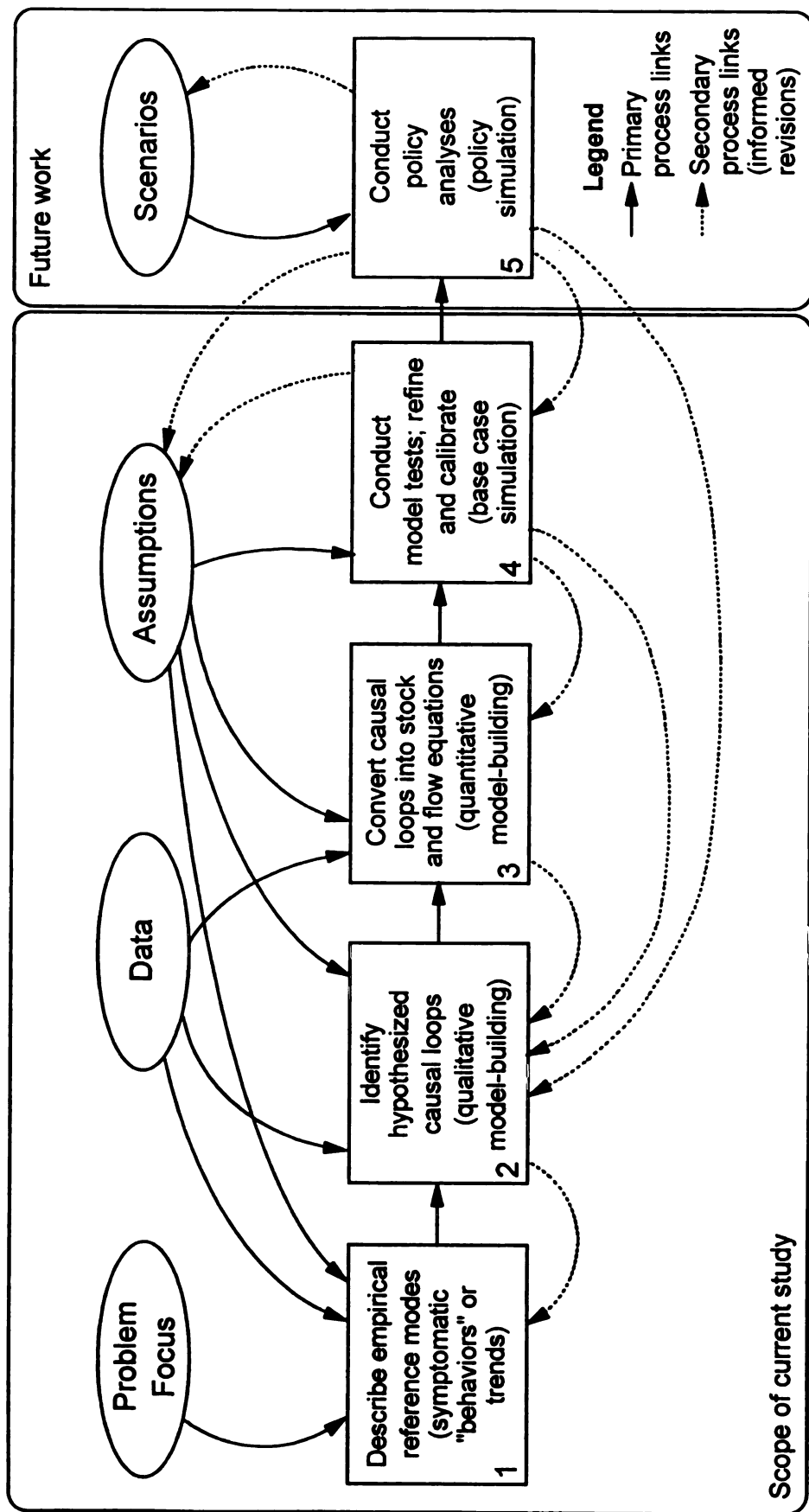


Figure 3.2 - The process of modeling for understanding

indicated by the secondary process links shown as dotted arrows, the process carried out in the study was iterative and flexible in its sequence. Cycling back through one or more previous steps was necessary in order to incorporate new understanding that occurred as the process was carried out. Note that the scope of the study was limited to steps 1 through 4. The product of the first four steps is a fully developed *base case* model. The base case model is the validated mathematical representation of the retained, or accepted, hypothesized causal loops. The validity of the base case model is assessed in part by the extent to which its simulated reproduction of key reference modes, or trends, match corresponding empirical data.

An in-depth presentation of the base case model for the study is presented in Chapter 4. The remainder of this chapter elaborates on specific procedures carried out in the current study: (1) sources of data for modeling, (2) working with core key informants, (3) specification of key constructs, reference modes, and a time horizon, and (4) building and validating the base case model.

Sources of Data for Modeling

Appropriate data for system dynamics modeling provides ‘dynamic description’ (Forrester, 1987a; Sterman, 2000). It must convey information about the ‘behavior’ of a particular set of variables, or constructs, over time. Data may be either quantitative (numbers) or qualitative (words); what is most important is that a variable’s rate of change over time can be estimated in a valid way (Jacobsen & Bronson, 1987). In the study modeling data was obtained from one or more sources and used to inform the quantification of *constructs* such that a clear *reference mode* for each one could be created over a specified *time horizon* (Saeed, 2001). Both primary data sources and

information (from peer-reviewed literature) were used for this purpose.

Primary Data Sources

Development of a system dynamics model for the study required data that described how change occurs within and between the three domains of the conceptual framework presented in Figure 2.1 (i.e., *intervention*, *psychosocial vulnerability*, and *epidemiological burden*). In particular, Michigan's Statewide Coordinated Statement of Need [SCSN] (Lounsbury, 2001b) provided substantive information about each of these domains. Data sources for the SCSN included statewide and regional HIV/AIDS needs assessments, various service planning, evaluation, or policy documents, epidemiological surveillance reports, and key informant interviews. In total, 48 documents were reviewed and 34 key informants were interviewed about the service needs of persons living with and affected by HIV/AIDS in the state [see Appendix A for SCSN Human Subjects Approval, Informed Consent Procedure, and other data collection-related information; to review a complete list of SCSN documents and identifiable key informants (i.e., those persons who elected to speak 'on the record'), see the document on-line at <http://www.msu.edu/user/lounsbu1/scsn2001.html>].

In addition to information obtained and processed for the purposes of the SCSN project, useful data for the study was obtained from two other sources. These included MDCH epidemiological data (MDCH, 2000a) and interview data from ten (N=10) core key informants from Michigan's HIV community (see Appendix B for Human Subjects Approval, Informed Consent Procedure, and other data collection-related information regarding these sources).

HIV/AIDS-focused Peer-reviewed Literature

The urgent and complex nature of the HIV/AIDS epidemic has motivated a wide range of basic and applied research initiatives. These efforts have generated a prolific number of peer-reviewed publications, a substantial portion of which is now referenced and summarized in carefully authored reviews. Examples of such works include (Mann & Tarantola, 1996) review of global trends in epidemiology and resource development, (Smith, 2001) encyclopedia of social, political, cultural, and scientific information, and the (IOM, 2001) critical analysis of factors affecting the on-going challenge of HIV prevention. These sources of data, as well as more than 400 individual articles on topics such as HIV disease progression, shortcomings and barriers to biomedical treatments, interventions to reduce risk-taking behaviors, health care service delivery innovations were also used to build and validate the study's system dynamics model.

Working with Core Key Informants

Forrester (1987a) writes, "if a model is to have impact, it must address the concerns of a target audience. Successful modeling should start by identifying the target audience for the model" (p. 136). Given the purpose and objective of the system dynamics model developed in the current study, the ideal target audience, or community, would be comprised of persons who are actively evaluating, designing, or delivering HIV/AIDS prevention and/or care services. As previously noted, ten (N=10) persons fitting this description were successfully involved as core key informants. Three additional persons were invited to participate, but chose not to for personal reasons related to concerns about confidentiality and/or time constraints.

In the study the term 'core key informant' was selected to emphasize the desire

and need for a highly interactive, mutually beneficial working relationship between the 'system dynamicist' and members of the intended target community. Core key informants in the study were recruited because they were, in fact, active evaluators, designers, and providers, and additionally because they had first-hand experience living with the virus. All core key informants were affiliated with either Michigan's PLWHA Task Force or with some other statewide or regional advocacy organization. Seven of the ten informants were PLWHA. Four were providers of HIV-related services in their community. Five had had substantial experience working as an HIV/AIDS policymaker or service planner. Three had participated in the preceding SCSN study. Four were women, only one of which was also living with HIV/AIDS.

Interview Sessions

The interviews conducted with core key informants were a success, both in terms of knowledge elicited about the problem focus and in terms of cultivating a participatory climate throughout the course of the study. Their experiences and perspectives proved to be diverse, yet profoundly insightful. In particular, it was happily discovered that all core key informants were well equipped and very willing to explore the dynamics of psychosocial vulnerability and its impact on both HIV/AIDS services and epidemiological burden.

In general, participation involved a single in-depth interview session with the opportunity to revise and/or add to a typed set of field notes that were assembled immediately after the interview. Early on in the interviewing process it was proposed that, if possible, one or more group interview sessions would be arranged. This proved to be too difficult carry out because participating core key informants did not live near each

other and personal schedules did not lend themselves to easy discovery of mutually convenient meeting times. As a result, all interviews were conducted one-on-one, between the system dynamicist (i.e., the principle investigator and the interviewer) and a single core key informant.

The wording of the informed consent text, however, allowed for the exchange of ideas among core key informants despite the impossibility of meeting face-to-face in small groups (see Appendix B). Interestingly, all core key informants chose to exercise their option to speak among each other, either directly or via the system dynamicist. The portion of the informed consent sheet that facilitated this is provided in the following excerpt:

As a participant in the study, your privacy [the core key informant's privacy] will be protected to the maximum extent allowable by law. Any information you provide for the purposes of the study, either orally or in writing, will be kept confidential. In order to create a 'safe space' for free-flowing conversation and exchange of ideas, you must agree to keep confidential the identity of any other participating core key informant of whom you may learn. Note, however, that you – and you alone – may choose to disclose the fact of your own involvement in the study to others.

Through this mechanism it was possible to create 'virtual group interviews,' which promoted more rapid refinement of ideas and a heightened sense of participation in the work at hand.

Interviews lasted from 2 to 4 hours. Core key informants were offered payment of \$50 at the end of their in-depth interview session. All informants either accepted the payment, although three persons asked that their \$50 be sent to a specified HIV/AIDS service organization. These three special requests were granted. Snacks or a light meal was provided. Meeting time and place was arranged at the convenience of core key informant. Core key informants could, at anytime and for any reason, stop participation in

the study. None, however, have yet exercised this right. These interviews were completed within a three-month period, between May 2001 and August 2001.

Workbooks

Consistent with suggested procedures for effective ‘knowledge elicitation’ for system dynamics modeling projects, a workbook was developed to aid the process of conducting the core key informant interview (Ford & Sterman, 1998). The workbook was designed to provide background information to core key informants about the purpose of the study and about the process of system dynamics modeling. It was also designed to serve as a semi-structured interview form with which to record a variety of types of data (i.e., text, numbers, diagrams, or graphs) about a short list of possible constructs, or variables, that were, *a priori*, thought to be germane to the purpose of the model.

Constructs featured in the workbook included the following: (1) funding for HIV/AIDS services, (2) quality of HIV/AIDS services, (3) interagency coordination, (4) HIV-related stigma, (5) HIV-related complacency, (6) PLWHA burnout, (7) PLWHA empowerment, (8) HIV/AIDS epidemiology. The section of the workbook that was used as an interview form was labeled ‘Mini-modeling Exercises.’ Core key informants were asked to focus only on those constructs for which they were most interested and/or knowledgeable.

Although informants reported that the workbook’s section on the study’s background information was useful, most of them found that the pages provided for data-recording to be “too restrictive” or “not relevant” to manage many of the ideas and issues they wished to bring up. As a result, the workbook was underused. Instead, expanded field notes from an unstructured interviewing technique became the common format for

core key informant interview data. The introductory text presented in the workbook is included in Appendix B.

Selecting a Time Horizon and Constructing Reference Modes

Having identified important sources of data for the model and having initiated the process of interviewing core key informants about the selection and definition of model constructs, the task of building behavior-over-time graphs, or reference modes, was begun.

Time Horizons

Richardson and Pugh III (1981) define the time horizon of a system dynamics model as “the period of time over which the problem plays itself out.” The time horizon may be specified in seconds, months, centuries, etc. In general, the time horizon depends on the purpose of the model. For the study, a time horizon of 40 years was originally chosen (see Table 3.1). It started in 1971, ten years before the first cases of AIDS were detected in the United States, and continued through 2011, ten years from now.

Table 3.1 - Proposed six-phase time horizon

Name	Intervention Orientation	Period	Number of years
Pre-discovery	Person-focused	1971 - 1981	10
Discovery	Community-focused	1982 - 1986	5
Mobilization	Community-focused	1987 - 1991	5
Medicalization	Person-focused	1992 - 1996	5
Normalization	Person-focused	1997 - 2001	5
Remobilization	Community-focused	2002 - 2011	10
Time horizon (years)			40

Based upon insights from Mann and Tarantola (1996) and Rosenbrock et al. (2000) about hypothetical stages of response to the HIV/AIDS epidemic, the proposed time horizon was divided into six discrete phases. These phases were labeled as follows: (1) pre-discovery, (2) discovery, (3) mobilization, (4) medicalization, (5) normalization, and (6) remobilization.

It should be noted that the first period (pre-discovery) and the last phase (remobilization) were not included in the stages of response identified by either Mann and Tarantola (1996) or Roseboch et al. (2000). The pre-discovery phase was added in order to account for the fact that disease progression from HIV susceptible to AIDS is estimated to be as high as 10 years. So, although the first case of HIV was not detected until 1981 (CDC, 2001a; CDC, 2001b), a more valid simulation of the emerging epidemic ought to reach back about 8 to 10 years. The remobilization phase has been included in order to help core key informants think critically about the future dynamics of the epidemic.

A period of just 18 years (1983 to 2001) was ultimately selected as the simulation period for the model developed in the study because it corresponded with currently available epidemiological surveillance data collected by MDCH's Bureau of Epidemiology (MDCH, 2000a) [see Table 3.2]. This shortened time horizon allowed for a more straightforward model validation process.

Reference Modes

Reference modes for key constructs are used to clarify the problem focus for the system dynamics study. The data that informs a reference mode is, by definition,

Table 3.2 - Model time horizon

Calendar date	Count	
	Year	Month
January 1983	0	0
December 1984	1	12
December 1985	2	24
December 1986	3	36
December 1987	4	48
December 1988	5	60
December 1989	6	72
December 1990	7	84
December 1991	8	96
December 1992	9	108
December 1993	10	120
December 1994	11	132
December 1995	12	144
December 1996	13	156
December 1997	14	168
December 1998	15	180
December 1999	16	192
December 2000	17	204
December 2001	18	216

historical. Its potential for communicating meaning is profound. According to Saeed (2001):

A reference mode is essentially a qualitative and intuitive concept since it represents a pattern rather than a precise description of a series of events. A reference mode subsumes history, extended experience, and a future inferred from projecting inter-related past trends. It can be seen with the mind's eye as an integrated fabric, although it can be represented on paper only as isolated tendencies. A reference mode will also not contain random noise normally found in historical trends, as this noise lies outside of the deterministic processes underlying our understanding of the system behavior. Finally, a reference mode is an integrated fabric that can only be visualized in the abstract, although it can be represented in a graphical form on a two-dimensional block (p. 5).

The problem focus in the study suggested the need for four sets of reference modes, as follows: (1) HIV/AIDS prevalence, incidence, and mortality; (2) HIV/AIDS prevention and care funding; (3) HIV/AIDS prevention and care service system quality;

(4) HIV/AIDS-related stigma and complacency (see Figures 3.3 to 3.6). The curves presented in these figures capture, to the best knowledge available, the essential shape of change over time for a given construct of interest. Note that how and why these hypothesized ‘shapes of change’ impact the dynamics of the problem is what the formal system dynamics model is ultimately intended to explain and validate.

Data used to create the reference modes in Figure 3.3 were obtained from quantitative data collected by MDCH from 1983 to 2000 (MDCH, 2000a). Note that the number of persons living with HIV/AIDS appears to increase rapidly from 1988 through 2001 and beyond. Data used to create the reference modes in Figure 3.4 were obtained from quantitative data collected by the Kaiser Family Foundation for fiscal years 1995, 1997, 1999 (Foster et al., 1999). Here it can be seen that funding for care services has dwarfed funding for prevention services from approximately 1988 onward. In contrast, data used to create the reference modes in Figures 3.5 and 3.6 were based upon a number of studies and reports (Doka, 1997; Gilmore & Somerville, 1994; Herek & Capitanio, 1993; Kowalewski, 1990; Letine et al., 2000; Lounsbury, 1997; Schag et al., 1992; St. Martin, 1996), some of a purely qualitative nature, about how communities have responded to the epidemic. These two reference modes indicate that the quality of care services is currently superior to the quality of prevention services, but that this has not always been the case. From 1981 until approximately 1998 core key informants located prevention service quality as higher, or more effective, than care service quality. Additionally, reference modes presented in Figures 3.5 and 3.6 were affirmed through interview data provided by the study’s core key informants. These reference modes show that HIV/AIDS-related stigma has stayed very high through the entire time horizon and

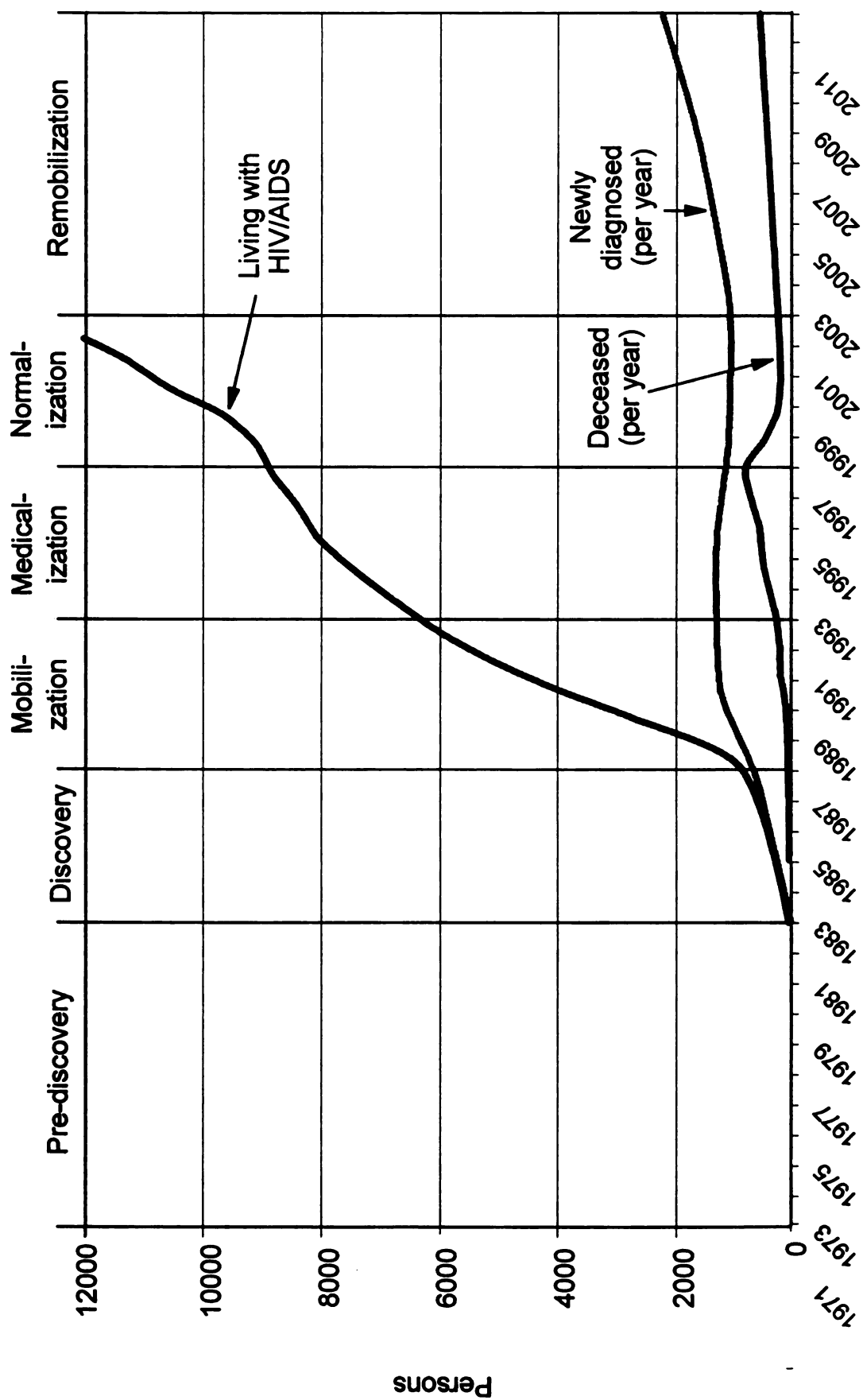


Figure 3.3 - Reference modes for HIV/AIDS prevalence, incidence, and mortality in Michigan

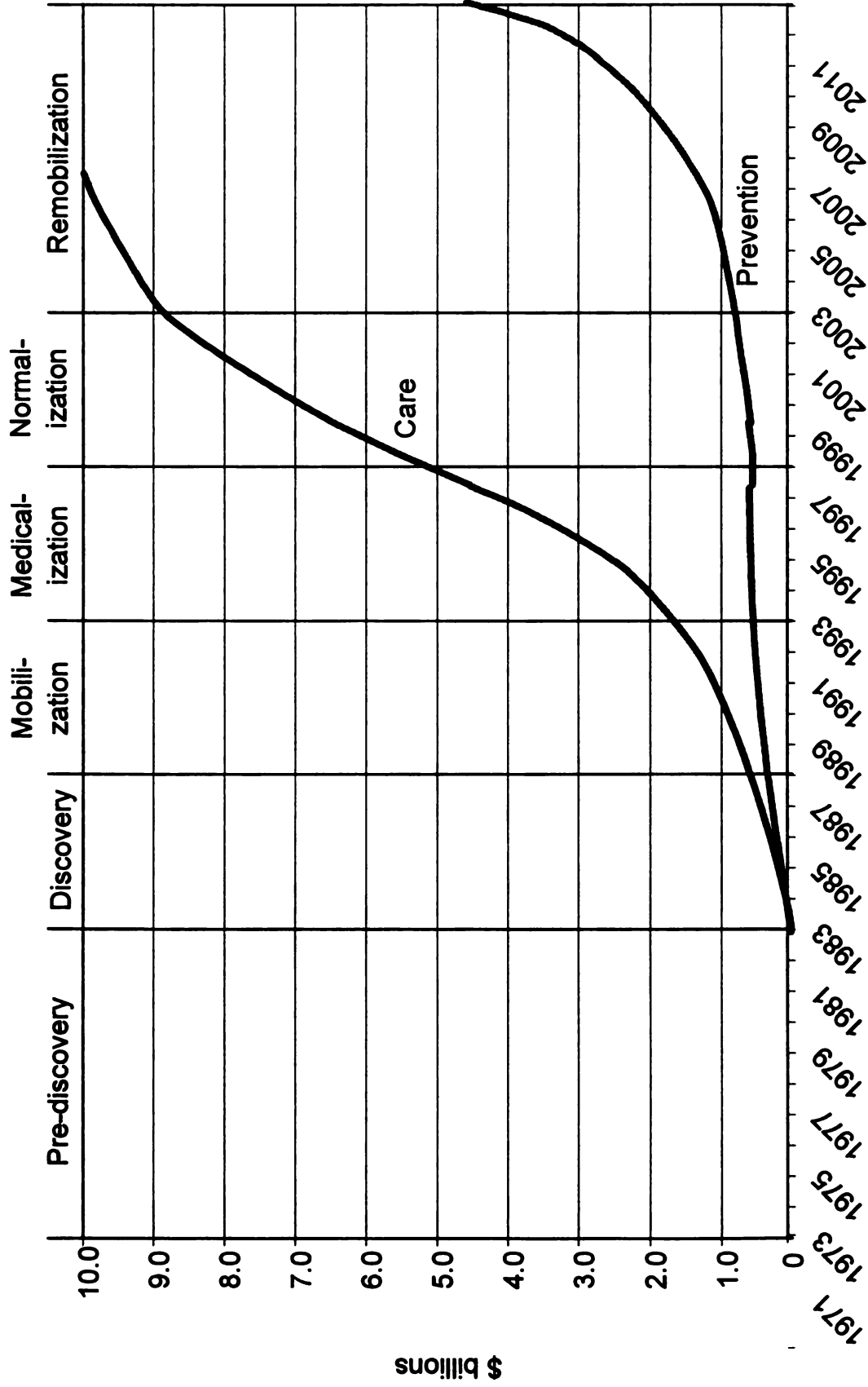


Figure 3.4 - Reference modes for HIV/AIDS-related care and prevention funding in the United States

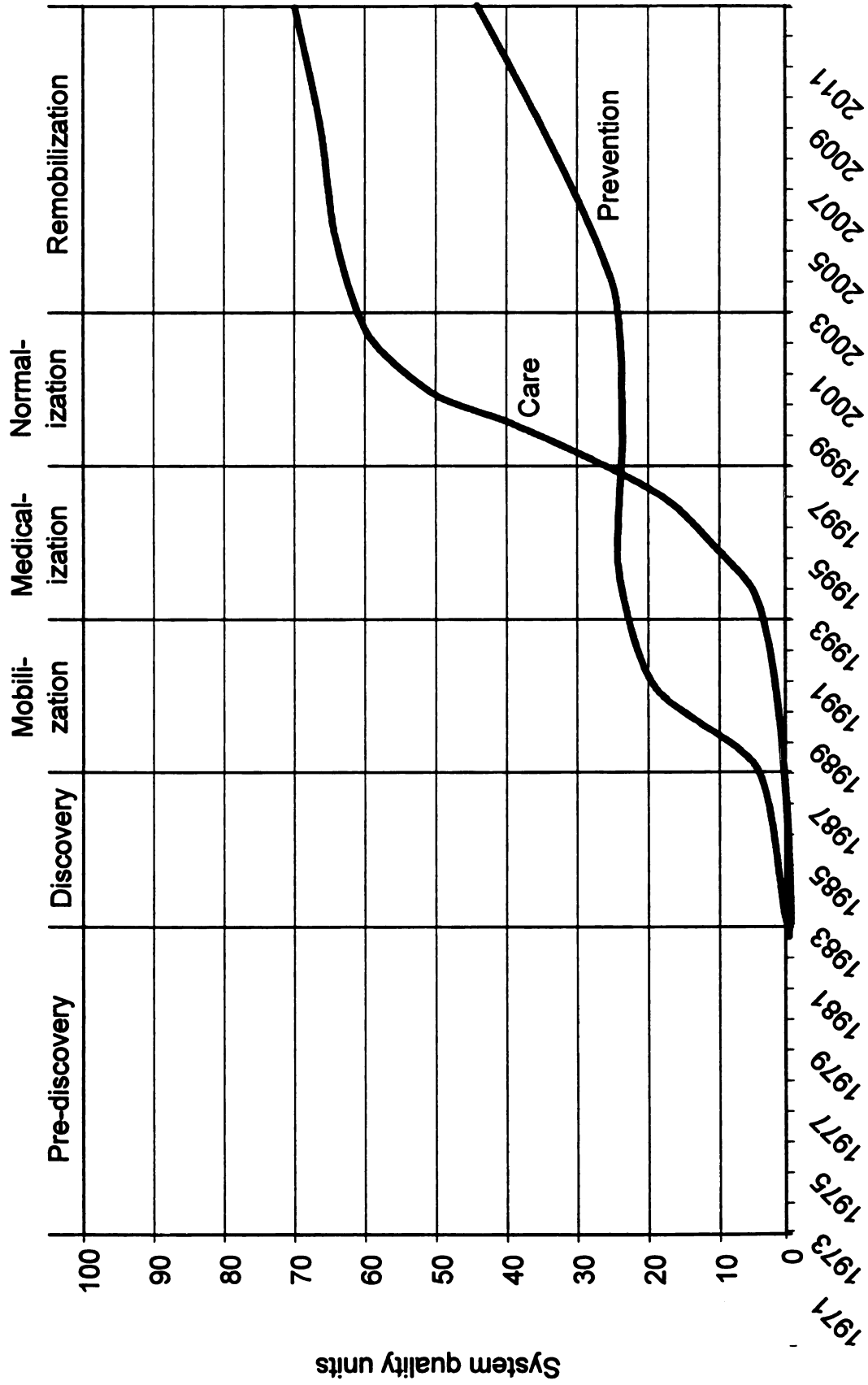


Figure 3.5 - Reference modes for quality of HIV/AIDS prevention and care services

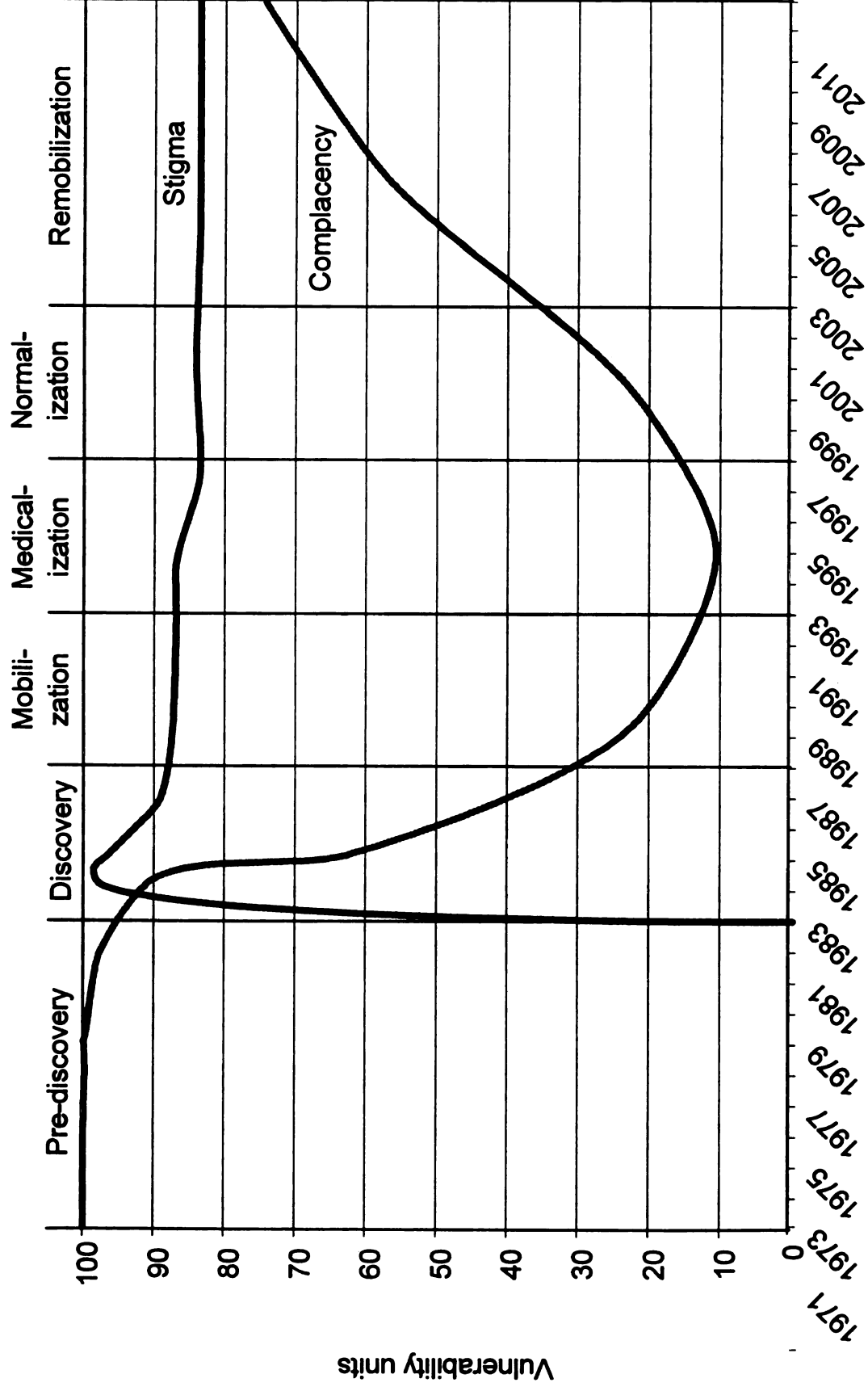


Figure 3.6 - Hypothesized reference mode for HIV/AIDS-related stigma and complacency

that complacency about HIV/AIDS has dipped dramatically since the early years of the epidemic, but may be increasing somewhat now and in the near future.

Building and Validating the Base Case Model

Generating the causal loop diagrams that described the study's key dynamic processes occurred in tandem with the development of the formal (i.e., mathematical) system dynamics model. As noted previously, the formal system dynamics model is a mathematical representation of stock (i.e., accumulation) and flow (i.e., rate of change). The concept of stock-and-flow is the essence of modern calculus. Using calculus to define and study complex processes has become an easier task as new software packages [such as Powersim (1994), which was used in the current study] have been successfully developed and marketed.

Stocks are the fundamental components of any system dynamics model. Stocks characterize the state of the system by allowing insight into its behavior. Forrester (1992) notes that:

Levels [stocks] are the inputs to the flow of decisions. Decisions control flow rates to and from levels. The flow rates cause changes in levels. But flow rates themselves are not inputs to the decisions. Instantaneous present rates of flow are in general measurable and unknown and cannot affect present instantaneous decision making. Only rates resulting from decisions change levels. Only levels control decisions and rates of flow (p. 54).

Because stocks accumulate past events, they affect a system's inertia and memory. A system's inertia can be defined as the sum of its delays. Stocks function as the source of delays. A delay is any process that reveals a lag, or a difference, between material or informational inflows and outflows. Essentially, stocks 'absorb' the differences in inflows and outflows, which account for the generation of system disequilibrium. Sterman (2000) explains that:

In equilibrium, the total inflow to a stock equals its total outflow so the level of the stock is unchanging. However, inflows and outflows usually differ because they are often governed by different system decision processes. Disequilibrium is the rule rather than the exception (p. 196).

The model built in the study is comprised of many stocks, both material and informational. Some stocks register increases or decreases in number of persons (i.e., material accumulation), others register increases or decreases in aggregate attitudes or perceptions of persons (i.e., information accumulation), still other register increases or decreases in the amount of a particular resources, such as funding (i.e., material accumulation). Details regarding units of both stocks and flows included in the base case model will be presented in Chapter 4. The following text provides the reader with additional information about how to read stock-and-flow diagrams.

Stock-and-flow Diagram Symbols

Stocks are typically represented by rectangles. Inflows are represented by pipes with arrows at one end pointing to a particular stock to indicate *addition*. Outflows are also represented by pipes that point out of a particular stock to indicate *subtraction*. Rates, or valves, control the inflow(s) and the outflow(s) to a given stock. Clouds represent the sources or sinks for the flows. Clouds at the end of an inflow pipe indicate that the source of a given material or information is coming from outside the boundary of the model (i.e., its generation is exogenous to the model). Clouds at the end of an outflow pipe indicate that material or information is leaving the boundary of the model.

Figure 3.7 presents a generic example of a simple stock-and-flow diagram. The diagram's corresponding equations may be written for the integral equation and the differential equation, respectively, as follows:

$$\text{Stock}(t) = \int_{(t_0 \rightarrow t)} [\text{Inflow}(s) - \text{Outflow}(s)]ds + \text{Stock}(t_0)$$

$$d(\text{Stock})/dt = \text{Net change in Stock} = \text{Inflow}(t) - \text{Outflow}(t).$$

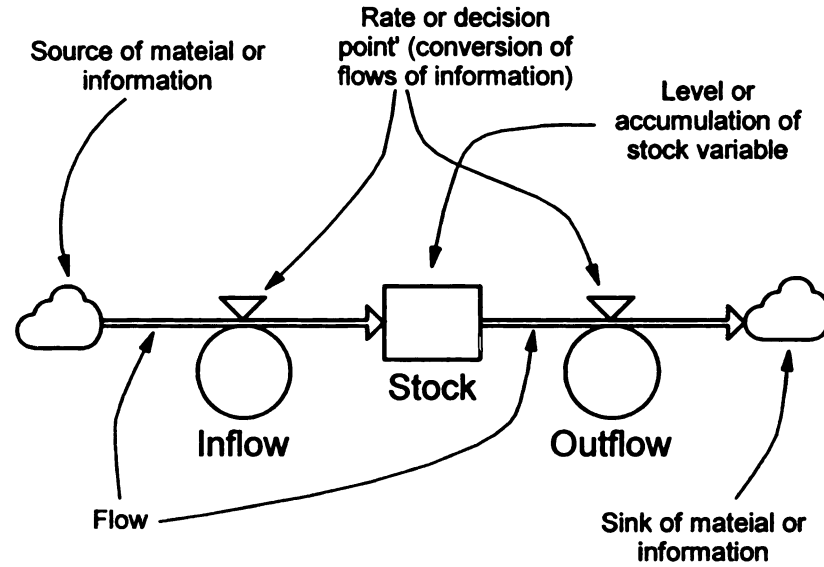


Figure 3.7 - Example of a simple stock-and-flow diagram

Other common symbols used in stock-and-flow diagrams are shown and defined in Figure 3.8. These include constants, auxiliaries, and table functions, each of which can be used to formulate rates of inflow or outflow to a stock. An example taken directly from the base case model developed in the current study is featured in Figure 3.9. Its corresponding equations are shown in Table 3.3. In the example, the stock variable is newly HIV infected persons (Epi_NI). The dimension, or unit, for this variable is ‘persons.’ Its value rises and falls over time depending upon the rate of inflow (Infect_r) and outflow (Seroconvert_r). The rate of inflow (Infect_r) is a function of the total number of persons living with HIV/AIDS in the state (Total_HIV_pos_p), the number of contacts per person at risk of infection (Contacts_per_at_risk_p), and chance of infection

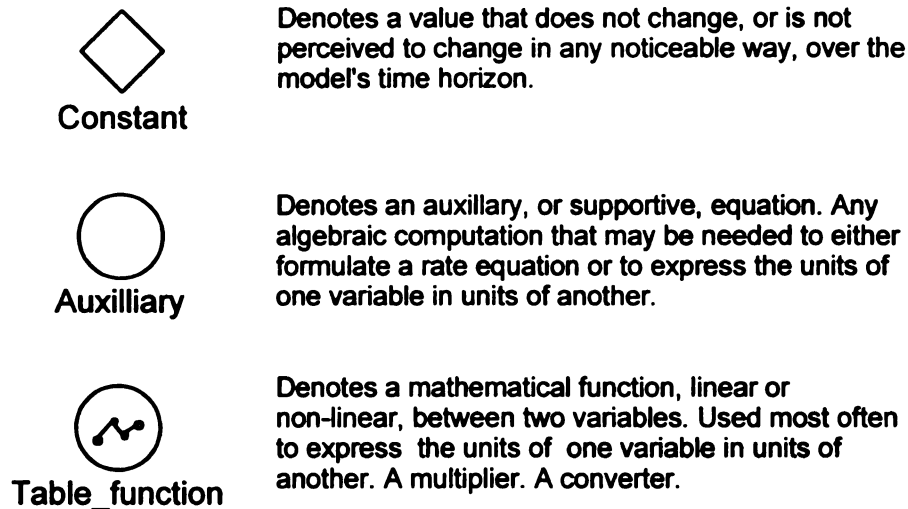


Figure 3.8 - Other notations used in stock-and-flow diagrams

(Chance_infection). The rate of outflow (Seroconvert_r) is simply a function of time to seroconvert (SC_t), which for the current model was set to 6 months.

Note that Contacts_per_at_risk_p and Chance_infection are table functions.

Contacts_per_at_risk_p is defined as a non-linear, monotonically increasing function that relates the proportion of persons at risk (0.0 to 1.0) to a specific number of contacts per month (0 to 8 contacts per person). Chance_infection is also defined as a non-linear, monotonically increasing function that relates average level of prevention complacency (PC; 0 to 100 units per person) to chance_infection (0.000 to 0.008). Note that three of the auxiliary variables are undefined (?). This is because the terms used to build their respective equations were not included in this diagram. Total_HIV_pos_p, for example, is defined as the sum of two other variables, total number of HIV diagnosed persons (Total_diag_p) and total number of uninfected, or undiagnosed, persons (Total_undiag_p).

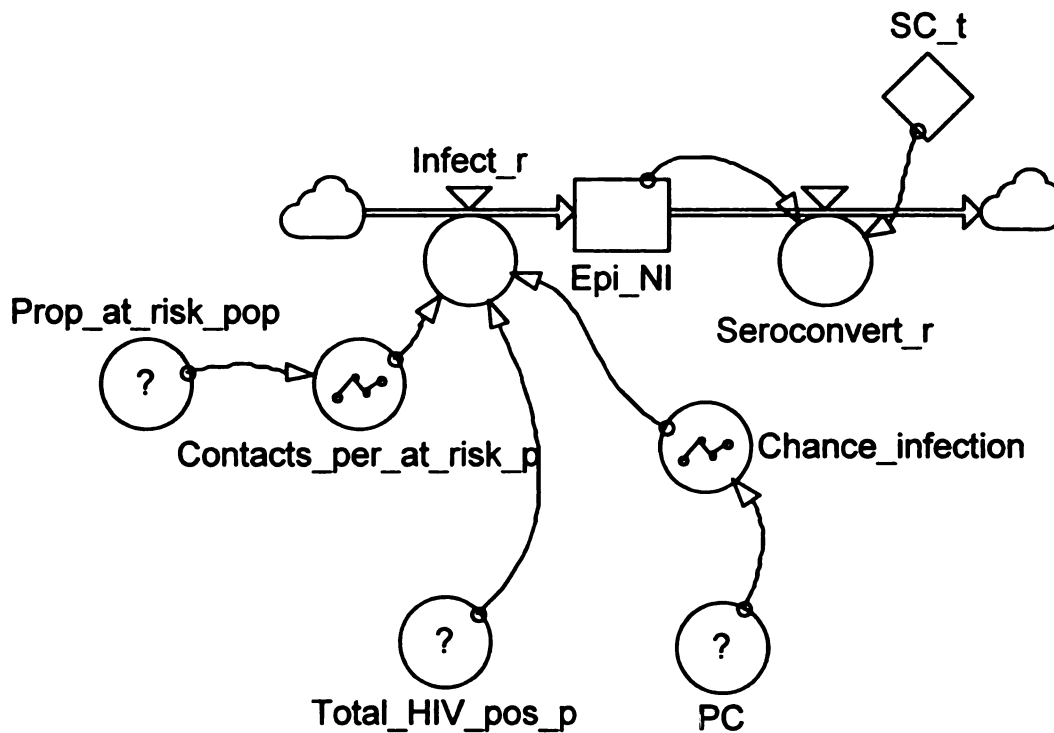


Figure 3.9 - Example of a stock-and-flow diagram

Modeling-building Technique

The completed base case system dynamics model is a mathematical representation of the full set of 13 causal loops that were ultimately used to define the study's problem focus. To achieve this end, causal loops were translated into stock-and-flow diagrams one by one, tested by generating simulation output (i.e., time series data and/or one or more behavior-over-time graphs), which was then examined for errors in parameter values or problematic model behaviors. Stock-and-flow diagrams were then modified and a new simulation run would be executed. This cycling of translation and model simulation continued until all causal loops were programmed and until the guidelines for model validation were adequately assessed and confirmed. Details regarding the model's stock-and-flow equations are presented in Chapter 4.

Table 3.3 - Variable types, equations, and definitions for Figure 3.9

Type	Equation	Definition
flow init	$Epi_NI = (+dt * Infect_r) - (-dt * Seroconvert_r)$ $Epi_NI = 500$	Newly infected persons.
aux	$Infect_r =$ $Total_HIV_pos_p * Contacts_per_at_risk_p * Chance_infection$	Rate of change in new HIV cases per month.
aux	$Seroconvert_r = Epi_NI / SC_t$	Rate of change of persons who seroconvert.
aux	$Chance_infection =$ $GRAPH(PC, 0, 10, [0, 0.00021, 0.00028, 0.00035, 0.00049, 0.00063, 0.0007, 0.00161, 0.00393, 0.00607, 0.008] \text{ "Min:0;Max:0.008;Zoom"})$	Probability of becoming infected with HIV as a function of prevention complacency across all epidemiological groups.
aux	$Contacts_per_at_risk_p =$ $GRAPH(Prop_at_risk_pop, 0, 0.05, [0, 2.18, 3.02, 3.93, 4.49, 4.98, 5.68, 5.96, 6.18, 6.46, 6.74, 7.02, 7.23, 7.44, 7.51, 7.72, 7.79, 7.86, 7.93, 8, 8] \text{ "Min:0;Max:8;Zoom"})$	Effect of average prevention complacency on exposure to HIV among vulnerable persons.
aux	$PC =$ $AVG(PC_EHU, PC_LHDWC, PC_LHD, PC_LHU, PC_MHDWC, PC_MHD, PC_MHU, PC_NI)$	Average prevention complacency.
aux	$Prop_at_risk_pop =$ $MI_vul_pop / (MI_vul_pop + Total_HIV_pos_p)$	Proportion of population at risk.
aux	$Total_HIV_pos_p = Total_diag_p + Total_undiag_p$	Total persons living with HIV/AIDS in Michigan per month.
const	$SC_t = 6$	Estimated time required to seroconvert (i.e., develop HIV antibodies).

Model Validation Procedure

In general, the ultimate validation of the formal system dynamics model occurs gradually as it is found to be increasingly accepted by members of the target audience for which it was created in the first place (Forrester & Senge, 1980). Consistent with this premise, the process of building and validating the system dynamics model in the current study was an exercise in packaging the collective intuition of the system dynamicist and his core key informants. At every step in the process of *modeling for understanding*, a

review of available information about the model's structure and behavior was requested of one or more core key informants by the system dynamicist. Their feedback was then used to inform decisions about 'next steps' in the construction of the model.

It is important to note that system dynamics, as a methodology, allows tests about 'change' that are simply not possible, or reachable, with other types of models commonly used in the social sciences (e.g., correlational models, including multiple regression models, structural equation models, and other multi-variate statistical techniques). Moreover, standard hypotheses testing using inferential statistical methods is generally either inappropriate or, at most, supplemental to the work of understanding and interpreting the meaning of a given system dynamics model. In the current study, validation procedures developed by Manni and Cavana (2000) and by Coyle (1996) were found to be most useful and appropriate (see Tables 3.4 and 3.5). Note that these procedures are based upon the work of Forrester and Senge (1980) and Coyle (1983) regarding model validity. More about how these guidelines were attended to in the study will be explained in Chapters 4 and 5.

Table 3.4 - Categories of tests used for model validation

No.	Validation test category
1	Verification tests, which are concerned with verifying that the structure and the parameters of the system have been correctly incorporated into the model.
2	Validation tests, which address the extent to which the simulated behavior of the model is like the actual 'real world' problem behavior it is intended to represent.
3	Legitimation tests, which affirm that the model follows commonly accepted principles or rules of system structure.

Table 3.5 - Guidelines for model validation

No.	Validation guideline
1	The behavior of the model must be plausible (i.e., it should generate output that is 'realistic').
2	The model must not produce nonsensical values, such as 'negative persons.'
3	The causal loop diagram must correspond to the statement of the problem.
4	The equations must correspond to the causal loop diagram (i.e., must match the qualitative representation of inflow and outflow).
5	The model must be dimensionally valid (i.e., the units of measurement or quantification of the constructs or variables on each side of the equation should be the same).
6	For material (i.e., physical) variables, the model should maintain 'conservation of flow.' (i.e., what enters the system should be accounted for at any point within the model's time horizon).

CHAPTER 4

MODEL CONSTRUCTS

This chapter describes the 15 constructs that were ultimately included in the base case system dynamics model. It is the objective of this chapter to explain how and why each of these constructs was included in the final version of the base case model. For the purpose of presentation, these constructs have been organized into three groups: one for each conceptual domain of focus in the study (i.e., *epidemiological burden*, *HIV/AIDS intervention*, and *psychosocial vulnerability*). The epidemiological burden domain includes two constructs: (1) HIV/AIDS epi burden and (2) HIV symptoms. HIV/AIDS intervention domain includes four constructs: (1) Care system quality, (2) prevention system quality, (3) care resources, and (4) prevention resources. The Psychosocial domain includes nine constructs. Six of the nine are *psychological* in nature. The remaining three constructs are *behavioral* in nature. The psychological constructs include: (1) Satisfaction with care system quality, (2) satisfaction with prevention system quality, (3) perceived treatment efficacy, (4) perceived HIV-related stigma, (5) self-concept, and (6) system awareness. The behavioral constructs include: (1) System change action, (2) care complacency, and (3) prevention complacency.

Note that constructs from one domain may have a direct causal link to constructs in the other two domains. Recall that system dynamics is a method that is explicitly designed to work with *dynamic interdependency*. How the causal linkages among

constructs were determined was an outcome of the process of *modeling for understanding*. A series of tables summarizing important information about each of the constructs in the model have been created for this chapter. Table 4.1 presents a complete set of construct definitions. Table 4.2 provides a breakdown of constructs by their generic mathematical structure (see Appendix C for a detailed description of generic mathematical structures used in the model). Table 4.3 compares the range of numeric values for each construct and specifies its unit of analysis. Table 4.4 details information about each constructs' initial value at time zero. Table 4.5 shows direct effects, or antecedent effects, for each construct (see Appendix D for a detailed description of antecedent effects and antecedent effect functions in system dynamics models). Information from these tables will be referenced as needed throughout the remainder of this chapter.

In addition, note that each construct is literally a set, or a *nexus*, of different types of variables, including stocks, rates, constants, auxiliaries, table functions, links, and flows. This will become apparent when the appendices that feature the actual model diagrams are reviewed (see Appendices E, F, and G). For the purpose of easy reference to diagrams for specific constructs, an alphabetic ID sequence has been created, beginning with 'A' for HIV/AIDS epi burden and ending at 'O' for prevention complacency. In total, the base case model's constructs are comprised of 992 variables (of which 91 are stocks, 660 are auxiliaries/table functions, and 175 are constants). These variables are connected via 1,700 links or flows.

Table 4.1 - Construct definitions

Domain	Construct ID	Construct name	Construct abbr.	Definition
Epi burden	A	HIV/AIDS epi burden	Epi	Collective load, or pressure, experienced by communities affected by HIV/AIDS in Michigan. Indicated by HIV/AIDS prevalence, incidence, and/or mortality. Represented by a vector of eleven (11) epidemiological stocks of persons, or subpopulations, living with HIV/AIDS and their associated flow through a process of disease progression and treatment.
Epi burden	B	HIV symptoms	Symptom	Extent to which PLWHA manifest physical signs of their disease. Represented by a vector of eight (8) epidemiological computations of the average number of HIV-related symptoms a given subpopulation of PLWHA is expected to endure given their disease stage and their access to care (i.e., treatment).
HIV/AIDS intervention	C	Care system quality	CSQ	Overall effectiveness of the services and infrastructure put in place to provide HIV/AIDS health care and support services (e.g., hospitals, clinics, community-based HIV/AIDS organizations). Specifically, the ability to meet the care needs of PLWHA and affected family and friends as described in Michigan's Statewide Coordinated Statement of Need (SCSN) (Lounsbury, 2001). Represented by a single service stock.

Table 4.1 - Construct definitions

Domain	Construct ID	Construct name	Construct abbr.	Definition
HIV/AIDS intervention	D	Prevention system quality	PSQ	Overall effectiveness of the services and infrastructure put into place to prevent new cases of HIV (e.g., informational campaigns, community interventions, access to condoms/clean needles). Specifically, the ability to identify priority populations for HIV prevention services and to delivery effective services to meet the needs of the persons who comprise these populations as described in Michigan's Comprehensive Plan for HIV/AIDS Prevention (MHAC, 2001). Represented by a single service stock.
HIV/AIDS intervention	E	Care resources	CR	Material and human resources made available to HIV/AIDS care organizations throughout Michigan by a consequence of system change action on behalf of the care service system and a given level of funding for HIV/AIDS health care and support services. Represented by a single service stock.
HIV/AIDS intervention	F	Prevention resources	PR	Material and human resources made available to HIV prevention organizations throughout Michigan by a consequence of system change action and a given level of funding for informational campaigns, community interventions, access to condoms/clean need that will decrease HIV incidence. Represented by a single service stock.
Psychosocial vulnerability	G	Satisfaction with care system quality	SCSQ	Extent to which members of each of the epidemiological subpopulations perceive that available health care and support for PLWHA is accessible and efficacious. Represented by a vector of eight (8) psychosocial information stocks.

Table 4.1 - Construct definitions

Domain	Construct ID	Construct name	Construct abbr.	Definition
Psychosocial vulnerability	H	Satisfaction with prevention system quality	SPSQ	Extent to which members of each of the epidemiological subpopulations perceive that available HIV prevention services for all members of the community are accessible and efficacious. Represented by a vector of eight (8) psychosocial information stocks.
Psychosocial vulnerability	I	Perceived treatment efficacy	PTE	Extent to which members of each of the epidemiological subpopulations believe that available clinical treatments, including the use of Highly Active Anti-retroviral Therapies (HAART), are able to manage, or control, the progression of HIV disease. Represented by a vector of eight (8) psychosocial information stocks.
Psychosocial vulnerability	J	Perceived HIV-related stigma	PHS	Extent to which members of each of the epidemiological subpopulations shoulder a personal sense of being viewed by others as less worthy or less valuable (because they perceive that their community enforces stereotypical profiles of people thought to be at high-risk of HIV/AIDS, i.e., men who have sex with men, substance users, commercial sex workers, persons of color, persons living in poverty). Represented by a vector of eight (8) psychosocial information stocks.

Table 4.1 - Construct definitions

Domain	Construct ID	Construct name	Construct abbr.	Definition
Psychosocial vulnerability	K	Self-concept (Empowerment)	SC	First component of a 3-component, dynamic definition of psychological empowerment. Extent to which members of the epidemiological subpopulations see themselves as self-assured, capable, respectable. Similar to other psychological constructs such as self-esteem, self-efficacy. Also, the absence of depression. It is directly influenced by both system awareness and system change action. Represented by a vector of eight (8) psychosocial information stocks.
Psychosocial vulnerability	L	System awareness (Empowerment)	SA	Second component of a 3-component, dynamic definition of psychological empowerment. Extent to which members of the epidemiological subpopulations know about the state of prevention and care services in Michigan. Specifically, the degree to which they actually understand how to gain access and obtain prevention and care services for themselves and/or for others and how to effectively join and/or create settings for policy analysis, system advocacy, and direct services delivery. It is directly influenced by both self-concept and system change action. Represented by a vector of eight (8) psychosocial information stocks.
Psychosocial vulnerability	M	System change action (Empowerment)	SCA	Third component of a 3-component, dynamic definition of psychological empowerment. Extent to which members of the epidemiological subpopulations actively engage in one or more efforts to improve the quality of the existing prevention and/or care infrastructure. It is directly influenced by both self-concept and system awareness. Represented by a vector of eight (8) behavioral information stocks.

Table 4.1 - Construct definitions

Domain	Construct ID	Construct name	Construct abbr.	Definition
Psychosocial vulnerability	N	Care complacency	CC	Extent to which diagnosed (i.e., tested HIV-positive) PLWHA do not initiate and sustain health care and support services and adhere to prescribed treatments, including Highly Active Anti-retroviral Therapies (HAART). Represented by a vector of four (4) behavioral information stocks.
Psychosocial vulnerability	O	Prevention complacency	PC	Extent to which members of the epidemiological subpopulations do not consistently execute safer-sex and safer-use behaviors to minimize the risk of further spreading HIV. Represented by a vector of eight (8) behavioral information stocks.

Table 4.2 - Constructs by generic mathematical structure

Construct ID	Construct name	Construct abbr.	Generic structure
A	HIV/AIDS epi burden	Epi	Supply chain
B	HIV symptoms	Symptoms	Classical co-flow
C	Care system quality	CSQ	Self-limiting compounding process
D	Prevention system quality	PSQ	Self-limiting compounding process
E	Care resources	CR	External resource production process
F	Prevention resources	PR	External resource production process
G	Satisfaction with care system quality	SCSQ	Hines co-flow
H	Satisfaction with prevention system quality	SPSQ	Hines co-flow
I	Perceived treatment efficacy	PTE	Hines co-flow
J	Perceived HIV-related stigma	PHS	Hines co-flow
K	Self-concept (Empowerment)	SC	Hines co-flow
L	System awareness (Empowerment)	SA	Hines co-flow
M	System change action (Empowerment)	SCA	Hines co-flow
N	Care complacency	CC	Hines co-flow
O	Prevention complacency	PC	Hines co-flow

Table 4.3 - Construct scale, Hines co-flow goal, and unit of analysis

Construct ID	Construct abbr.	Min value	Max value	Hines co-flow goal	Unit of analysis
A	Epi NI	0	Indef.	NA	Persons
A	Epi EHU	0	Indef.	NA	Persons
A	Epi MHU	0	Indef.	NA	Persons
A	Epi LHU	0	Indef.	NA	Persons
A	Epi ADU	0	Indef.	NA	Persons
A	Epi MHD	0	Indef.	NA	Persons
A	Epi LHD	0	Indef.	NA	Persons
A	Epi ADD	0	Indef.	NA	Persons
A	Epi MHDWC	0	Indef.	NA	Persons
A	Epi LHDWC	0	Indef.	NA	Persons
A	Epi ADDWC	0	Indef.	NA	Persons
B	Symptom	0	Indef.	NA	Symptoms/Person
C	CSQ	0	100	NA	System quality units
D	PSQ	0	100	NA	System quality units
E	CR	0	Indef.	NA	Resource units
F	PR	0	Indef.	NA	Resource units
G	SCSQ	0	100	80	Satisfaction units/Person
H	SPSQ	0	100	40	Satisfaction units/Person
I	PTE	0	100	60	Perceived treatment efficacy units/Person
J	PHS	0	100	70	Perceived stigma units/Person
K	SC	0	100	60	Self-concept units/Person
L	SA	0	100	30	System awareness units/Person
M	SCA	0	100	20	System change action units/Person
N	CC	0	100	50	Care complacency units/Person
O	PC	0	100	50	Prevention complacency units/Person

Table 4.4 - Construct Initial value and unit of analysis

ID	Construct abbr.	Initial value												Unit of analysis	
		Epidemiological subpopulations										Global			
		Early stage		Mid stage			Late stage								
				MHU	MHD	MHDWC	LHU	LHD	LHDWC						
		NI	EHU	1000	2	1	45	2	1						
A	Epi	500	500	6	12	2	6	1	2	45	12	8	6	NA	Persons
B	Symptom	1	6											NA	Symptoms/Person
C	CSQ	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	System quality units
D	PSQ	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	System quality units
E	CR	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	Resource units
F	PR	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	Resource units
G	SCSQ	50	50	50	50	50	50	50	50	50	50	50	50	NA	Satisfaction units/Person
H	SPSQ	50	50	50	50	50	50	50	50	50	50	50	50	NA	Satisfaction units/Person
I	PTE	20	20	20	20	20	20	20	20	20	20	20	20	NA	Perceived treatment efficacy units/Person
J	PHS	90	90	90	90	90	90	90	90	90	90	90	90	NA	Perceived stigma units/Person
K	SC	50	50	50	50	50	50	50	50	50	50	50	50	NA	Self-concept units/Person
L	SA	0	0	0	0	0	0	0	0	0	0	0	0	NA	System awareness units/Person
M	SCA	0	0	0	0	0	0	0	0	0	0	0	0	NA	System change action units/Person
N	CC	NA	NA	NA	NA	60	60	60	60	NA	NA	60	60	NA	Care complacency units/Person
O	PC	90	90	90	90	90	90	90	90	90	90	90	90	NA	Prevention complacency units/Person

Note: 'NA' = Not Applicable; Initial values for Epi ADU = 5, ADD = 0, and ADDWC = 0.

Table 4.5 - Summary of antecedent links by key construct

Variable nexus ID	Construct name	Construct abbr.	Antecedent effect
A	HIV/AIDS epi burden	Epi	PC CC
B	HIV symptoms	Symp	Epi
C	Care system quality	CSQ	SCA CR
D	Prevention system quality	PSQ	SCA PR
E	Care resources	CR	Epi CR
F	Prevention resources	PR	Epi PR CR
G	Satisfaction with care system quality	SCSQ	CSQ
H	Satisfaction with prevention system quality	SPSQ	PSQ
I	Perceived treatment efficacy	PTE	Epi
J	Perceived HIV-related stigma	PHS	PSQ Symp
K	Self-concept (Empowerment)	SC	PHS SA SCA
L	System awareness (Empowerment)	SA	SC SCA
M	System change action (Empowerment)	SCA	SPSQ SCSQ SC SA
N	Care complacency	CC	CSQ SC PTE
O	Prevention complacency	PC	PTE SC PHS

Epidemiological Burden

The epidemiological burden domain is comprised of two constructs: (1) HIV/AIDS epidemiological burden [Epi] and (2) HIV symptoms [Symptom]. These constructs were used to model the dynamics of risk of infection (i.e., HIV susceptibility) and disease progression (living with HIV/AIDS).

HIV/AIDS Epidemiological Burden

HIV/AIDS epi burden was defined as the number of persons affected by HIV/AIDS in Michigan. Note that epi burden can be assessed in terms of prevalence, incidence, and mortality. The construct was represented as a vector of eleven (11) stocks of persons, or subpopulations, that represent the process of disease progression and treatment, from the moment of HIV infection to AIDS-related death (see Table 4.1). Its generic mathematical structure was the ‘supply chain.’ A supply chain structure is commonly used to describe a multi-staged process used to deliver something (either material or informational) from point A to point B (see Table 4.2; for greater detail about the ‘supply chain’ structure, see Appendix C).

As shown in Table 4.3, epi burden’s unit of analysis was *persons*. Stock variables for epi burden have a minimum value of zero and an indefinite maximum value. As shown in Table 4.4, initial values for epi burden stocks ranged from as high as 1000 persons to as low as 0 persons. These initial values reflect the assumption that, back in 1983/84, a substantial number of Michiganders would have been living with HIV, although none were diagnosed. Official epidemiological data to support these estimated initial values were not available. However, as will be shown in Chapter 5, they adequately reproduced MDCH reference modes for HIV/AIDS starting in 1983/84. Two other constructs were hypothesized to have a direct effect on epi burden, namely prevention complacency (PC) and care complacency (CC).

Population disaggregation. In terms of developing the base case model, this construct was the first and most important to be designed. Its disaggregation (i.e., the structure) determined the extent to which all psychosocial and behavioral constructs

could be disaggregated. A number of options about how best to structure this construct were identified by core key informants and other data sources used for the study. For example, demographic characteristics such as gender, race/ethnicity, sexual orientation, and substance use were all considered. Ultimately, none of these were incorporated into the model. Although these characteristics were affirmed to be important to understanding particular types of HIV/AIDS issues, it was decided that the base case model would not be used to explicitly explore the dynamics of a specific demographically defined population. However, future work could include adaptations of the current base case model that would facilitate exploration of problems or concerns related to one or more of these demographic characteristics.

The final disaggregation of the epi burden construct for the base case model was based upon two criteria: (1) disease stage and (2) treatment status. In particular, core key informants underscored the need for the model to address how prevention services impacted HIV testing behavior and how disease stage affected decisions to engage or reject the care services.

Figure 4.1 shows a partial disaggregation of the five major epidemiological subpopulations included in the base case model. These subpopulations show how persons move from the point of HIV infection to AIDS-related death. Analysis of interview data from core key informants as well as other sources (e.g., CDC, 2001d) suggested that these five subpopulations ought to be further disaggregated for the purpose of model validation as well as for eventual policy innovation. These additional, qualitatively important subpopulations included the following: (1) persons at-risk of contracting HIV, (2) persons who had tested positive but who were not yet in care, (3) persons who had

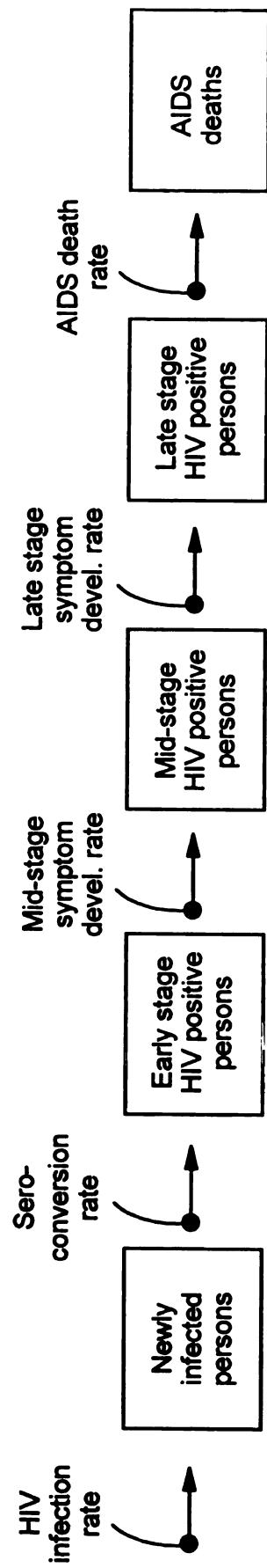


Figure 4.1 - Stock-and-flow of main HIV/AIDS epidemiological subpopulations in the model

tested positive and who were currently in care, and (4) persons who had tested positive who had dropped out of care.

Figure 4.2 shows the final disaggregation of the Epi construct with estimated time delays. As shown here, the four other qualitatively important epidemiological subpopulations were included in the model. Table 4.6 provides a definition and abbreviation for each subpopulation included the model. Note that although persons at-risk (i.e., persons not yet infected with HIV) are not included here as in independent stock variable, they are ‘observable’ in terms of changes in the HIV infection rate. For the purposes of the base case model, persons at-risk were operationally defined as the model’s originating flow of persons entering the system (i.e., 10% of Michigan entire population, which was based upon U.S. Census information for 1970, 1980, 1990, and 2000).

Sample epidemiological time scenarios. A quick evaluation, or ‘check,’ of the time delays associated with the epidemiological sector further explains the structure of the epi burden construct. Using the time delays from the model as shown in Figure 4.2, Table 4.7 presents five epidemiological time scenarios that illustrate how disease stage (i.e., early, mid, late) and treatment (i.e., full care, no care, care drop out) affect post-infection longevity. Comparison of the five estimates of total years of life with HIV shows that learning about one’s HIV status earlier and seeking care earlier can be beneficial, which is consistent with much of the research about disease progression (CDC, 2001d; Gallant, 2000; Graham et al., 1992; Hendriks et al., 1993).

Note that the estimated time delays are not meant to be precise predictions of longevity, although they are in line with current averages reported by the CDC. Recent

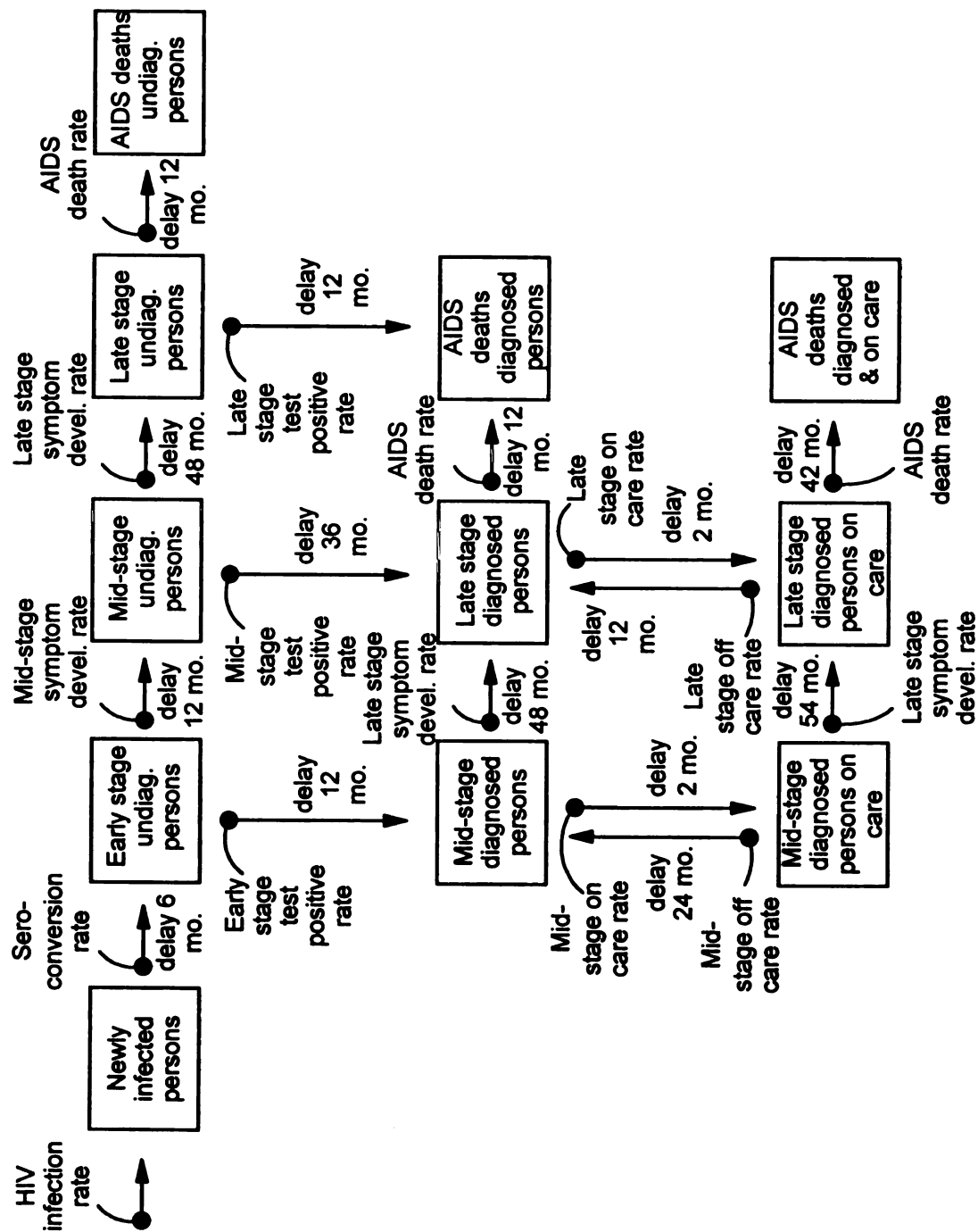


Figure 4.2 - Disaggregated stock-and-flow of HIV/AIDS epidemiological subpopulations

Table 4.6 - Epidemiological population disaggregation

Construct ID	Epidemiological subpopulation	Subpopulation abbr.	Definition
A	Newly infected persons	Epi NI	Persons who have recently been infected with HIV (0 to 6 months), but who have not yet seroconverted.
A	Early HIV undiagnosed persons	Epi EHU	Persons who have recently seroconverted (i.e., would receive positive results from an HIV antibody test) but who have not yet presented for an HIV test.
A	Mid HIV undiagnosed persons	Epi MHU	Persons who have been living with HIV for more than 18 months but less than 5 years who have not yet tested for HIV.
A	Late HIV undiagnosed persons	Epi LHU	Persons who have been living with HIV for more than 5 years but less than 7 years who have not yet tested for HIV.
A	AIDS-related deaths among undiagnosed persons	Epi ADU	Persons who have succumbed to complications due to HIV/AIDS who never presented for testing and therefore were never known to be HIV positive until their death.
A	Mid HIV diagnosed persons	Epi MHD	Persons who have tested positive for HIV within 18 months of being infected but who are NOT currently receiving formal HIV/AIDS care services.
A	Late HIV diagnosed persons	Epi LHD	Persons who have tested positive for HIV within 4.5 years of being infected but who are NOT currently receiving formal HIV/AIDS care services.
A	AIDS-related deaths among diagnosed persons	Epi ADD	Persons who have tested positive for HIV and who succumbed to complications due to HIV/AIDS at a point when they were not receiving any formal HIV/AIDS care services.
A	Mid HIV diagnosed persons with care	Epi MHDWC	Persons who have tested positive for HIV within 20 months of being infected who are currently receiving some degree of formal HIV/AIDS care services.

Table 4.6 - Epidemiological population disaggregation

Construct ID	Epidemiological subpopulation	Subpopulation abbr.	Definition
A	Late HIV diagnosed persons with care	Epi LHDWC	Persons who have tested positive for HIV within 4.7 years of being infected who are currently receiving some degree of formal HIV/AIDS care services.
A	AIDS-related deaths among diagnosed persons with care	Epi ADDWC	Persons who have tested positive for HIV and who are succumbed to complications due to HIV/AIDS while receiving some degree of formal HIV/AIDS care services.

Table 4.7 - Selected epidemiological time scenarios

Time delay segment	Time scenario description (months)				
	Early test	Mid-stage test	Late test or no test	Early test	Early test
	Full care	Full care	No care	Mid-stage care drop out	Late stage care drop out
Time to seroconvert	6	6	6	6	6
Time to develop mid-stage symptoms (undiagnosed)		12	12		
Time to develop late stage symptoms (undiagnosed)			48		
Time to death (undiagnosed)					
Time to test positive (early stage)	12	36		12	12
Time to test positive (mid-stage)					
Time to test positive (late stage)			12		
Time to begin care (mid-stage)	2			2	2
Time to end care (mid-stage)				12	
Time to begin care (late stage)		2			12
Time to end care (late stage)					
Time to develop late stage symptoms (diagnosed, no care)				48	
Time to death (diagnosed, no care)				12	12
Time to develop late stage symptoms (diagnosed, with care)	54				54
Time to death (diagnosed, with care)	42	42			
Total months	116	98	78	92	98
Total years	9.7	8.2	6.5	7.7	8.2

treatment advances have added approximately 3 to 4 years of life, bringing the average total disease process from point of infection to AIDS-related death to 11 years (CDC, 2001d). The model's epidemiological time scenarios reflect these numbers. By observation it can be seen that both receiving a late HIV positive test result and never actually learning about being HIV positive are associated with the fastest course of disease progression (6.5 years). In contrast, seeking testing soon after seroconversion and moving and staying in care is associated with the slowest course of disease progression (9.7 years). Having affirmed the reasonableness of basic delay structure of the model, more complex dynamics concerning the actual quality of services and community perceptions and reactions to HIV/AIDS burden could be explored.

HIV Symptoms

HIV symptoms (Symptoms) was defined as the extent to which PLWHA manifest physical signs of their disease. It was represented by a vector of eight (8) epidemiological computations of the average number of HIV-related symptoms a given subpopulation of PLWHA is expected to endure given their disease stage and their access to care (i.e., treatment) (see Table 4.1). It's generic mathematical structure was the 'classical co-flow' (see Table 4.2; for greater detail about the 'classical co-flow' structure, see Appendix C). The classical co-flow structure is used to keep track of an attribute of a stock variable as its level changes over time. The classical co-flow was selected for HIV symptoms because it allowed the modeler to simulate differing average levels of symptoms for different subpopulations and to keep track of these average levels as persons move through the system.

As shown in Table 4.3, its unit of analysis was *symptoms per person*. For any given subpopulation, the average level of HIV symptoms could be as low as zero. A maximum level of symptoms was allowed to vary over time. It was indefinite. Table 4.4 shows that HIV symptoms were initially set to as low as 1 per person for newly infected persons (Epi NI) and as high as 12 per person for undiagnosed persons at the mid-stage (Epi MHU) and the late stage HIV disease (Epi LHU). Conceptually, it was anticipated that the longer one lived with HIV, the more symptoms one would experience, which was consistent with reports from HIV positive core key informants. Expected HIV symptom levels have actually been shown to vary to a high degree among PLWHA (Lifson et al., 1991). In general, various levels of HIV symptoms used in the model are arbitrary, yet conceptually plausible given simulated disease stages and treatment statuses. The only construct that was hypothesized to directly affect HIV symptoms was HIV/AIDS epi burden (see Table 4.5).

HIV/AIDS Intervention

The HIV/AIDS intervention domain is comprised of four constructs that represent both prevention and care approaches to managing HIV/AIDS in the community. They include (1) care resources [CR], (2) prevention resources [PR], (3) care system quality [CSQ], and (4) prevention system quality [PSQ]. Core key informants emphatically underscored the need for strategies that bridged these prevention and care. Understanding how to achieve and maintain the best balance, or mix, of prevention and care was not easy for core key informants to visualize. However, core key informants noted that, in retrospect, their experience in HIV/AIDS was that policy issues about care service delivery were generally more concrete, or easy to plan for and act upon, than prevention

service delivery because there was always an unambiguous criterion of need: the number of reported cases of PLWHA.

Care System Quality

The care system quality (CSQ) construct was defined as the overall effectiveness of the services and infrastructure put into place to provide HIV/AIDS health care and support services (see Table 4.1). Specifically, CSQ was the ability to meet the care needs of PLWHA and affected family and friends as described in Michigan's SCSN) (Lounsbury, 2001. CSQ's generic mathematical structure was the 'self-limiting compounding process' (see Table 4.2; for greater detail about the 'self-limiting compounding process' structure, see Appendix C). Compounding processes generate exponential growth curves, either increasing or decreasing. Self-limiting compounding processes first show exponential growth but then, due to some other factor, flatten out as they approach a particular limit to growth. The expected shape of the resultant curve is like an 'S.'

Representing CSQ with the self-limiting compounding structure is appropriate because, although resource development for both care and prevention have increased steadily since the inception of the HIV epidemic, it is unlikely that these trends will continue. In particular, it was observed that the marginal cost of clinical care services to any given community has increased over time because gains in HIV treatments are requiring greater investments in research and development and more expensive technology and because prevalence of persons living with HIV has increased as a result of increases in longevity and shortcomings of prevention.

CSQ was represented by a single stock variable. Its unit of analysis was *system quality units* (see Table 4.3). It was initialized at one (1) system quality unit. Its range was as low as 0 system quality units and as high as 100 system quality units (see Table 4.4). In general, it was hypothesized that CSQ would exhibit an S-shaped pattern of growth, consistent with the 'limits to growth' archetype (Dowling & MacDonald, 1998; Kim & Anderson, 1998; Senge, 1990). CSQ was hypothesized to be causally impacted by both system change action (SCA) and care resources (CR) (see Table 4.5).

Prevention System Quality

The prevention system quality (PSQ) construct was defined and designed like CSQ, but for prevention instead of care services and infrastructure. PSQ is defined as the overall effectiveness of the infrastructure put into place to prevent new cases of HIV (e.g., informational campaigns, community interventions, access to condoms/clean needles) (see Table 4.1). Specifically, PSQ reflects the ability, or capacity, of the system to identify priority populations for HIV prevention services and to delivery effective services to meet the needs of the persons who comprise these populations, as described in Michigan's Comprehensive Plan for HIV/AIDS Prevention (MHAC, 2001).

Like CSQ, the generic mathematical structure for PSQ was the 'self-limiting compounding process.' Also like CSQ, PSQ was represented by a single stock variable, its unit of analysis was system quality units, and it was initialized at one (1) system quality unit. It ranged from 0 to 100 system quality units (see Tables 4.3 and 4.4). Lastly, PSQ was hypothesized to be causally impacted by both system change action (SCA) and care resources (CR), just as was CSQ (see Table 4.5).

Care Resources

Care resources (CR) were defined as the material and human resources made available to HIV/AIDS care organizations throughout Michigan as a consequence of system change action on behalf of the care service system and a given level of funding for HIV/AIDS health care and support services (see Table 4.1). Its generic mathematical structure was the 'external resource production process' (see Table 4.2; see Appendix C for more detail about this structure). An external resource production process was used to represent the flow of production using as a function of care funding (i.e., the external resource).

The unit of analysis for CR was *resource units*, which had a minimum value of 0 and a maximum value that was indefinite. It was represented by a single stock variable, which was given an initial value of one (1) (see Tables 4.3 and 4.4). With respect to empirical levels of HIV/AIDS-related service resources, it was unequivocally acknowledged that prevention has been historically less well funded than care, although detailed time series data on funding of prevention services relative to care services was not readily available. Current care funding for 2001 in Michigan reached \$18 million, compared with \$6.6 million for prevention (personal communication, Debra Szwejd, November 14, 2001). Note also that the reference mode for HIV/AIDS funding in the United States was affirmed by core key informants to fit funding patterns in Michigan. Collectively, this information was sufficient for the purpose of specifying both CR and prevention resources (PR) in the base case model. CR was hypothesized to be directly causally impacted by the number of persons actually living with HIV/AIDS and available care funding.

Prevention Resources

Parallel to CR, prevention resources (PR) were defined as the material and human resources made available to HIV prevention organizations throughout Michigan as a consequence of system change action and a given level of funding for informational campaigns, community interventions, access to condoms/clean need, etc., that will decrease HIV incidence. It was represented by a single stock variable, which was given an initial value of one (1) (see Table 4.1). Like CR, PR's generic mathematical structure was the 'external resource production process' (see Table 4.2), its unit of analysis was *resource units* (see Table 4.3), which had a minimum value of 0 and a maximum value that was indefinite (see Table 4.4). PR was hypothesized to be directly causally impacted by the number of persons actually living with HIV/AIDS as well as available care funding relative to available prevention funding (see Table 4.5).

Psychosocial Vulnerability

Of particular interest among core key informants was how selected psychological and social constructs impacted the effectiveness of prevention and care services in the community. Thematic analysis of interview data from core key informants (in addition to other sources of information used for the study) identified nine constructs that were included in the base case model. These were: (1) satisfaction with care system quality, (2) satisfaction with prevention system quality, (3) perceived treatment efficacy, (4) perceived HIV-related stigma, (5) self-concept, (6) system awareness, (7) system change action, (8) care complacency, and (9) prevention complacency. Note that first six can be classified a psychological (i.e., attitudinal, cognitive, affective) constructs and the last three as behavioral (i.e., action-oriented) constructs.

The psychosocial constructs have been constructed using the ‘Hines co-flow’ generic structure. The Hines co-flow is a modification of the classical co-flow. Like the classical co-flow, the Hines co-flow stores information about an attribute, or characteristic, of a person or a thing. In addition, the Hines co-flow allows information to ‘move with its owner,’ such that a dynamic average of the attribute is continually assessed as persons, or other objects, move through a given stage-wise process. The Hines co-flow is comprised of two parts: (1) a supply chain structure and (2) a corresponding series of linked ‘smooths.’ A smooth is the dynamic average value of a stock over a specified time interval (e.g., the average level of satisfaction with care system quality computed over a changing or ‘shifting’ 6 month period of time). The behavior of a Hines co-flow structure is a function of both the initial value of the construct as well as the ‘goal,’ or expected ending value of the construct, given a particular period of time (i.e., the model’s time horizon). For more information about the Hines co-flow structure, see Appendix C.

Psychological Constructs

There were six psychological constructs in the psychosocial vulnerability domain. Psychological constructs were attitudinal, cognitive, and/or affective in nature. The following text describes each of them.

Satisfaction with care system quality. Satisfaction with care system quality (SCSQ) was defined as the extent to which members of each of the epidemiological subpopulations perceive that available health care and support for PLWHA is accessible and efficacious. This key construct was represented by a vector of eight (8) information stock variables (see Table 4.1). Its unit of analysis was *satisfaction units per person*. Its

minimum value was 0 satisfaction units per person and its maximum value was 100 satisfaction units per person. The strongest Hines co-flow goal value among all six psychosocial constructs was assigned to SCSQ, set at 80 satisfaction units per person (see Table 4.3). This relatively high value was selected to affirm, or acknowledge, the remarkable strides that have been made regarding clinical treatments for PLWHA. Its initial value was set to 50 satisfaction units per person across all eight subpopulations (see Table 4.4).

Satisfaction with care system quality (SCSQ), as well as satisfaction with prevention system quality (SPQS), were included in the model because they were seen as important motivators for seeking HIV/AIDS-related services, such as an HIV antibody test. Core key informants noted, for example, that if a first-time visit to an HIV/AIDS-related program or agency did not go well, a new client may never come back, or would come back only reluctantly after some period of time had passed. Care system quality (CSQ) was the only hypothesized direct causal effect on SCSQ. Similarly, prevention system quality (PSQ) was the only hypothesized direct causal effect on SPSQ (see Table 4.5).

Satisfaction with prevention system quality. Satisfaction with prevention system quality (SPSQ) was defined as the extent to which members of each of the epidemiological subpopulations perceive that available HIV prevention services for all members of the community are accessible and efficacious. It was represented by a vector of eight (8) information stocks. Its unit of analysis was *satisfaction units per person*. Its minimum value was 0 satisfaction units per person and its maximum value was 100 satisfaction units per person (see Table 4.1).

The goal for SPSQ was set to 40 (see Table 4.3). This low value, compared to SCSQ's goal value of 80, was chosen because core key informants generally agreed that the HIV community has become, over time, substantially more content with the state of the care system than they were with the prevention system. The difference in level of satisfaction between care and prevention was attributed to a better developed care system infrastructure and, more recently, to HIV surveillance reports that continue to show that HIV incidence is on the upswing, particularly in urban, black communities in Michigan (MDCH, 2000a).

The initial value for SPSQ was, like SCSQ, set to 50 satisfaction units per person. In part, this reflects the notion that opinions regarding HIV/AIDS care and prevention services were just emerging in the early years of the epidemic. Until people discovered and used care and prevention services, which took time to develop and put into place, opinion about their quality was neither strong nor weak, hence a value of 50 units per person across all eight subpopulations (see Table 4.4).

Perceived treatment efficacy. Another psychosocial construct, perceived treatment efficacy (PTE), was seen as closely related to CSQ. It was defined as the extent to which members of each of the epidemiological subpopulations believe that available clinical treatments, including the use of HAART, effectively manage, or control, the progression of HIV disease. It was represented as a vector of eight (8) information stocks (see Table 4.1). PTE was understood to affect aspects of prevention as well as care. With respect to prevention, core key informants and recent research indicated that PTE would increase the behavioral sector construct prevention complacency (PC) (CDC, 2001d). With respect to care, core key informants and recent research indicated that higher levels

of PTE lowered the behavioral sector construct Care Complacency (CC) which was mainly about the dynamics of treatment adherence and/or sustaining formal access to clinical services (Carpenter et al., 2000; Chesney et al., 2000; Rabkin & Chesney, 1999). To some extent, core key informants observed that PTE was inflated as a result of advertisements that overstated the positive effects of anti-retroviral therapies (Kelly et al., 1998; Kravcik et al., 1998; Lehman et al., 2000).

PTE's unit of analysis was *perceived treatment efficacy units per person*, and it ranged from a minimum value of zero to a maximum value of 100. Its initial value was 20 units per person across all eight subpopulations, and its goal value was set to 60 perceived treatment efficacy units per person (see Tables 4.3 and 4.4). This moderately high goal of the system was selected because core key informants as well as a variety of recently published work indicated that, since the introduction of anti-retroviral therapies, people have been inclined to believe that HIV treatments 'really work' (CDC, 2001d; Gallant, 2000; Graham et al., 1992; Kelly et al., 1998). This impression, of course, was not as strong in the early years of the epidemic. To account for this, the Hines co-flow goal value was set to 20 perceived treatment efficacy units per person. PTE was hypothesized to be causally impacted by epi burden (see Table 4.5). In particular, it was hypothesized that an increasing mortality rate would affect PTE.

Perceived HIV-related stigma. HIV-related stigma was a topic that received considerable focus among core key informants. In the study, HIV-related stigma was viewed as an exogenous construct. It existed outside of the bounds of the problem focus and was, therefore, unchangeable. Perceived HIV-related stigma (PHS), however, was seen as endogenous to the dynamics of the problem focus, and therefore changeable. For

the purpose of the current study, perceived HIV-related stigma was defined as the extent to which members of each of the epidemiological subpopulations shouldered a personal sense of being viewed by others as less worthy or less valuable (because they perceived that their community held stereotypical profiles of people thought to be at high-risk of HIV/AIDS, i.e., men who have sex with men, substance users, commercial sex workers, persons of color, persons living in poverty).

PHS was represented as a vector of eight (8) psychosocial information stocks (see Table 4.1). Its unit of analysis was *perceived stigma units per person*. Its goal value was set to 70 perceived stigma units per person (see Table 4.3). The strongest, or highest, initial value among the psychosocial constructs was assigned to PHS at 90 perceived stigma units per person (see Table 4.4). These two values are relatively high (given a scale of 0 to 100), reflecting what core key informants as well as other sources (Herek & Capitanio, 1993; Letine et al., 2000; Pierret, 2000) reported about sustained, high levels of fear, anxiety, and mistrust as a result of sustained, high levels of HIV stigma in the community.

PHS was reported to affect both how people sought prevention and care services as well as how providers delivered them. For example, confidentiality surrounding the use of testing services and participation in community outreach initiatives is affected by PHS. Overall, it makes finding and staying in touch with members of higher risk groups more difficult (CDC, 2001d; Mosen et al., 1998; Rotheram-Borus et al., 1997). One core key informant observed that “if stigma were reduced, then the classical [find them; treat them] public health model would work.”

Although the importance of doing something to mitigate the effects of PHS in the

community has received increased attention in the past few years, core key informants as well as other sources, indicated that little had been done to explicitly address it. A number of informants explained that PHS continues to strongly impact gay men, commercial sex workers, IDUs. Recently, stronger PHS has been associated with being black or Latino. To a certain extent, PHS has become more about 'who you are' than is about 'being HIV positive,' a point that has recently emerged in the HIV/AIDS literature (Bayne-Smith, 1996; Campbell, 1995; Doka, 1997; Fullilove et al., 2000; Herek & Greene, 1995; Hutchinson & Quataro, 1995; Perreault & Bourhis, 1999). There may also be a new 'interaction effect' between sexual orientation stigma and race stigma, both of which were referenced as a particularly strong attributes of PHS. "HIV is now 'a black thing' whereas before it was 'a gay white male thing.' I think the epidemic is being redefined in racial terms, and this sets up new challenges. The stigma of gay sex and of being black gets intertwined here."

Core key informants also noted that PHS was a particularly salient barrier to care services for newly infected persons (i.e., persons who have contracted HIV within the last five years). For them there was an added degree of PHS attributed to becoming infected after basic prevention messages had been become widely disseminated in most communities. Core key informants also noted that, as time goes by, a process of adjustment occurs such that most PLWHA accept the fact that they are HIV positive and that this, in turn, seems to diminish their personal perceptions of HIV-related stigma. As one care key informant put it: "You don't care about the stigma after a while." With this in mind, PHS was hypothesized to be causally affected by prevention system quality (PSQ) and HIV symptoms (see Table 4.5).

Self-concept (empowerment). Self-concept (SC) was the first sub-construct of a 3-construct, dynamic definition of psychological empowerment, the other two components being system awareness (SA) and system change action (SCA). SC was defined as the extent to which members of the epidemiological subpopulations saw themselves as self-assured, capable, and respectable. It was associated with other psychological constructs such as self-esteem and self-efficacy, and it was also viewed as the absence of depression.

Consistent with empowerment research (Perkins, 1995; Rappaport et al., 1984; Zimmerman, 1995), the notion of SC was affirmed by core key informants to be central to realizing successful empowerment. As an individual's personal situation stabilizes, after feeling connected to what one needs to be able to change his own situation, then other, broader matters of concern (i.e., system problems) can be taken up. These efforts ultimately transformed into personal as well as community change. Over time, the new role(s) helped built self-confidence, in part by learning more about HIV/AIDS itself as well as more about the true dynamics of the system of HIV/AIDS services.

SC was represented as a vector of eight (8) information stocks (see Table 4.1). Its unit of analysis was *self-concept units per person*. Its minimum value was zero self-concept units per person and its maximum value was 100 self-concept units per person. The goal value for SC was set to 60 self-concept units per person (see Table 4.3). Initial values for SC stocks were set to 50 self-concept units per person, a difference of only ten units (see Table 4.4). Key informants explained their relatively high marks for SC as a kind of 'marker of denial,' which was what was often needed to keep someone who was struggling to live with HIV motivated about their future. SC was hypothesized to be

directly impacted by three other constructs, namely perceived HIV-stigma (PHS), system awareness (SA), and system change action (SCA) (see Table 4.5).

System awareness (empowerment). System awareness (SA) was the second sub-construct of psychological empowerment. It was defined as the extent to which members of the epidemiological subpopulations knew about the actual quality, or effectiveness, of prevention and care services in Michigan. Specifically, SA was the degree to which they actually understood how to gain access and obtain prevention and care services for themselves and/or for others, as well as how to effectively join and/or create settings for HIV/AIDS-related policy analysis, system advocacy, and direct services delivery.

SA was represented as a vector of eight (8) psychosocial information stocks (see Table 4.1). Its unit of analysis was *system awareness units per person*. The goal for SA was set to 30 system awareness units per person, which reflects a sense that communities are more knowledgeable about prevention and care services now, but only moderately (see Table 4.3). Its minimum value was zero system awareness units per person and its maximum value was 100 system awareness units per person (see Table 4.4). SA stocks were initialized at zero because before the first cases of HIV were discovered, there was theoretically no system awareness. Core key informants felt that more work should have been done and still needs to be done within their communities to build awareness about how to use existing prevention and care services effectively. In particular, not knowing more about how to access services was attributed to poor inter-agency collaboration and inefficient client referral procedures. SA was hypothesized to be causally impacted by the other two empowerment constructs: self-concept (SC) and system change action (SCA) (see Table 4.5).

Behavioral Constructs

Behavioral, or action-oriented, constructs within the psychosocial vulnerability domain included the following: (1) system change action (SCA), (2) prevention complacency (PC), and (3) care complacency (CC). Core key informants provided a rich picture about why these behavioral constructs were important to include in the model.

System change action (empowerment). System change action (SCA) was described by core key informants as ‘participatory action,’ ‘peer-led interventions,’ ‘community leadership,’ and ‘community capacity-building’ that led to the improvement of system quality and of quality of life of PLWHA and other affected populations. It is defined as the extent to which members of the epidemiological subpopulations actively engaged in one or more efforts to improve the quality of the existing prevention and/or care infrastructure.

SCA was represented as a vector of eight (8) information stock variables (see Table 4.1). Its unit of analysis was *system change units per person*. Its minimum value was zero system change units per person and its maximum value was 100 system change units per person (see Table 4.3). A relatively low Hines co-flow goal value (i.e., 20 system change units per person) was assigned to SCA despite clear acknowledgement that the HIV epidemic was benefited by periods of relatively strong advocacy and grass-roots involvement on behalf of communities affected by HIV/AIDS, the proportional level of action has generally represented a small, very vocal, very busy minority (Herek & Greene, 1995; Omoto & Synder, 1995) (see Table 4.4).

Expanding on this notion, one core key informant recalled how difficult it was start to build an HIV care system. Early on those involved were dedicated and,

interestingly, diverse (in terms of race, sexual orientation, and gender), but there were few of them and the community was generally afraid to get too close to these activities. Moreover, core key informants believed that, although formidable relative to SCA for other public health problems, 18 years of change has not brought about much more commitment to system improvement than existed in 1984. Like SA, the initial value for SCA stocks were set to 0 system change action units per person, reflecting that SCA in the community was slow to get going and that no such activity existed before the discovery of the first AIDS cases in 1981.

Levels of SCA were viewed by core key informants as closely associated with levels of satisfaction with system quality (i.e., SCSQ and SPSQ). In particular, informants explained how SCA could be triggered by a profound level of dissatisfaction, or frustration with the quality of services delivered in the community. One core key informant noted that “becoming empowered” required a “bottoming out.” “You reach a particular low as you are trying to deal with HIV. At a point where you feel like you are going to die [i.e., are super sick, weak, depressed], you realize that you have two choices: (1) just go ahead and die or (2) begin to ‘draw power,’ physically and mentally, to yourself [i.e., literally ‘get empowered’].” At a certain point this informant just started “making my own doors.” Some of this was due to being extremely frustrated with the system. “You realize that you have to do it on your own. You know that there is help out there, but you are going to have to really work to get it.” Over time, the role of system advocate expanded, what became motivating was a desire to “get things changed” and “to do something to make a difference.” Reflecting on the meaning of these comments, SCA was hypothesized to be causally impacted by four other constructs as follows: (1)

satisfaction with prevention system quality [SPSQ], (2) satisfaction with care system quality [SCSQ], (3) self-concept [SC], and (4) system awareness [SA] (see Table 4.5).

Care complacency. Two forms of complacent behavior emerged from core key informant interview data. The first of these was care complacency (CC). CC was defined as the extent to which diagnosed PLWHA (i.e., those who had tested HIV-positive and were aware of their status) did not initiate and/or sustain recommended health care and support service behaviors, including adherence to HAART. CC was represented as a vector of four (4) information stocks (see Table 4.1). Initial values for CC stocks were set to 60 CC units per person and the CC goal value was set to 50 (see Tables 4.3 and 4.4). Taken together, these values reflect that the system has not yet mastered a way of helping clients adhere to treatments. Much of this failure can be attributed to the complicated nature of managing HIV. Core key informants underscored that HAART has made CC an even more salient issue. CC was hypothesized to have three causal constructs: (1) care system quality [CSQ], (2) self-concept [SC], and (3) perceived treatment efficacy [PTE] (see Table 4.5).

Prevention complacency. The second type of complacency was prevention complacency (PC). PC was defined in terms of risk-taking behavior, such as practicing unsafe sex or unsafe drug use, both behaviors that can put individuals at direct risk of contracting HIV. PC was also defined in terms of HIV test-taking behavior. Low PC indicated low risk-taking behavior and strong motivation to take an HIV test. The need for effective HIV testing programs was a commonly noted theme among core key informants. One core key informant stated that he believes that most people who are newly infected “know it” (i.e., they suspect they are, in fact, HIV positive). Symptoms of

HIV were typically mentioned as the main reason behind actually deciding to present for an HIV antibody test.

Encouraging people get tested so that they know their HIV serostatus has been a high priority of the CDC ever since the HIV antibody test was available (CDC, 1999d), but success in this regard has been limited. According to the results of a recent forum on the topic of HIV test ‘failure to return’ (FTR) convened by MDCH (Lounsbury, 2001a), participating HIV counselors identified a variety of factors that influenced HIV testing, such as: (1) whether or not the possibility of being HIV positive is truly a priority for the client, considering other health or personal concerns that may be on-going in his or her life; (2) denial, fear, or mistrust about HIV/AIDS or HIV/AIDS service providers; (3) the assumption that the testing agency will actively track down persons who are HIV-positive if they don’t come back for a result. Counselors also described larger, community level factors, such as the extent to which HIV service agencies were adequately staffed and capable of effective inter-agency coordination so that client needs could be met in a timely and thorough manner.

PC affected all epidemiological subpopulations in the model, whether diagnosed or not. It was represented as a vector of eight (8) information stocks (see Table 4.1). The PC goal value was set to 50 prevention complacency units per person (the same level as CC). Its unit of analysis was *prevention complacency units per person* (see Table 4.3). In comparison to CC, initial values for PC stock were set 30 units higher, to 90 prevention complacency units per person (see Table 4.4). These initial values reflect that, while PC was noted to have dropped for some time during the first decade of the epidemic, it had surged back up over the last ten years. Core key informants attributed this mainly to

heightened perceived treatment efficacy (PTE) after the introduction of anti-retroviral therapies. PC was hypothesized to be causally related to three constructs, including (1) perceived treatment efficacy [PTE], (2) self-concept [SC], and (3) perceived HIV stigma [PHS] (see Table 4.5).

CHAPTER 5

RESULTS

Results of the study are presented in two parts. For the purpose of demonstrating model validity, the first part of this chapter provides a comparative analysis of the *simulated* to the *empirically grounded* reference modes for selected constructs used in the study. Recall that reference modes were developed for selected constructs within each of the study's three conceptual domains (i.e., *epidemiological burden*, *HIV/AIDS intervention*, and *psychosocial vulnerability*). The second part of this chapter provides multiple, in-depth perspectives on the dynamics of the study's problem focus. Causal loop diagrams and descriptive narratives of these diagrams are used to present the base case model's finalized system of feedback structures. In addition, simulation output for selected constructs from each causal loop diagram are used to present the model's behavior over time. Collectively, the results presented here are used to provide information about the extent to which the base case model adheres to validation guidelines and to clarify the nature of causal relationships among constructs included in the final base case model.

Comparison of Simulated to Empirically Grounded Reference Modes

To begin, it must be demonstrated that the model can adequately reproduce, or simulate, key reference mode behaviors. In particular, it must be demonstrated that the behavior of the model is plausible, or 'realistic' (i.e., Table 3.5's first model validation

guideline), and it must be demonstrated that it does not produce nonsensical values (i.e., Table 3.5's second model validation guideline). As noted above, the base case model is defined as the system of mathematical equations that reproduces the shape, or behavior-over-time, of the key reference modes used to define the problem of focus in the study. The comparative analysis of the *simulated* to the *empirically grounded* reference modes for HIV/AIDS prevalence, incidence, and mortality are presented next. Note that all graphical simulation results are expressed in terms of a count of months, from month 0 (i.e., January 1983) to month 216 (i.e., December 2001).

Prevalence, Mortality, and Incidence

County-level HIV/AIDS surveillance data describing HIV/AIDS prevalence, mortality, and incidence in Michigan have been officially collected and analyzed by the MDCH Bureau of Epidemiology since 1983 (MDCH, 2000a). Five figures and one table have been compiled to show the extent to which the dynamics of the base case model 'fit,' or correspond, to the dynamics of actual epidemiological data reported by the Bureau of Epidemiology.

Prevalence. Figure 5.1 presents the hypothesized (i.e., empirically grounded) and simulated reference mode for HIV/AIDS prevalence in Michigan from 1983 to 2001 (i.e., from month 0 to month 216). Note that, in the case of prevalence, data is not reported before month 36 (i.e., December 1986). The base case model shows a prevalence estimate from month zero (i.e., January 1983). In the model, prevalence was the sum of all 8 Epi stock variables representing PLWHA.

Comparison of the two graphs indicated a close fit in terms of slope and magnitude beginning with month 48 (i.e., December 1987) and onward. Initial values for

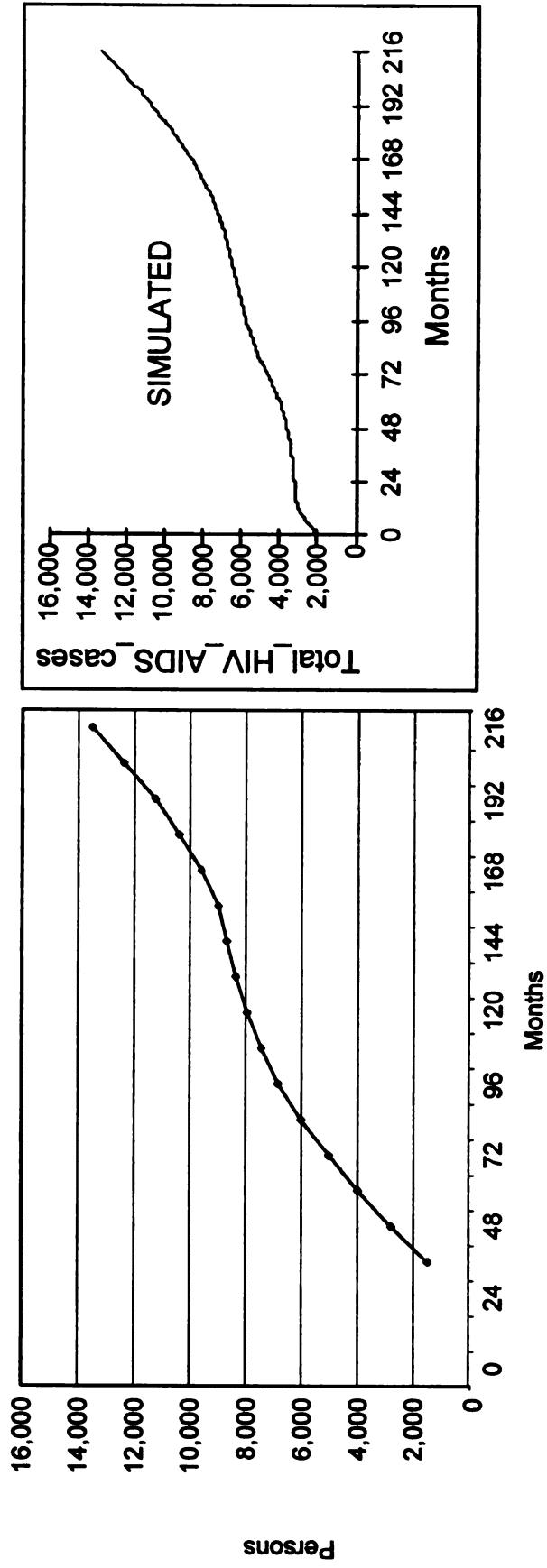


Figure 5.1 - Hypothesized and simulated reference mode for HIV/AIDS prevalence in Michigan, 1983 - 2001

the Epi stocks were set to begin the simulation with 2,051 persons, reflecting the extent to which HIV/AIDS existed in Michigan in 1983. Although it may be argued that the simulated prevalence curve starts too high, taking into consideration the fit of its shape over the entire time horizon as well as the final simulated estimate of prevalence in 2001 (see Table 5.1) suggests that an initial estimate of 2,051 persons was not unreasonable.

Table 5.1 - Simulated epidemiological indicators, 1983 - 2001

Calendar year	Years	Months	PLWHA (cases)	Diagnosed/ Tested	Undiagnosed/ Untested	Deaths
January 1983	0	0	2,051	6	2,045	5
December 1984	1	12	3,122	378	2,743	100
December 1985	2	24	3,344	1,223	2,120	275
December 1986	3	36	3,478	1,833	1,645	493
December 1987	4	48	3,726	2,223	1,503	741
December 1988	5	60	4,126	2,550	1,577	1,012
December 1989	6	72	4,736	2,889	1,847	1,303
December 1990	7	84	5,368	3,304	2,064	1,624
December 1991	8	96	5,820	3,779	2,041	1,994
December 1992	9	108	6,180	4,214	1,966	2,422
December 1993	10	120	6,516	4,562	1,954	2,914
December 1994	11	132	6,861	4,843	2,017	3,472
December 1995	12	144	7,293	5,178	2,115	4,007
December 1996	13	156	7,897	5,665	2,232	4,438
December 1997	14	168	8,678	6,298	2,380	4,779
December 1998	15	180	9,639	7,072	2,567	5,049
December 1999	16	192	10,741	7,942	2,800	5,306
December 2000	17	204	11,981	8,906	3,075	5,572
December 2001	18	216	13,372	9,990	3,382	5,841

Mortality. Figure 5.2 presents the hypothesized and simulated reference mode for HIV/AIDS mortality per year in Michigan from 1983 to 2001. Mortality was computed as the sum of the three Epi stock variables of persons who had succumbed to AIDS-related. Comparison of the two graphs indicated a close fit in terms of slope, although the simulated curve peaks approximately 2 years earlier than the hypothesized curve, which

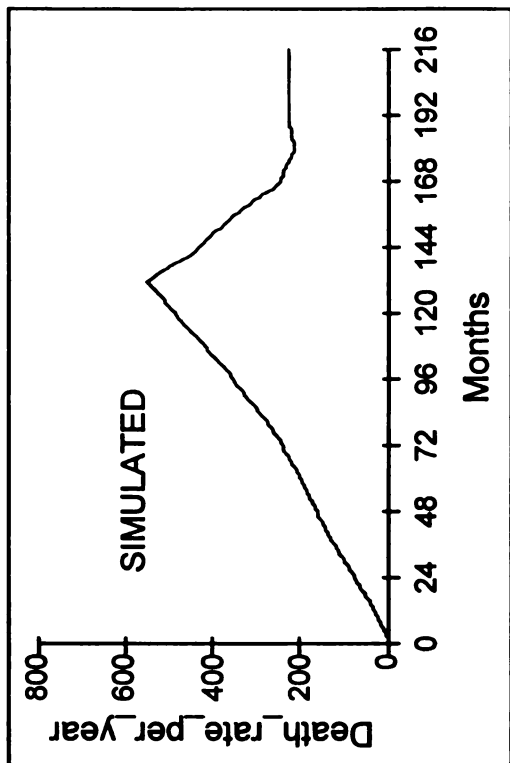
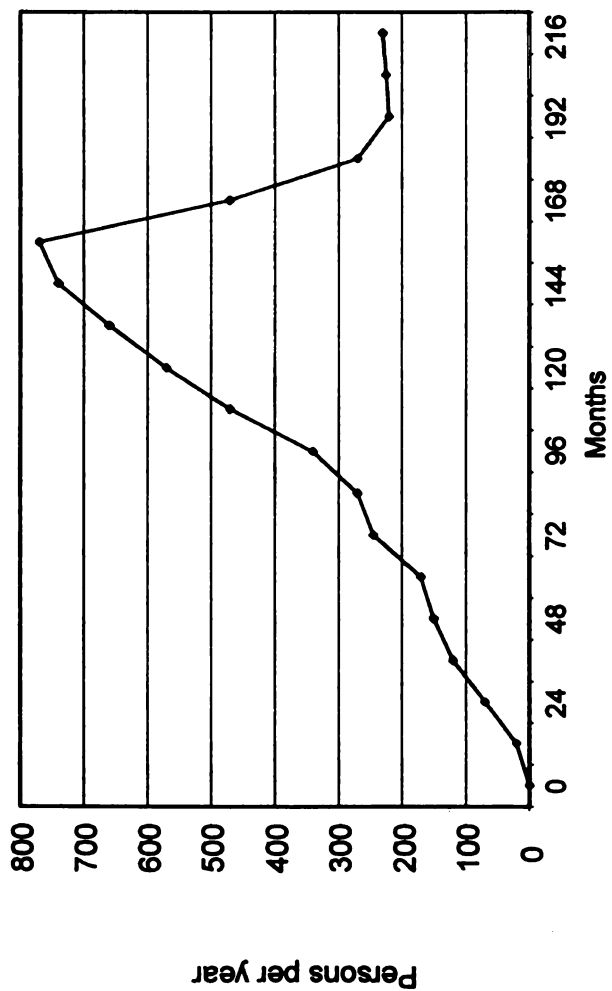


Figure 5.2 - Hypothesized and simulated reference mode for HIV/AIDS mortality rate per year in Michigan, 1983 - 2001

hit a high at month 168 (14 years; December 1997). In addition, the simulated curve's peak was lower in magnitude than the hypothesized curve by about 200 persons. By month 192 (16 years; 1999), however, both curves are essentially identical.

Figure 5.3 presents the hypothesized and simulated reference mode for HIV/AIDS cumulative mortality in Michigan over the same time horizon. Comparison of these two graphs indicated an extremely close fit in terms of both slope and magnitude. Yearly levels of this variable are also shown in the last column of Table 5.1. The simulated December 2001 value was 5,841 persons.

Incidence. Data reported for HIV incidence, or the number of new cases of HIV that occur within a given period of time, is a 'best guess' of the Bureau of Epidemiology. In fact, no estimates of incidence were even offered by the Bureau until December 1990. Figure 5.4 presents the hypothesized and simulated reference mode for HIV/AIDS incidence per year in Michigan from 1983 to 2001. The simulated curve starts out at approximately 1,250 persons per year, but drops precipitously within two years (i.e., 1985). It then begins to climb again, quickly, generating peak at month 72 (i.e., 1989) at approximately 1,000 persons per year, then dropping to about 800 persons by month 96 (i.e., 1991). Thereafter, the simulated incidence curve climbs steadily, reaching an estimate of approximately 1,600 new cases per year by month 216 (i.e., 2001). As of 1999, this rate appears to have dropped to just 825 persons (MDCH, 2001), a trend that is encouraging, yet inconsistent with recent epidemiological studies about the United States as a whole (IOM, 2001).

At first glance, the hypothesized and the simulated curves appear very different. Comparing the shape of the curve over the entire time horizon, one would have to assert

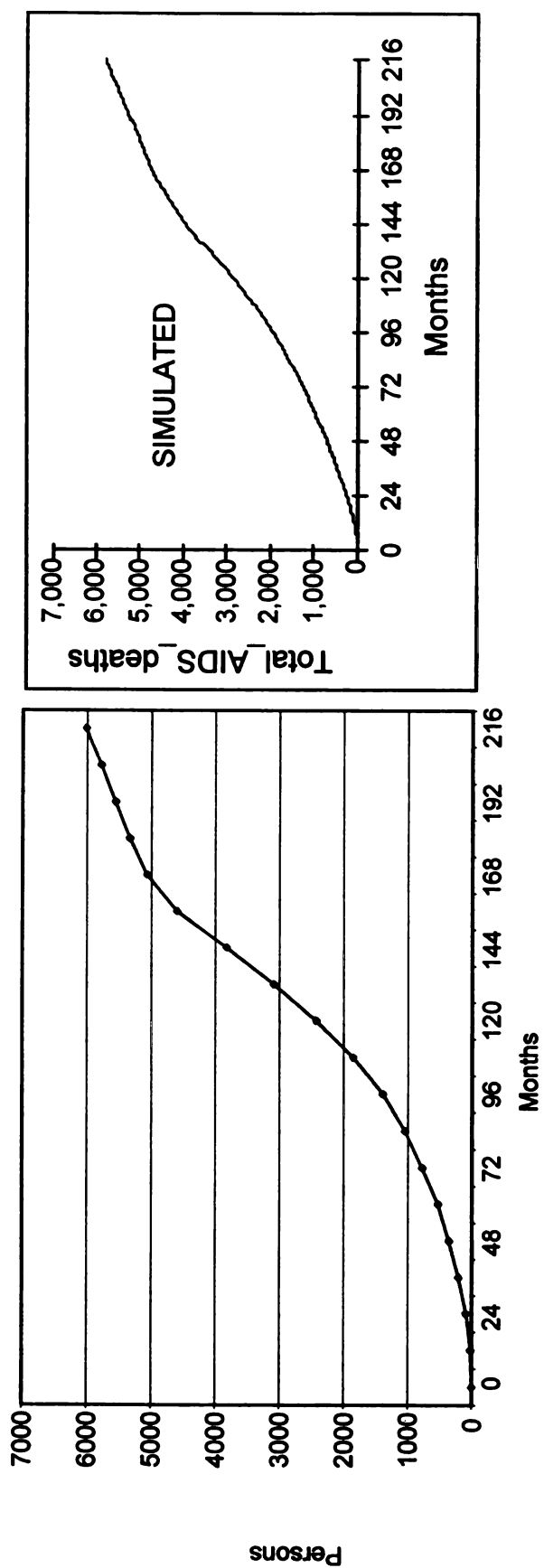


Figure 5.3 - Hypothesized and simulated reference mode for HIV/AIDS cumulative mortality in Michigan, 1983 - 2001

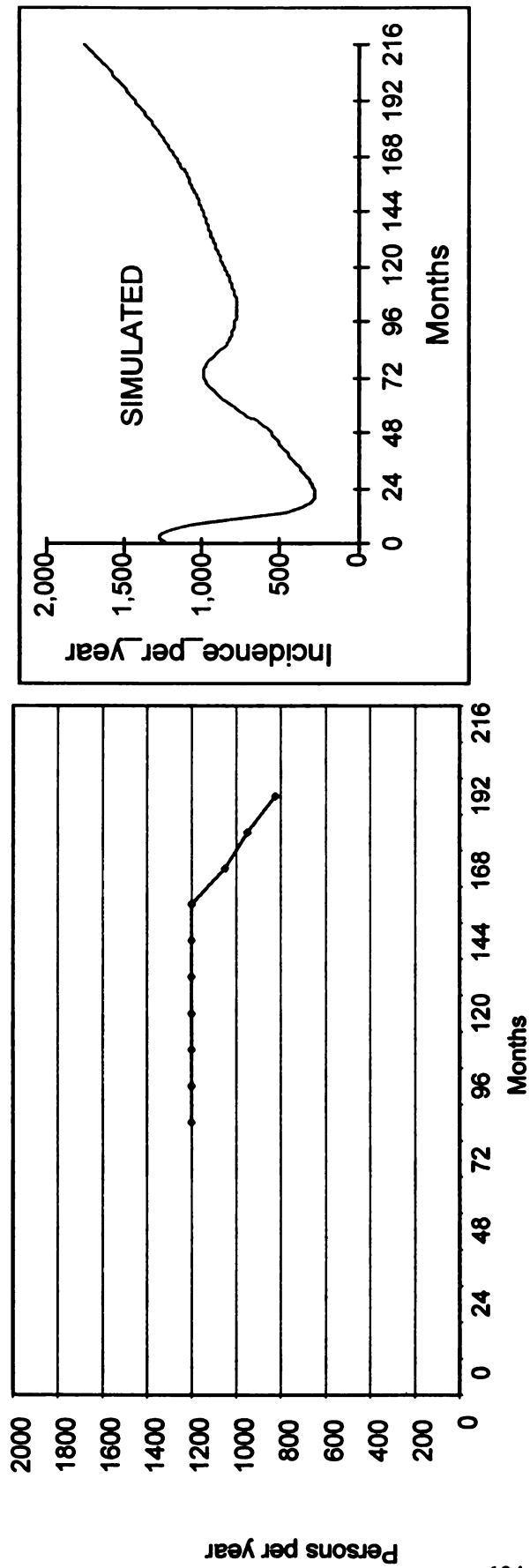


Figure 5.4 - Hypothesized and simulated reference mode for HIV/AIDS incidence per year in Michigan, 1983 - 2001

that these two curves differ markedly in shape. Focusing on the dynamics of a narrower time horizon for which a report on incidence is available, (i.e., months 84 to 192; December 1990 to December 1999), it can be seen that the average number of new cases of HIV over that period was simulated to be 1,200 persons per month. This is still high if the December 1999 drop-off to 825 persons per year is considered, but more or less in line with MDCH reports if the time period is cut back to 1996. As Figure 5.5 shows, estimates of HIV incidence in Michigan were reported to be as low as 1,100 and as high as 1,200 persons per year from 1990 to 1996 (MDCH, 2000a; MDCH, 2001).

Prevention and Care Funding

Data regarding actual allocations of care resources and prevention resources (i.e., funding) for HIV/AIDS was obtained from a report by (Foster et al., 1999) in a comprehensive analysis of the state of HIV prevention in the United States (IOM, 2001). As noted previously, detailed time series data on funding of prevention services relative to care services was not readily available, however it was reported that care funding in Michigan reached \$18 million in 2001, compared with \$6.6 million for prevention (personal communication, Debra Szwejda, November 14, 2001), revealing a funding difference that is more or less consistent with Foster's report. Moreover, the reference mode for HIV/AIDS funding in the United States was affirmed by core key informants to fit Michigan. Note that in lieu of reliable data expressed in dollars, prevention and care resources are quantified in resource units. Resource units include funding as well as physical and human resources.

Figure 5.6 presents the hypothesized and the simulated reference mode for HIV/AIDS-related care resources (CR) and prevention resources (PR). Note that the y

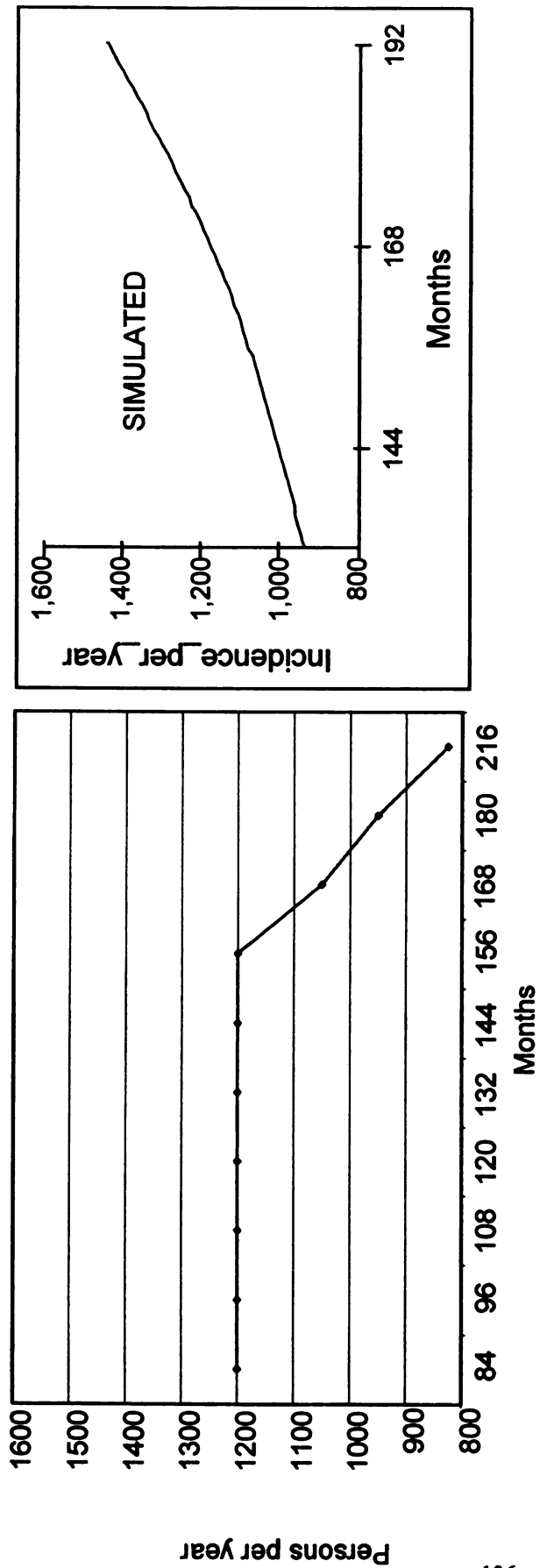


Figure 5.5 - Hypothesized and simulated reference mode for HIV/AIDS incidence per year in Michigan, 1990 - 1999

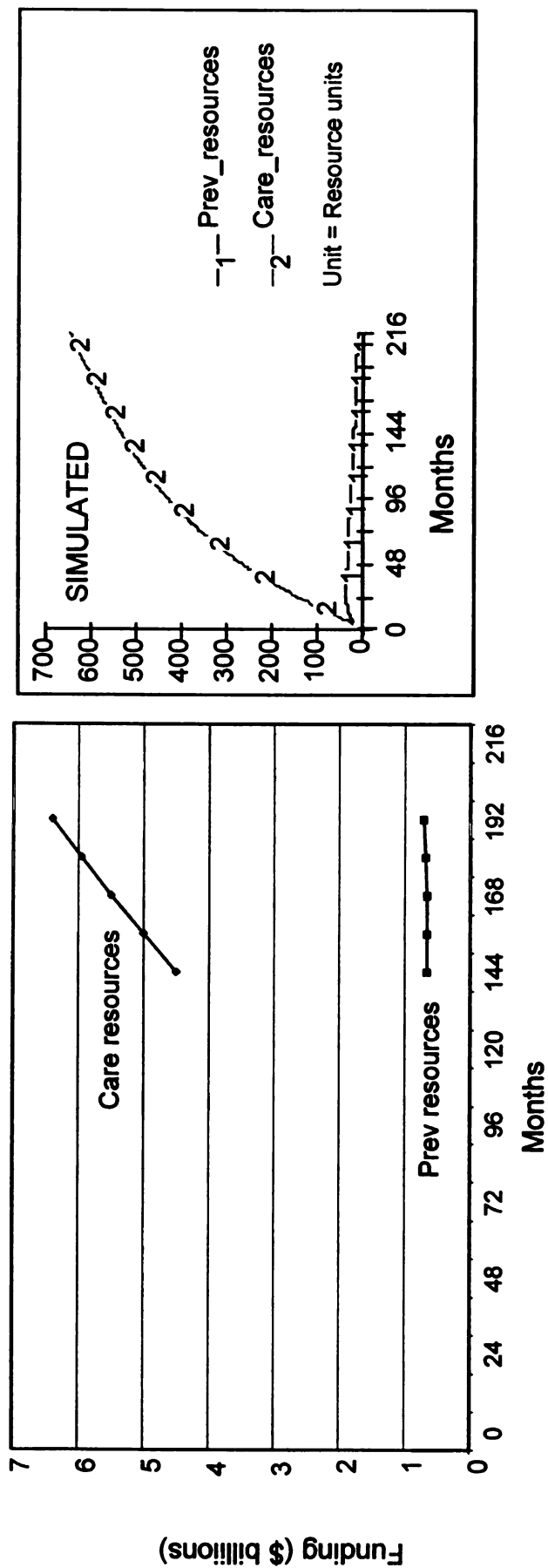


Figure 5.6 - Hypothesized and simulated reference mode for HIV/AIDS-related care and prevention funding in the United States, 1983 -2001

axis scales do not match. This is because the reference mode for the entire country is exhibited in the left-hand graph in terms of billions of dollars. Michigan's actual reference mode would be represented by only a small fraction of that total amount. Comparing the slopes of the hypothesized and the simulated reference modes over the period from month 144 to month 192 (i.e., December 1995 to December 1999), however, revealed a close match in terms of curve slope.

Prevention and Care Service System Quality

The unit of analysis for prevention system quality (PSQ) and care system quality (CSQ) was system quality units. Quality units are defined as the extent to which care or prevention services are accessible and efficacious for persons and/or their communities. In general, core key informant interview data suggested the shape and magnitudes of the prevention system quality (PSQ) and care system quality (CSQ) was similar to the curves shown in Figure 5.7. Core key informant data also indicated that prevention system quality (PSQ) was higher than care system quality (CSQ) until the introduction of anti-retroviral therapies in 1994/1995. After that, care system quality (CSQ) was considered superior to prevention system quality (PSQ). Here again, it is concluded that the hypothesized and the simulated curves are comparable to each other in terms of shape and magnitude. Note, however, that simulated curve for care system quality (CSQ) begins a downward trend at month 180 (i.e., December 1998), a behavior that was not anticipated in the hypothesized reference mode.

Stigma and Complacency

Perceived HIV stigma (PHS), prevention complacency (PC), and care complacency (CC) comprise the final set of hypothesized and simulated key reference

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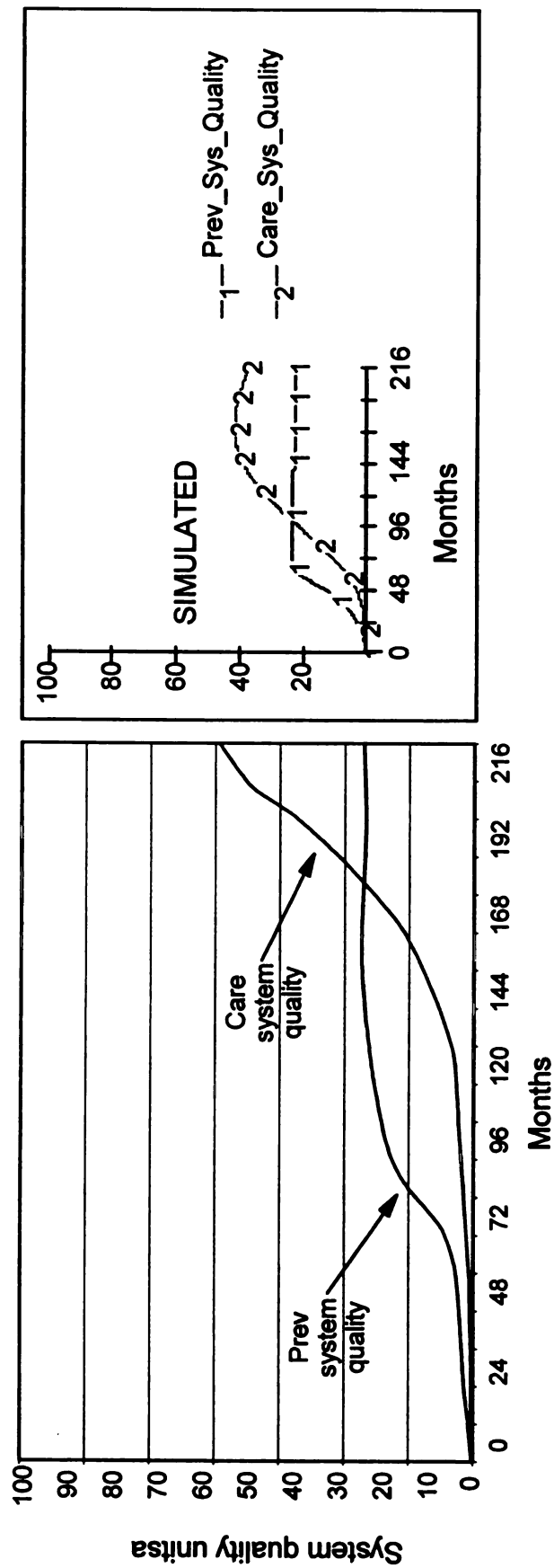


Figure 5.7 - Hypothesized and simulated reference mode for HIV/AIDS system quality in Michigan, 1983 - 2001

modes to be presented for the base case model. Figure 5.8 compares the reference modes for all three of these constructs. With respect to perceived HIV stigma (PHS), the hypothesized reference mode goes very high very early, almost to its maximum, and then to remain high for the duration of the time horizon. HIV-positive core key informants strongly affirmed this trend, noting that the work of managing their own sense of perceived HIV stigma was an on-going piece of work. By comparison, it is clear that simulated reference mode for perceived HIV stigma (PHS) reproduced the hypothesized curve closely, both in terms of shape and magnitude.

An assessment of the complacency reference mode is more complicated. Recall that, initially, ‘complacency’ was not theoretically separated into ‘prevention’ complacency and ‘care’ complacency. The need to distinguish between the two became clear during the latter part of the model building process. As a result, the originally hypothesized reference mode for complacency represents the overall trend for both types of complacency. As the model matured, prevention complacency (PC) became defined as the extent to which individuals, either HIV-positive or HIV-negative, engaged in behavior that would put them at-risk of being infected or of infecting another person. It also defined as an antecedent to the decision to take the HIV antibody test. Care complacency (CC) was second form of complacency, and it affected PLWHA only. Care complacency (CC) was defined as the extent to which persons who became HIV infected engaged the care system. It quantified their willingness and/or ability to engage the HIV care system and to adhere to best practices in HIV/AIDS treatment.

In the model, both prevention complacency (PC) and care complacency (CC) have a direct impact on HIV/AIDS epidemiological burden (Epi burden). Prevention

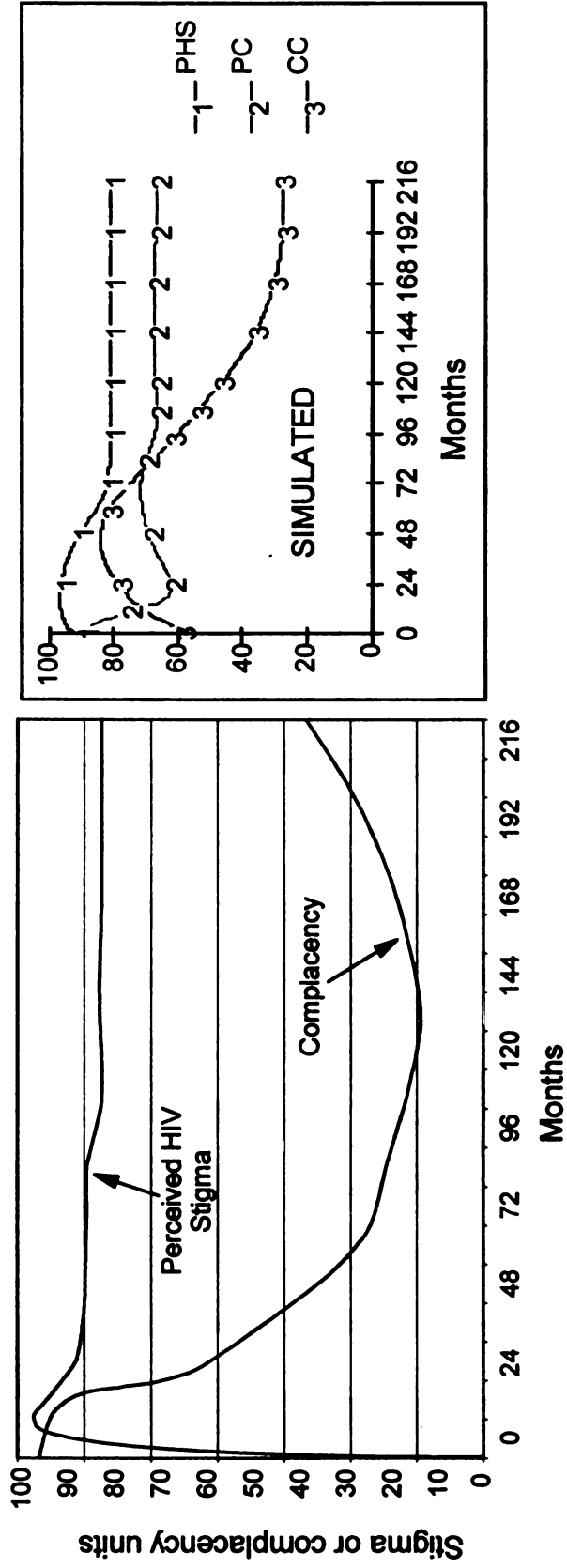


Figure 5.8 - Hypothesized and simulated reference mode for HIV/AIDS stigma and complacency in Michigan, 1983 - 2001

complacency (PC) directly affects HIV incidence and HIV testing rates at three points (i.e., early, mid-, and late stage). Care complacency (CC) directly affects how many persons are in care and how long they may stay in care. Once tested, or diagnosed, persons typically move into a situation where they were receiving some level of HIV/AIDS treatment. However, care complacency (CC) affected decisions to drop out of care or to start care later, as well as decisions to restart care, had they dropped out at some point in the past.

Interestingly, the simulated reference mode for prevention complacency (PC) expresses a similar shape to the hypothesized reference mode, but not if the entire simulated time horizon is considered. In particular, the hypothesized curve shape was found to be ‘squashed,’ or horizontally shrunken, in the simulated reference mode over the time period from month zero to month 72 (i.e., January 1983 to December 1989). However, the simulated version of prevention complacency (PC) is much higher than the hypothesized reference mode across the entire time horizon. It is also interesting to note that if the dynamic average of the curves representing prevention complacency (PC) and care complacency (CC) is taken across the entire time horizon, the resulting curve does, in fact, approach the shape that was originally hypothesized for combined notion of ‘complacency.’ However, the curve still does not drop and recover as quickly as was expected. In conclusion, it is clear that the simulated curves for prevention complacency (PC) and care complacency (CC) do not fit the originally hypothesized complacency construct. Yet, there were parts of both the simulated curves that suggested that the qualitative idea of ‘complacency,’ *per se*, was correctly hypothesized.

Key Causal Processes Identified

As the process of modeling was carried out, it became evident that the underlying dynamics of the current study's problem focus could be expressed through a set of five key causal processes. These processes have been named as follows: (1) the perceived stigma process; (2) the care complacency process; (3) the prevention complacency process; (4) the community empowerment process; and (5) the resource allocation process.

A causal loop diagram of each process has been created. Table 5.2 presents a count of the number of loops and constructs that comprise each of these processes. As previously noted in Chapter 3, there are a total of 13 causal loops, each of which represents a unique feedback structure in the model and each of which communicates a story, or *narrative*, about a substantive dynamic process related to the problem focus. Approximately half of the loops are balancing (i.e., feedback structures that are negative, goal-seeking, stabilizing, reducing, dampening) and half are reinforcing (i.e., feedback structures that are positive, growing, destabilizing, increasing, amplifying).

Table 5.2 - Summary of key dynamic process loops and constructs

Key dynamic process	Loops		Constructs				
	B	R	Total constr.	Model sector			
				Epl	Service	Psych social	Behave
Perceived stigma		2	8	1	2	3	2
Care complacency	1	1	7	2		3	2
Prevention complacency	1	1	7	2		3	2
Community empowerment	4	1	9		4	4	1
Resource allocation		2	7	1	4		2

Note: B = Balancing (negative feedback); R = Reinforcing (positive feedback).

For easy reference, loops have been assigned a 'loop ID.' Loop IDs that begin with an R are *reinforcing*; loop IDs that begin with a B are *balancing* (refer back to Chapter 3, *Interpreting Loop Polarity* for more detail about working with causal loops). In addition, constructs are referenced by their 'construct ID' (the alphabetic code assigned to each construct, as introduced in Chapter 4).

Perceived Stigma Process

The causal loop diagram for the perceived stigma process is presented in Figure 5.9. It features two reinforcing loops (R1 and R2). As might be anticipated, the perceived stigma process was built around the perceived HIV stigma construct (PHS). Two constructs were directly antecedent to perceived HIV stigma (PHS), namely HIV symptoms and prevention system quality (PSQ). In turn, perceived HIV stigma (PHS) directly influenced self-concept (SC).

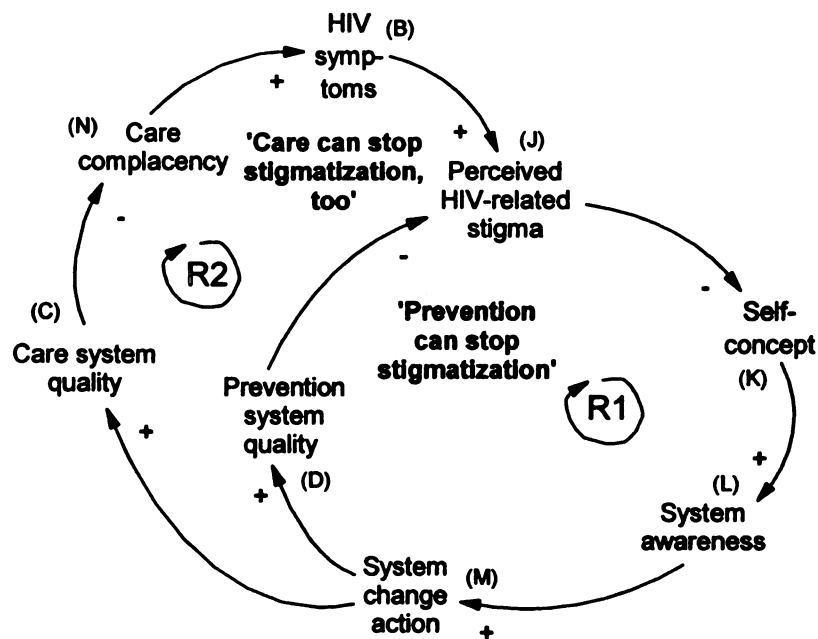


Figure 5.9 - Causal loop diagram for perceived stigma process

Feedback structure. Loop R1 is comprised of five constructs. Following the causal pathway around the loop, one is taken through what has been previously defined as the model's empowerment meta-construct [i.e., self-concept (SC) → system awareness (SA) → system change action (SCA)]. Given the potential effect of prevention system quality (PSQ) on perceived HIV stigma (PHS), the narrative associated with loop R1 could be titled 'prevention can stop stigma.' This loop's narrative might be read this way: An increase in the level of perceived HIV stigma (PHS) experienced by a particular subpopulation, or group [e.g., mid-stage HIV diagnosed persons in care (MHDWC)] of persons will tend to decrease, or dampen, their sense of self-concept (SC). As their self-concept (SC) dampens, so does their motivation to learn about, or become more aware of, what HIV/AIDS-related resources exist in the community, how to access them, and/or how easy or difficult it is to use them, etc. As a result of their lower system awareness (SA), they are also less likely to engage in any type of system change action (SCA), which could potentially make HIV/AIDS-related services more accessible or more effective for their community as a whole.

Note, however, that to the extent that this group of persons does not become involved in an effort to change the system, they have no effect on the quality of prevention services. Over time, the collective effect of their decreased system change action (SCA), in conjunction with the effect of decreased system change action (SCA) attributable to other groups, would be, for example, that HIV/AIDS public service announcements were not run, activity groups or support groups in the community were not attended, concerned members of the community stopped attending regional HIV/AIDS prevention planning meeting, etc. Then, as the quality of the prevention

system (PSQ) drops, perceived HIV stigma (PHS) would rise, further deflating self-concept (SC). Alternatively, as the quality of the prevention system (PSQ) increases, perceived HIV stigma (PHS) would decrease, which would begin to pump up self-concept (SC). This alternate ending to R1's narrative, therefore, is what suggested its title: 'prevention can stop stigma.'

Loop R2 reveals a similar set of dynamics as loop R1, but for the care side of the system. The narrative for loop R2 might be 'care can stop stigma, too.' Improvement in care system quality would likely address matters of care complacency (CC) among diagnosed PLWHA only, which would also likely reduce their personal symptoms of the disease. To the extent that any group of PLWHA is experiencing fewer HIV-related symptoms, they are likely to also experience a decreased sense of perceived HIV stigma (PHS). In this sense, R2 is, like R1, a substantive way to reduce levels of perceived HIV stigma (PHS).

Model Behavior. Four figures show selected simulations for the perceived stigma process (see Figures 5.10, 5.11; 5.12; and 5.13). Figure 5.10 presents four simulation graphs showing how changes in aggregate perceived HIV stigma (PHS) [i.e., Note that heretofore the term 'aggregate' will be used to refer to the average value for a given construct among all subpopulations at a given point in the time horizon for whom the construct has been designed] are dynamically related to changes in aggregate self-concept (SC), which was causally influenced by perceived HIV stigma (PHS). Figure 5.10 also shows how prevention system quality (PSQ) influences perceived HIV stigma (PHS) as well as how aggregate symptom levels are associated with aggregate perceived HIV stigma (PHS).

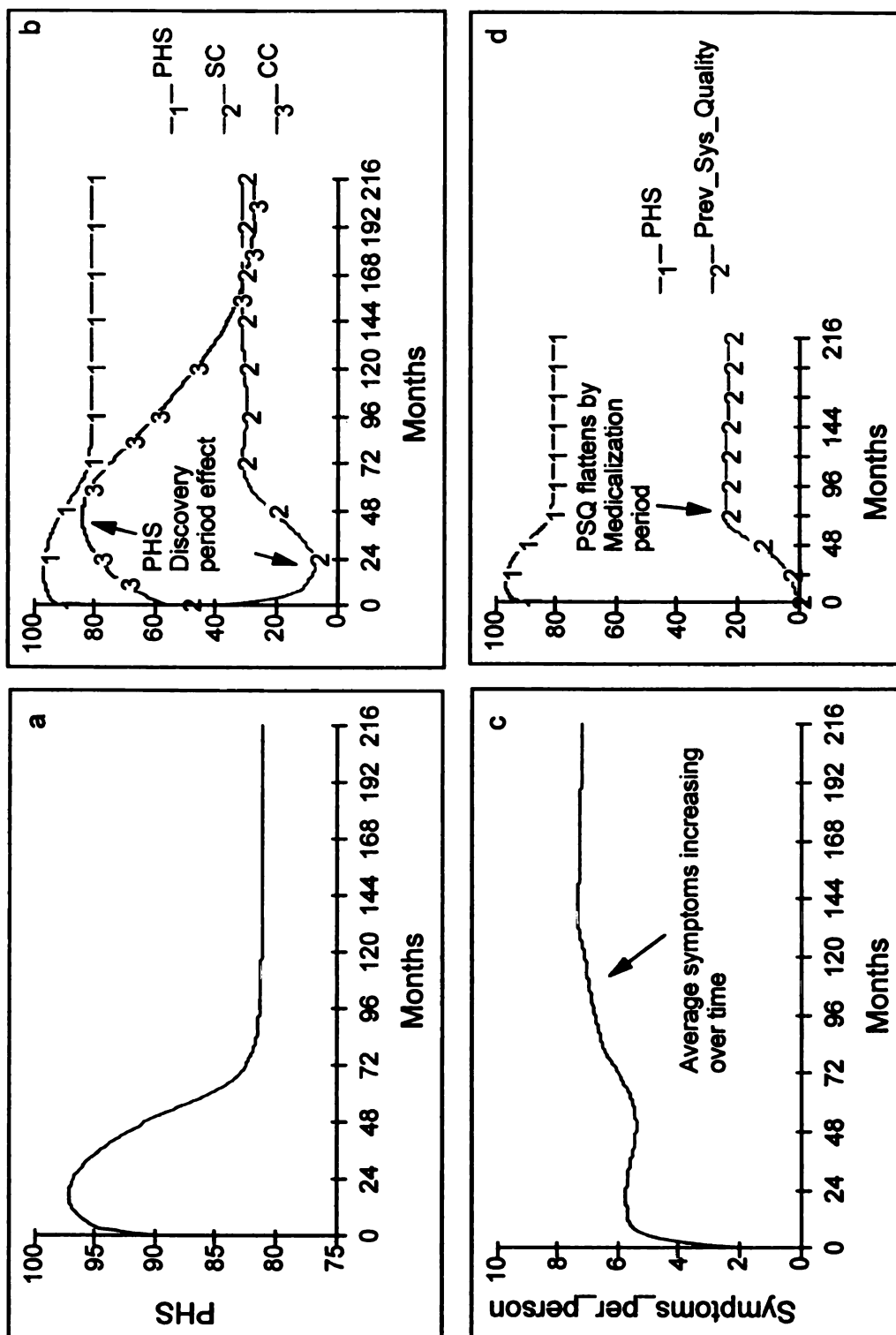


Figure 5.10 - Perceived stigma process simulations: (a) Aggregate perceived HIV stigma; (b) comparison of aggregate perceived HIV stigma, and aggregate self-concept, aggregate care complacency; (c) aggregate symptoms per person; (d) comparison of aggregate perceived HIV stigma and prevention system quality

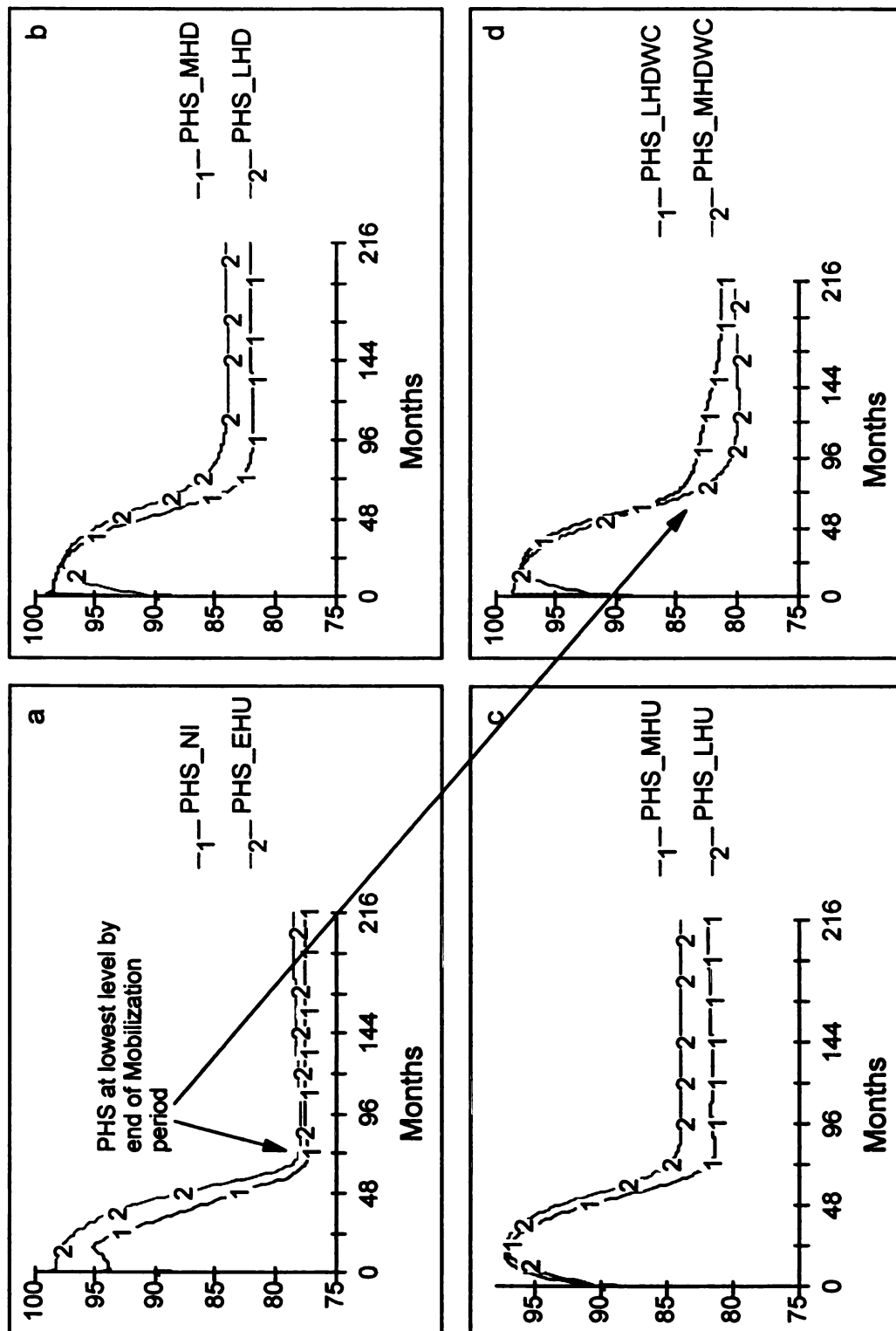


Figure 5.11 - Perceived stigma process simulations: Subpopulation comparisons of perceived HIV stigma for (a) early stage undiagnosed persons; (b) mid-stage and late stage diagnosed persons; (c) mid-stage and late stage undiagnosed persons; and (d) mid-stage and late stage persons with care

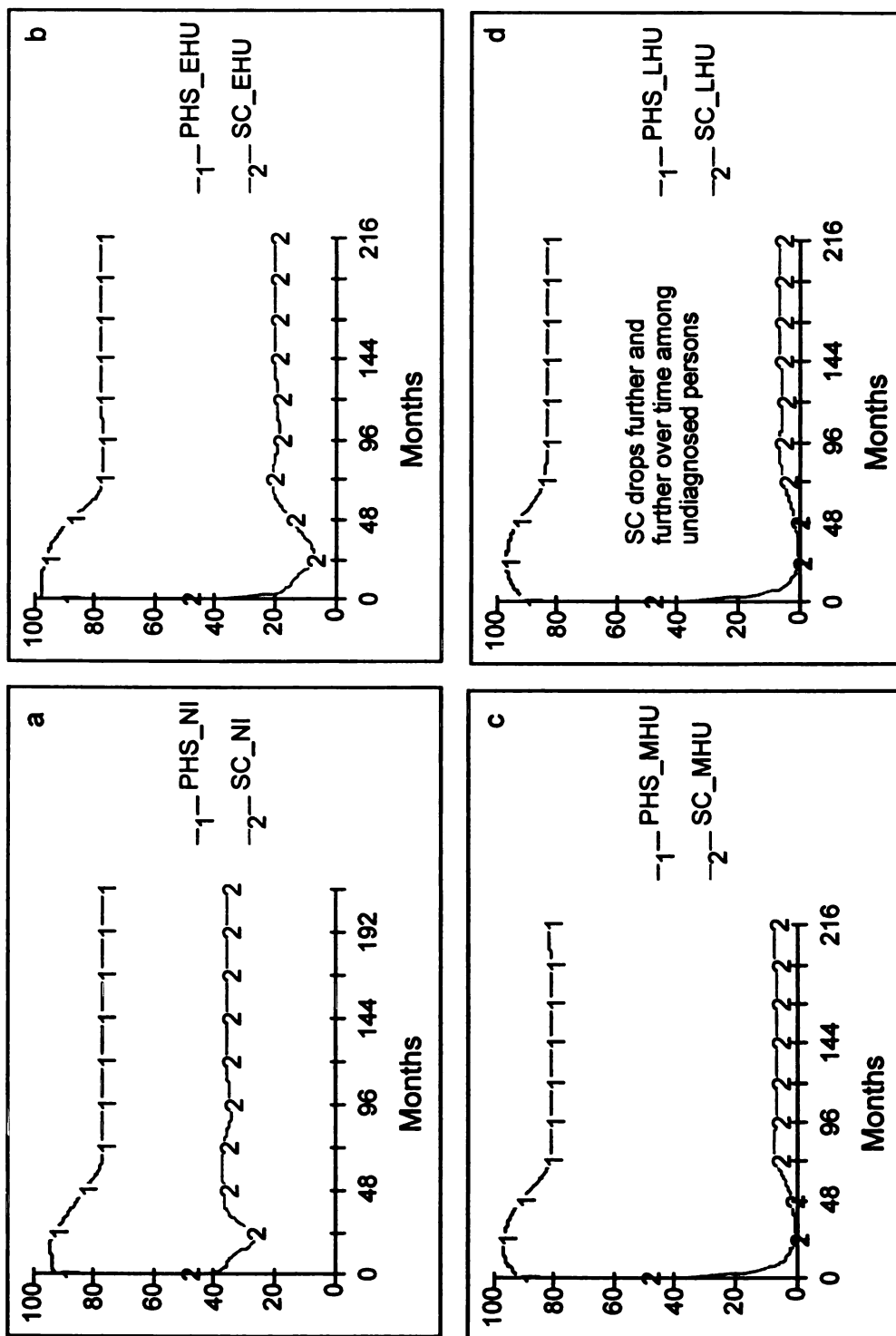


Figure 5.12 - Perceived stigma process simulations: Subpopulation comparisons of perceived HIV stigma and self-diagnosed persons; (a) newly infected persons; (b) early stage undiagnosed persons; (c) mid-stage undiagnosed persons, and (d) late stage undiagnosed persons

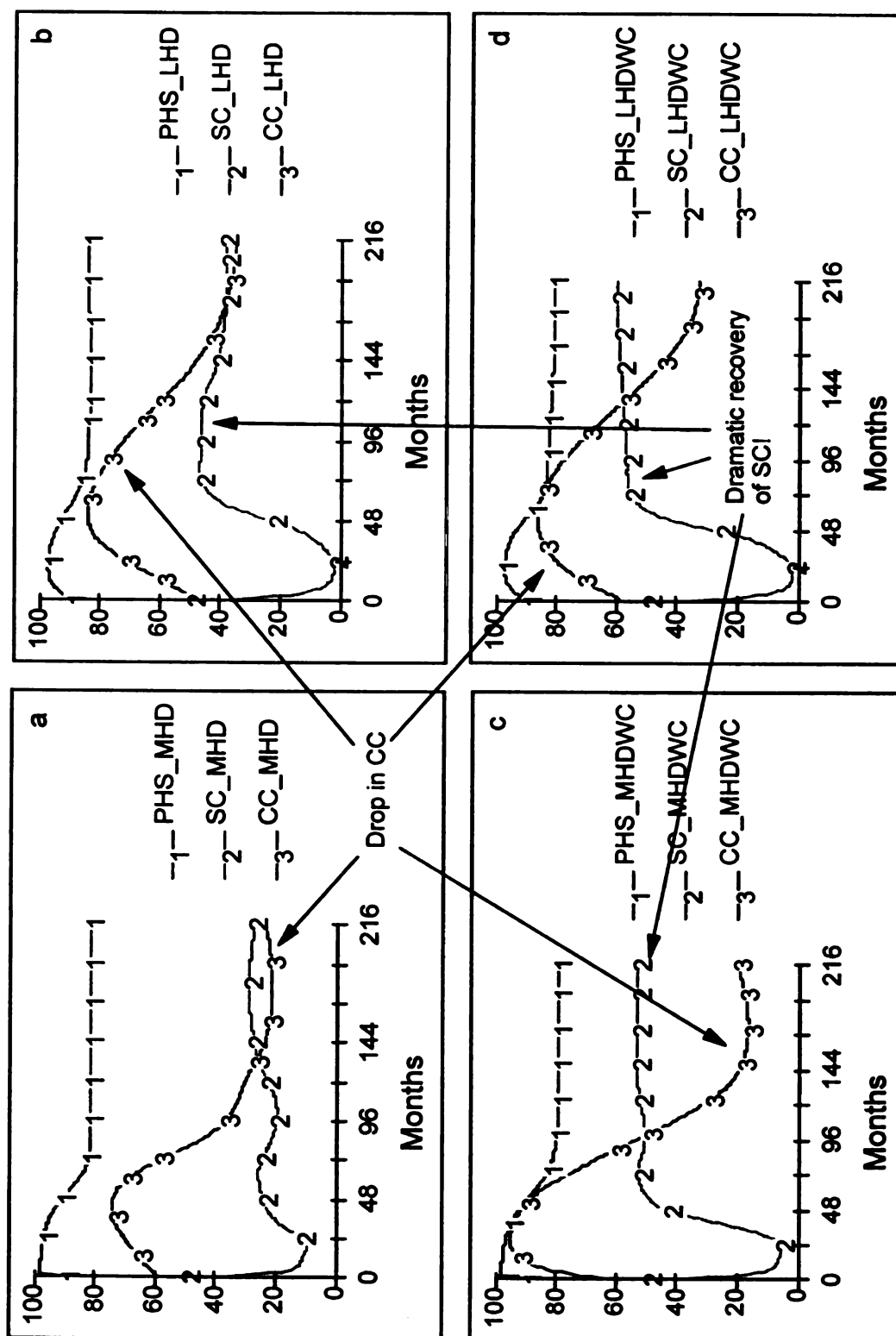


Figure 5.13 - Perceived stigma process simulations: Subpopulation comparisons of perceived HIV stigma, self-concept, and care complacency for (a) mid-stage diagnosed persons; (b) late stage diagnosed persons; (c) mid-stage persons with care, and (d) late stage persons with care

Graph (a) demonstrates how perceived HIV stigma (PHS) was high and stays high across the entire time horizon. In graph (b), aggregate care complacency (CC), which causally impacts aggregate perceived HIV stigma (PHS) through HIV symptoms, rises until approximately month 48 (i.e., December 1987), then falls off relatively quickly until month 192 (i.e., December 1999), where it levels out at a moderately low level.

Aggregate self-concept (SC) dips to an all-time low early on in the epidemic (i.e., month 24; December 1985), but then increases to a new equilibrium level at about month 96 (i.e., 1991). The peak in aggregate care complacency (CC) and the low in self-concept (SC) came after aggregate perceived HIV stigma's (PHS) all-time high at month 12 (i.e., December 1984). One assessment of these dynamics is that the perceived HIV stigma (PHS) during the 'discovery' period has a dramatic and fast impact on both self-concept (SC) and care complacency (CC) that stretches well into the 'mobilization' period.

Figure 5.10 graph (c) indicates that HIV symptom levels are also dynamically associated with aggregate perceived HIV stigma (PHS). However, it is curious that these dynamics show that aggregate average symptom levels are increasing during the 'medicalization' period and beyond, when they might be expected to drop as more PLWHA have access to better treatments. One explanation for this is that persons coming into the system at a later stage are presenting as less well to begin with, hence higher symptoms on average. Another explanation is that treatments are, to some extent, beginning to fail, which might also account for higher symptoms on average. Graph (d) strongly suggests that improvements in prevention system quality (PSQ) had desirable effects on aggregate levels of perceived HIV stigma (PHS), but as prevention system quality (PSQ) leveled out, so did its effect on perceived HIV stigma (PHS).

Figures 5.11 presents comparisons of perceived HIV stigma (PHS) by each epidemiological subpopulations defined in the model. It shows that all groups experience a similar effect of the stigma, although graph (a) and graph (d) show that not being diagnosed and being in the early stage of the disease (PHS NI and PHS EHU) as well as being in care (PHS LHDWC and PHS MHDWC) seems to decrease levels of perceived HIV stigms (PHS). This 'buffering' effect of being in care is also observable in graph (b), where it can be seen that being diagnosed, but not in care (PHS MHD and PHS LHD), seemed to be associated with somewhat higher levels of perceived HIV stigma (PHS). In general, this analysis shows that perceived HIV stigma (PHS) is high and remains high for all subpopulations in the model.

Figure 5.12 presents comparisons of levels of perceived HIV stigma (PHS) and self-concept (SC). As disease stage advances among undiagnosed persons (from NI to EHU to MHU and finally to LHU), it can be seen that self-concept (SC) dampens. Self-concept (SC) for newly infected persons was relatively stable, although not strong. In contrast, self-concept (SC) for late stage undiagnosed persons was close to zero.

Figure 5.13 made a similar comparison for diagnosed persons or persons in care (MHD, LHD, MHDWC, and LHDWC). Among these subpopulations, self-concept (SC) dropped to a low by month 24 (i.e., 1985), but then recovers rapidly for all groups. Mid-stage diagnosed persons (MHD) do not, however, recover to the level that late stage diagnosed persons or persons in care (MHDWC and LHDWC) do. This potential psychological 'buffering' effect of being in care was dramatically represented for persons at the later stage of HIV disease.

Care Complacency Process

The causal loop diagram for the care complacency process is presented in Figure 5.14. It features two loops, one balancing and one reinforcing (B1 and R3). Referring to the care complacency (CC) construct, it can be seen that psychosocial constructs directly influence care complacency (CC). These constructs are perceived treatment efficacy (PTE) and self-concept (SC). Care complacency (CC), in turn, influences the average level of HIV symptoms among persons who have been diagnosed, some of whom are actually in care, some of whom are not. Keep in mind that care complacency (CC) was not quantified for subpopulations of persons who were undiagnosed (i.e., who had not yet received the results of a positive HIV antibody test). Care complacency (CC)

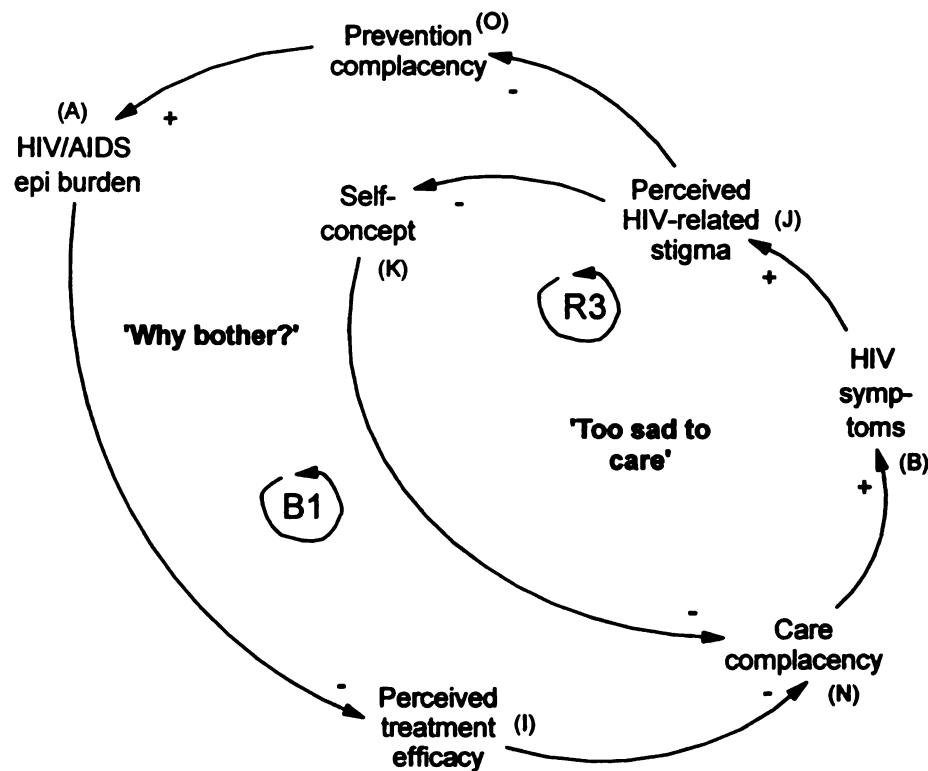


Figure 5.14 - Causal loop diagram for care complacency process

pertains only to those four epidemiological subpopulations that have been diagnosed (i.e., tested and found to be HIV positive).

Feedback structure. The narrative associated with loop R3 might be referred to as the ‘too sad to care’ effect. To the extent that self-concept (SC) drops, persons become depressed and motivated, and care complacency (CC) is likely to increase. For example, persons receiving care for their HIV may become less willing to take their medication, keep doctors appointments, or do other things to take care of their health. Over time, increased care complacency (CC) will result in increased HIV symptoms. The symptoms, some of which may be detectable by others around them, will tend to increase, or generate, stronger feelings of perceived HIV stigma (PHS). In turn, self-concept (SC) drops even further.

Loop B1 calls attention to a similar feedback process, but the trigger that reduces care complacency (CC) is perceived treatment efficacy (PTE). The narrative for B1 might be titled ‘why bother?’ Recall that perceived treatment efficacy (PTE) is defined as the extent to which members of each of the epidemiological subpopulations believe that available clinical treatments, including the use of HAART, are effective at managing or control the progression of HIV disease. Therefore, for PLWHA who are receiving care services, the stronger their perception that the treatments are working, the more they will ‘follow doctor’s advice.’ The willingness to adhere to treatments can be expected to stay strong, unless there is an awareness of a growing number of treatment failures, either in their own lives or in the lives of others. For example, if AIDS-related deaths increased, perceived treatment efficacy (PTE) would be decreased. Over time, the loss of belief in the efficacy of available treatments could dampen care complacency (CC), which could

exacerbate AIDS-related deaths, further decreasing perceived treatment efficacy (PTE). Alternative treatment approaches, not formally recognized by the care system, may be one way for PLWHA to turn. In any case, the effect would be to reduce treatment adherence to generally prescribed medical protocols. Over time, HIV symptoms would be likely to rise again, which would tend to further increase perceived HIV stigma (PHS). A subsequent reduction in prevention complacency (PC) would then be expected, which would likely have some degree of favorable impact on HIV/AIDS epidemiological burden.

Model Behavior. Two figures present selected simulations for the care complacency process (see Figures 5.15 and 5.16). Figure 5.15 shows aggregate care complacency (CC) in graph (a). Across the four subpopulations of persons who are diagnosed and/or in care services, it appears that care complacency (CC) peaked at about month 48 (i.e., December 1987). Thereafter, it declines gradually, with only the slightest suggestion that it may trend back upwards after month 216 (i.e., 2001). Overall, aggregate care complacency (CC) shows a downward trend over time. This is positive, or constructive, and possibly indicates that HIV/AIDS-related treatments are easier to take as ‘medicalization’ period has turned out improved approaches to managing HIV. It may also be an indication that services are delivered with greater attention to matters related to care complacency (CC), or that PLWHA are, their own accord, more likely to engage their care today than they were during the earlier periods of the epidemic.

Graphs (b) and (c) provide a comparison of mid- and late stage diagnosed persons and mid- and late stage persons with care, respectively. Interestingly, mid-stage persons in care showed the highest level of care complacency (CC), but only for a two to three

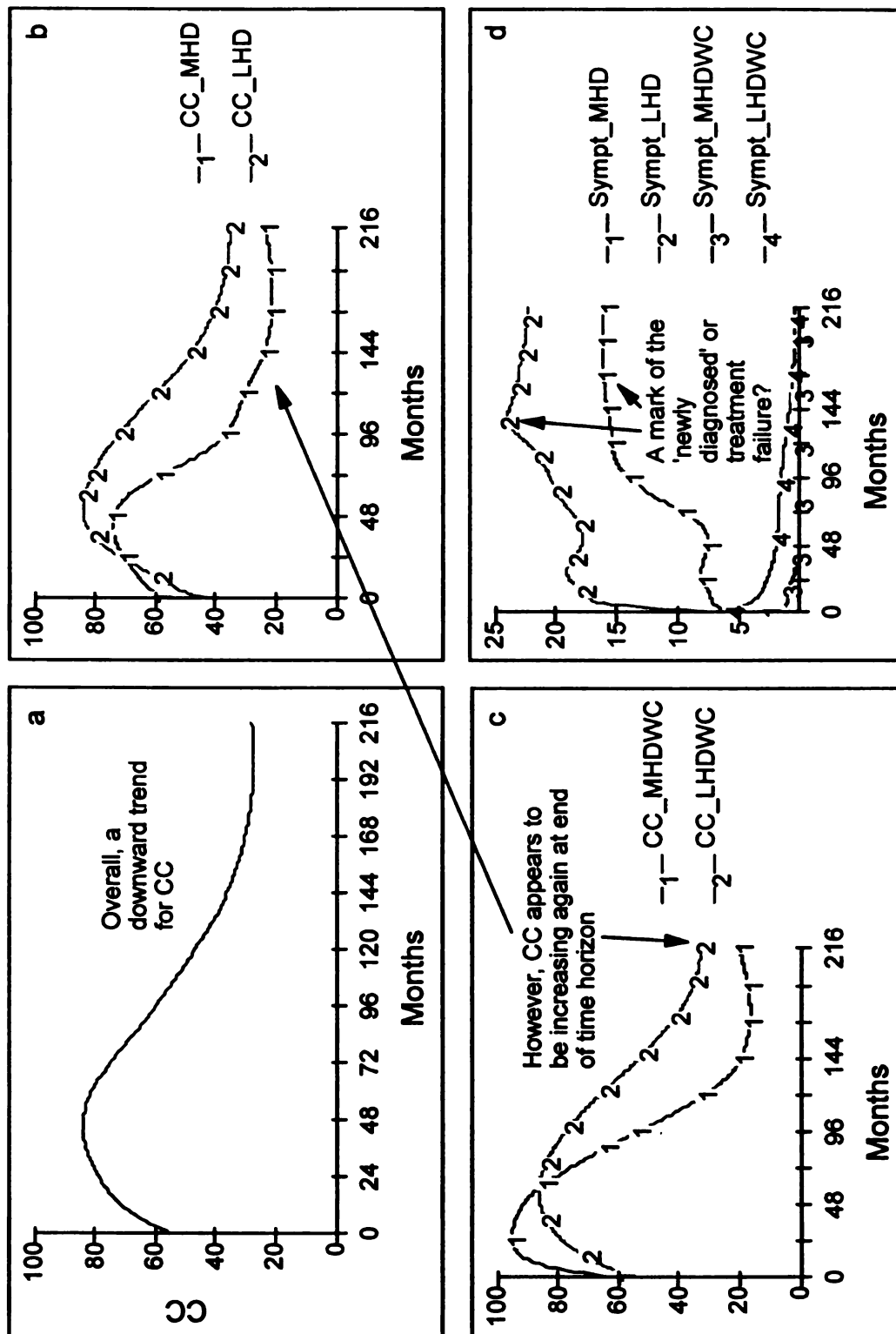


Figure 5.15 - Care complacency process simulations: (a) Aggregate care complacency; and subpopulation comparisons of care complacency for (b) mid-stage and late stage persons; (c) mid-stage and late stage persons with care; and (d) average HIV symptoms mid-stage and late stage undiagnosed and diagnosed persons

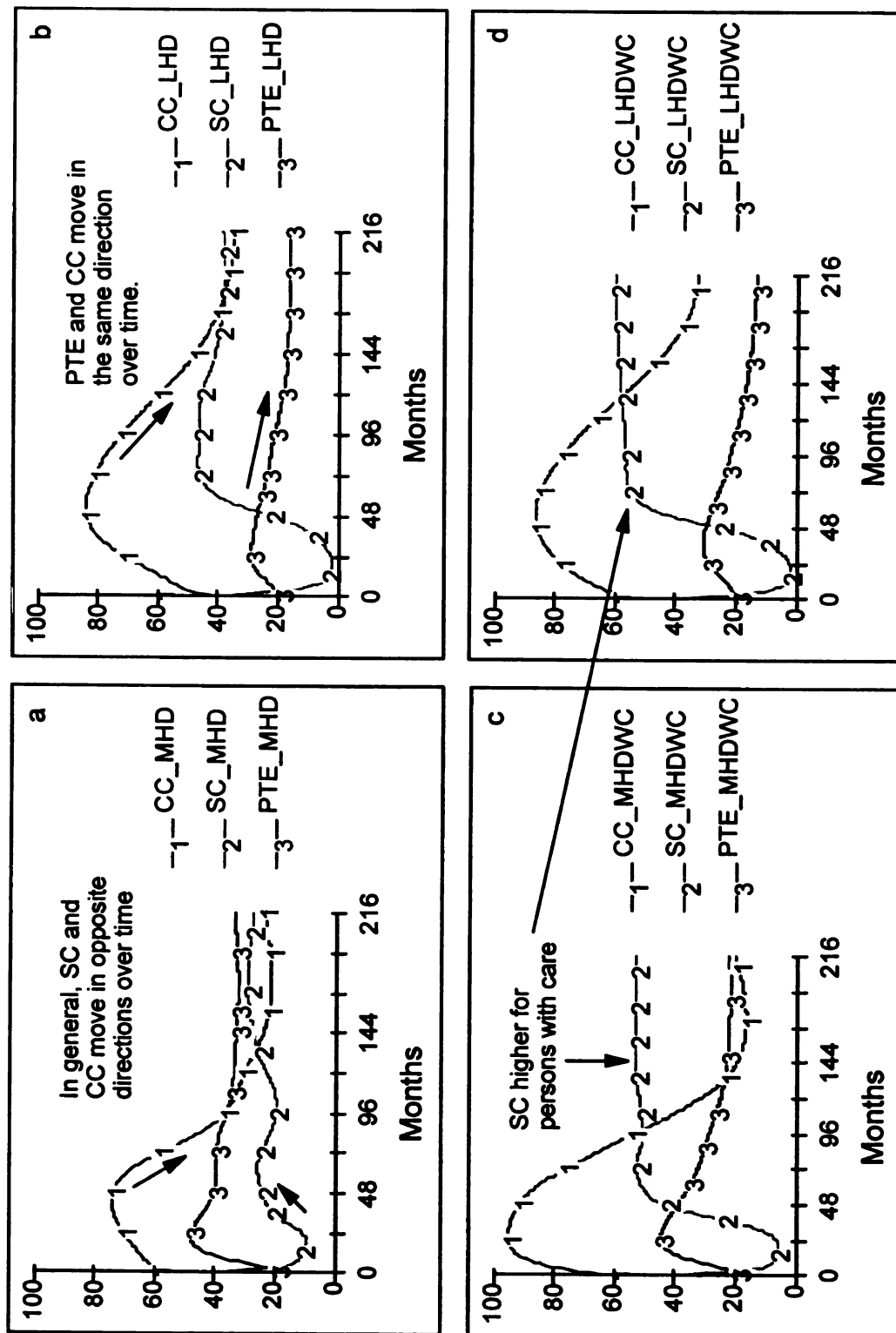


Figure 5.16 - Care competency process simulations: Subpopulation comparisons of care competency, self-concept, and perceived treatment efficacy for (a) mid-stage diagnosed persons; (b) late stage diagnosed persons, (c) mid-stage persons with care, and (d) late stage persons with care

year period relatively early on in the epidemic (i.e., pre-1988). By 1996, mid-stage persons in care are actually the most adherent. Curiously, the curves for late-stage persons, whether only diagnosed or diagnosed and in care, show the same pattern of care complacency (CC).

Moreover, graph (d) shows that, in simulation, reducing care complacency really does make a difference. The HIV symptom levels of those subpopulations who are diagnosed and in care services (MHDWC and LHDWC) are extremely low relative to those who are simply diagnosed, but for whatever reason, not engaged in care (MHD and LHD). In particular, long-term HIV diagnosed persons who are not in care appear to show a spike increase in HIV symptoms at month 144 (i.e., December 1995). This reflects how in-demand more effective HIV treatments were at that point in the epidemic, just as the care-related benefits of the ‘medicalization’ period were beginning to make a difference.

Figure 5.16 provides a comparison of all four care-seeking subpopulations on three causally related constructs, namely: care complacency (CC), self-concept (SC), and perceived treatment efficacy (PTE). Note that both self-concept (SC) and perceived treatment efficacy (PTE) are antecedent to care complacency (CC). It appears that care complacency (CC) has been improving (i.e, decreasing) as perceived treatment efficacy (PTE) has been strengthening, although self-concept (SC) seems to be working against any constructive gains in care complacency (CC) over the ‘discovery’ and some of the ‘mobilization’ periods (i.e., from December 1983 to December 1990). Clearly, people who were in care showed higher levels of perceived treatment efficacy (PTE). Persons who are diagnosed but not in care (MHD and LHD) seem to have a relatively depressed

sense of perceived treatment efficacy (PTE). Yet, because care complacency (CC) has been decreasing for all groups over time, it seems that treatment to manage their HIV disease.

Prevention Complacency Process

The causal loop diagram for the prevention complacency process is presented in Figure 5.17. Note that it is essentially the complement of the care complacency process, with the care complacency (CC) construct being replaced with the prevention complacency (PC) construct. Like the care complacency process, the prevention complacency process features two loops, one balancing and one reinforcing (B2 and R4). Also like the care complacency process, the construct of focus, prevention complacency (PC), is directly influenced by both perceived treatment efficacy (PTE) and self-concept (SC).

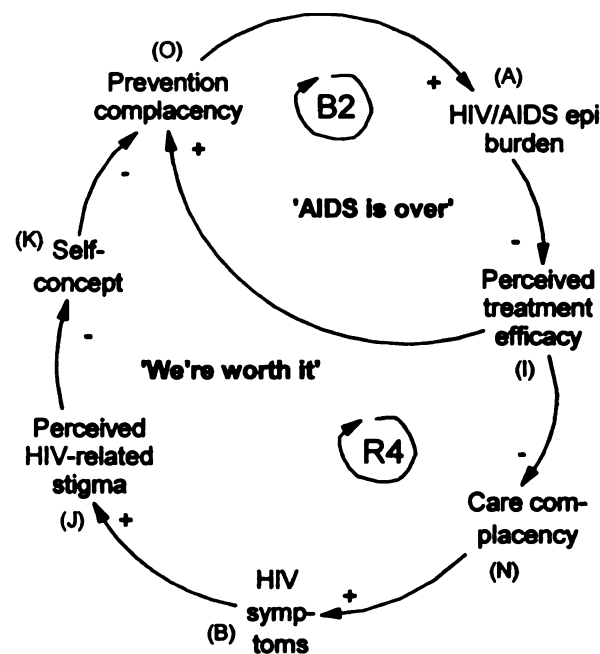


Figure 5.17 - Causal loop diagram for prevention complacency process

There are two main differences between the prevention complacency process and the care complacency. First, the prevention complacency process affects all 8 epidemiological subpopulations, whether they are diagnosed or undiagnosed, in care or not in care. Second, the prevention complacency process affects the HIV infection rate as well as the decision to take an HIV test. In contrast, care complacency (CC) affects only the extent to which diagnosed persons choose to connect themselves to treatment offered through the care system.

Feedback structure. Loop B2 shows how perceived treatment efficacy (PTE) affects prevention complacency (PC). This three-construct loop suggests that any subpopulation in the model would be likely to increase its level of prevention complacency (PC) by, for example, unprotected sex or drug use, as a result of an increase in their perception or belief that HAART and other available treatments are really working (i.e., are accessible and efficacious). The narrative for this feedback structure might be referred to as ‘AIDS is over.’ Strong perceived treatment efficacy (PTE) would suggest that people would be more willing to rationalize that (1) available treatments make HIV an easily managed health problem and/or (2) available treatments act as an effective prophylactic (e.g., condoms aren’t necessary).

Loop R4 taps into the idea that persons will not take risks regarding their personal chance of becoming HIV-positive because of a strong sense of self-concept (SC). The narrative played out here could be called ‘We’re worth it.’ In general, a strong or increasingly strong sense of self is going to have a prohibitive effect on risk-taking behavior and/or increase a group’s motivation to take the HIV anti-body test. In turn, fewer persons would be expected to contract HIV. However, if AIDS-related deaths

increase in any discernable way, perceived treatment efficacy (PTE) is likely to diminish. Over time, care complacency (CC) is likely to increase as a result, bringing a higher burden of HIV symptoms and, naturally, higher levels of perceived HIV stigma (PHS).

Model Behavior. Seven figures of simulations for the prevention complacency process were prepared (see Figures 5.18 to 5.24). The first of this series, Figure 5.18, presents aggregate prevention complacency (PC) in graph (a) along with three HIV testing rates in graph (b), a comparison of aggregate prevention complacency (PC) with perceived treatment efficacy (PTE) and self-concept (SC) in graph (c), and a comparison of aggregate prevention complacency (PC) and the HIV infection rate in graph (d). Graph (a) shows that prevention complacency (PC) drops for all subpopulations during the first few years of the epidemic, but then creeps up again, peaking at about month 72 (i.e., December 1989). Thereafter prevention complacency (PC) stays relatively flat, but high.

As noted previously, prevention complacency (PC) can be thought of as both a the extent to which safer sex is practiced by and the extent to which people seek out HIV prevention services, including services for HIV testing. In graph (b), the early HIV test positive rate is increasing rapidly over the last ten years (i.e., 1991 to 2001), which may very well be the result of sustained, high levels of unsafe sexual behavior. During the ‘mobilization’ period, however, it appears that a relatively slight increase in prevention complacency (PC) had a steep, decreasing effect on HIV testing behavior [see graph (b)] as well as on sexual risk-taking [as indicated by the dramatic drop in the overall HIV infection rate; see graph (d)]. This suggests as a highly elastic relationship between prevention complacency (PC) as ‘safer sex’ and as ‘HIV testing behavior.’ Because perceived HIV stigma (PHS) is a construct included in this process, these two ‘dips’ in

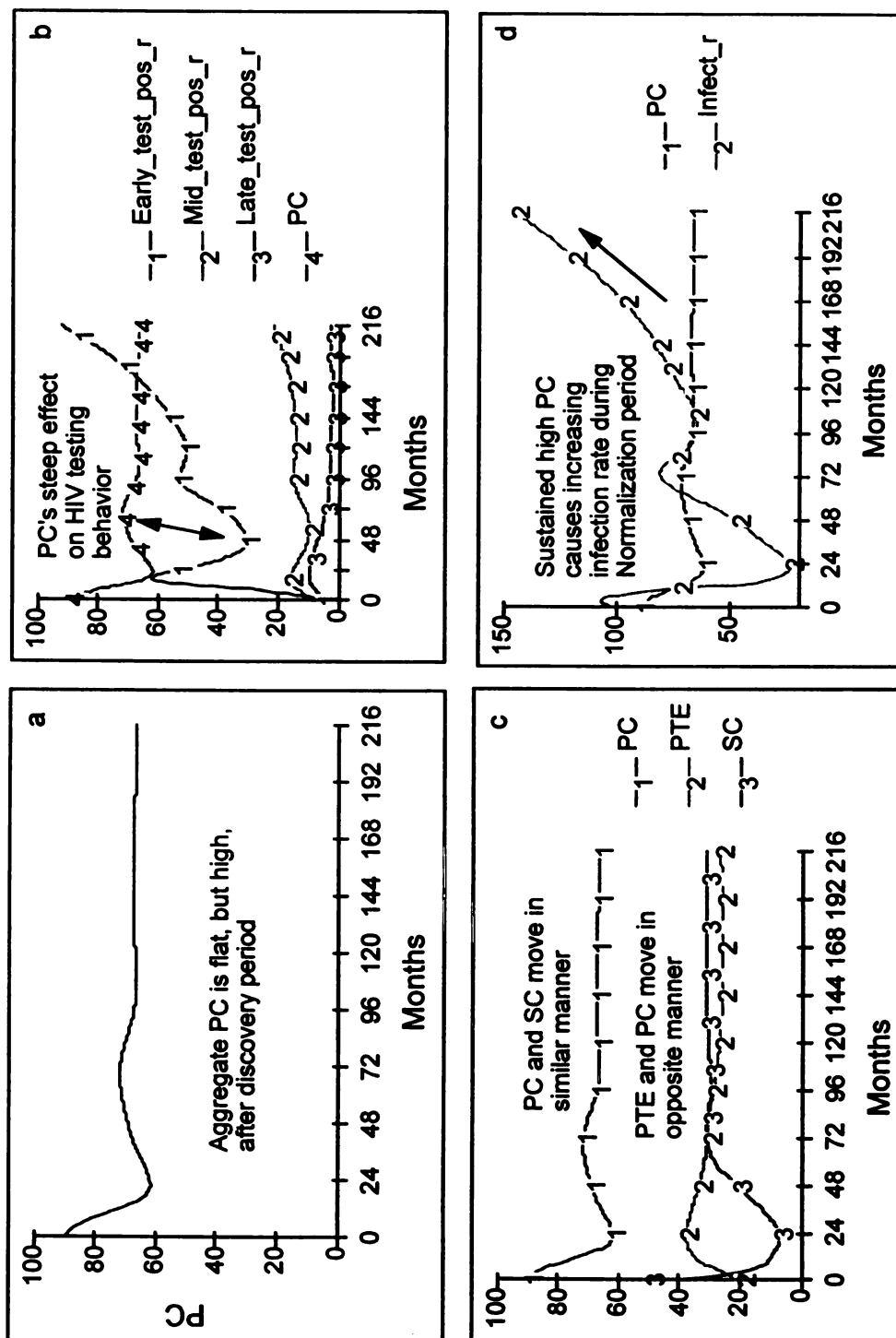


Figure 5.18 - Prevention complacency process simulations: (a) Aggregate prevention complacency; (b) aggregate prevention complacency and early, mid, and late HIV testing rates; (c) aggregate prevention complacency, aggregate perceived treatment efficacy, and aggregate self-concept; and (d) aggregate prevention complacency and HIV infection rate

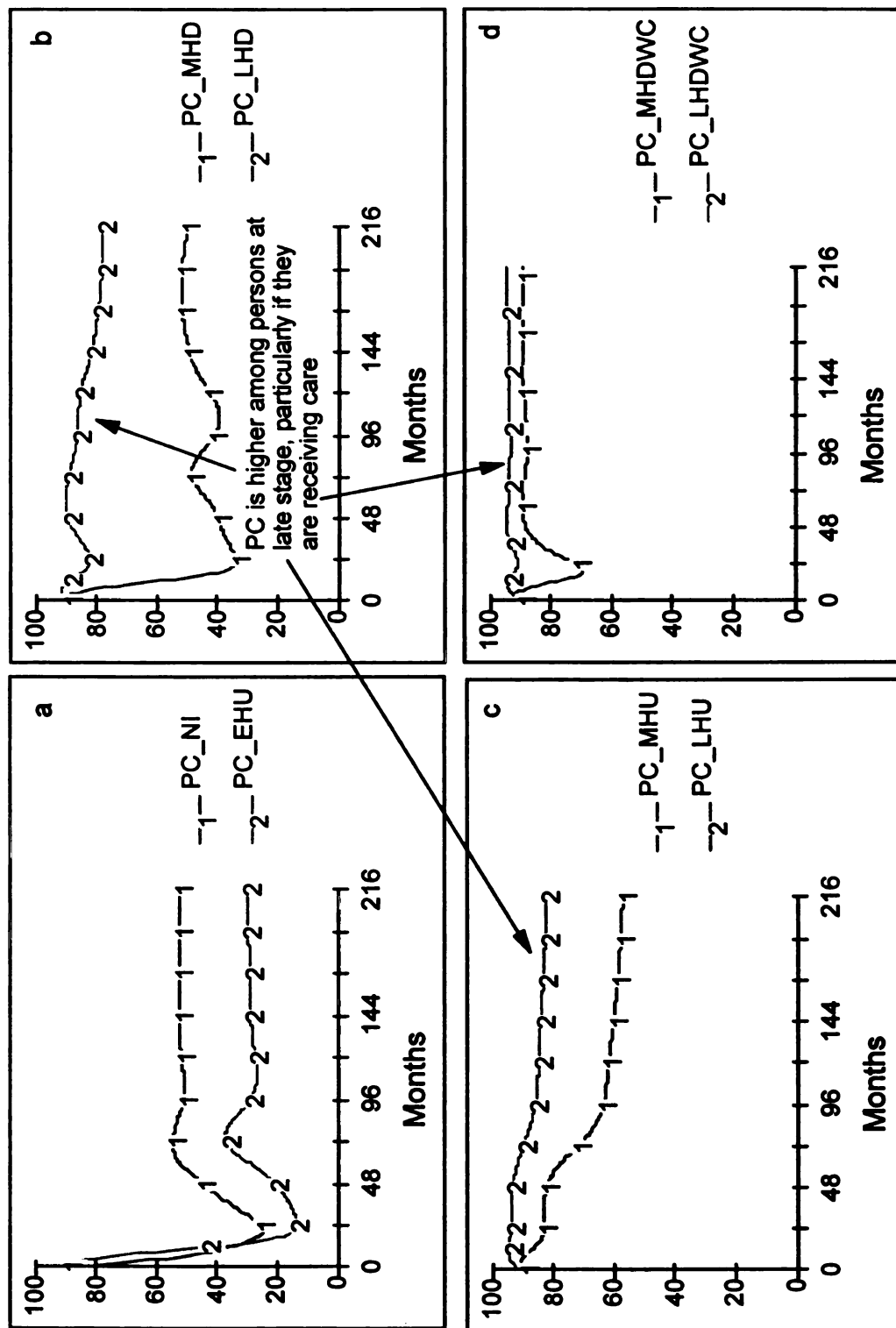


Figure 5.19 - Prevention complacency process simulations: Subpopulation comparisons of prevention complacency for (a) early stage undiagnosed persons; (b) mid-stage and late stage diagnosed persons; (c) mid-stage and late stage undiagnosed persons; and (d) mid-stage and late stage persons with care

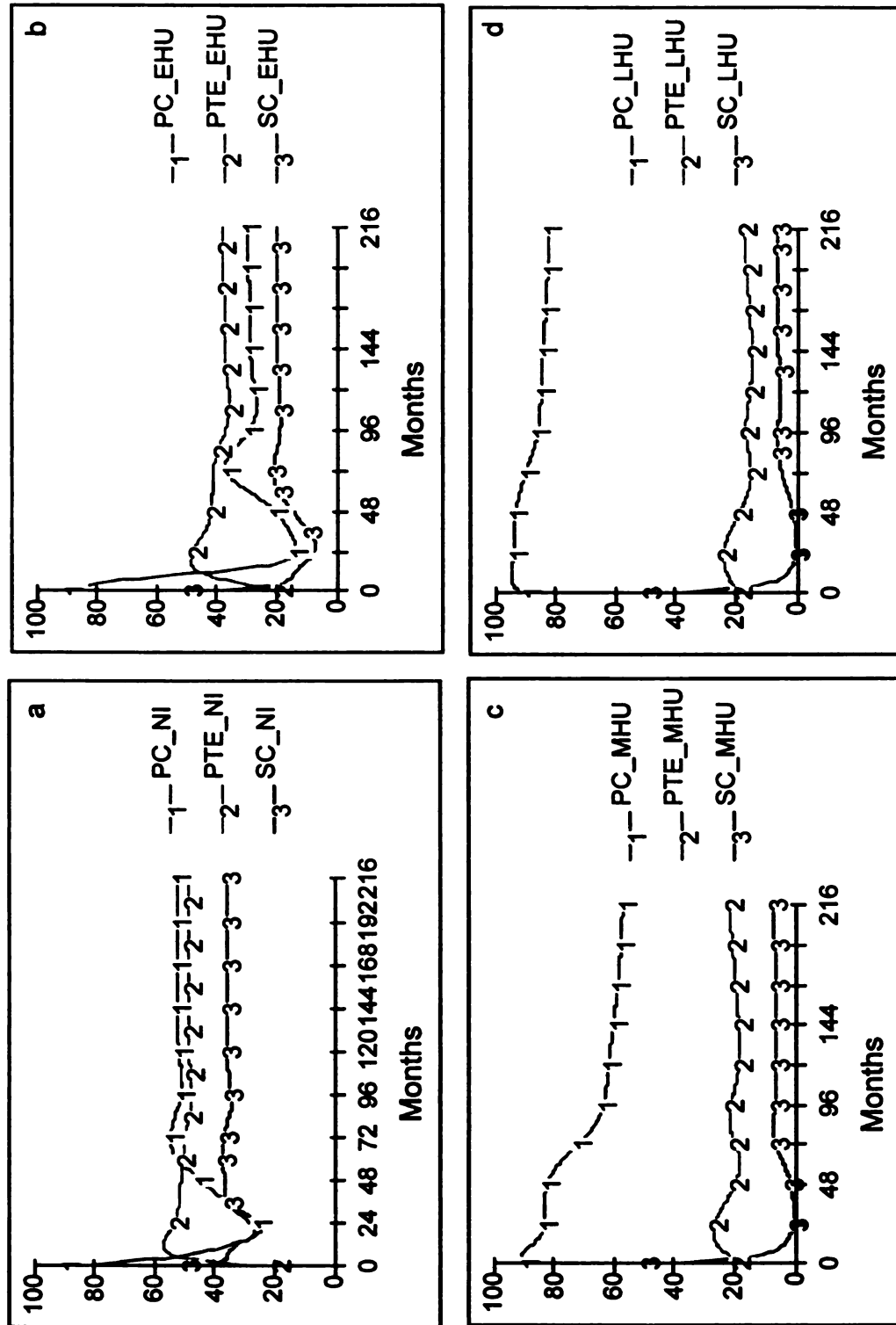


Figure 5.20 - Prevention complacency process simulations: Subpopulation comparisons of prevention complacency, perceived treatment efficacy, and self-concept for (a) newly infected persons; (b) early stage undiagnosed persons; (c) mid-stage undiagnosed persons; and (d) late stage undiagnosed persons

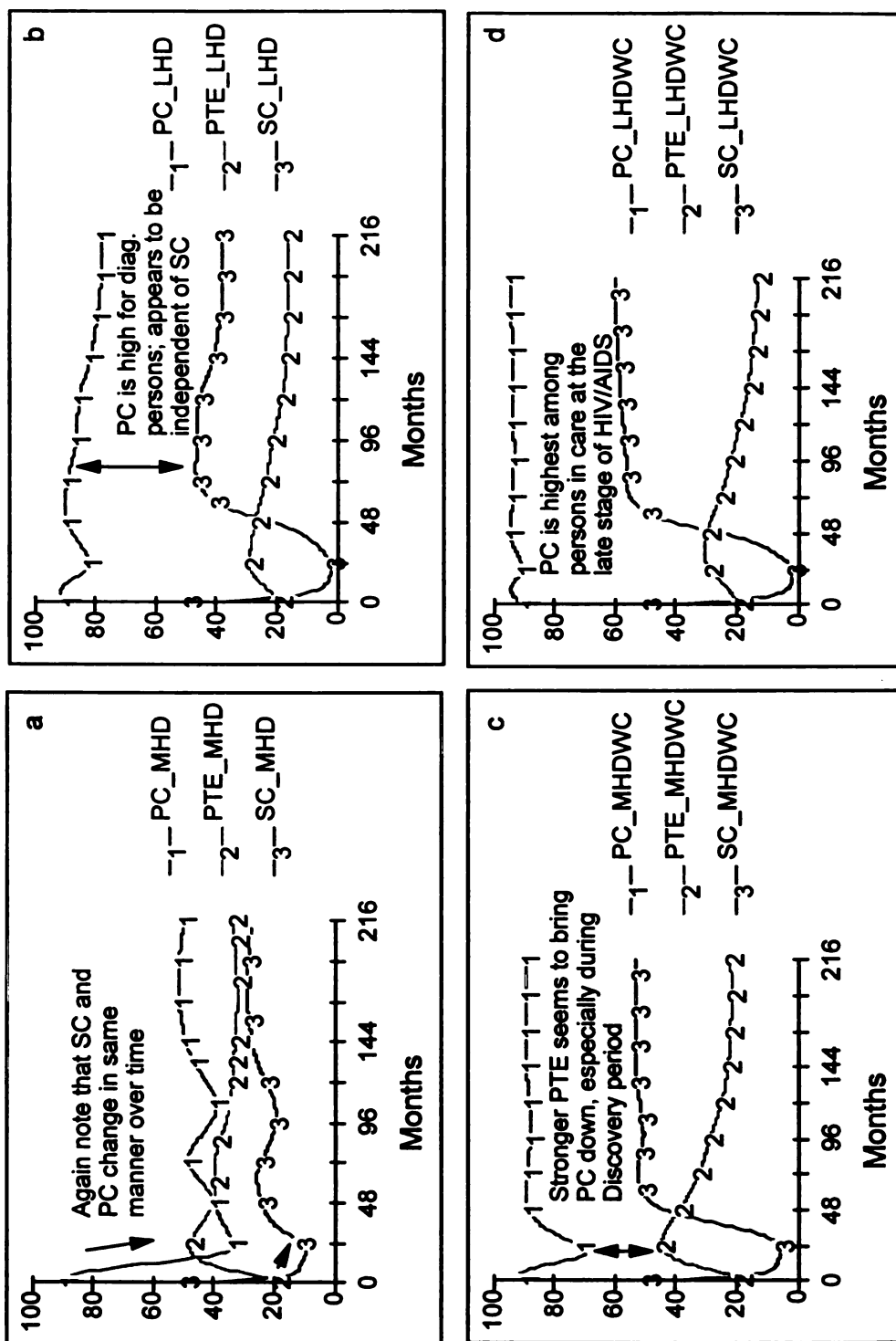


Figure 5.21 - Prevention complacency simulations: Subpopulation comparisons of prevention complacency, perceived treatment efficacy, and self-concept for (a) mid-stage diagnosed persons; (b) late stage diagnosed persons; (c) mid-stage persons with care; and (d) late stage persons with care

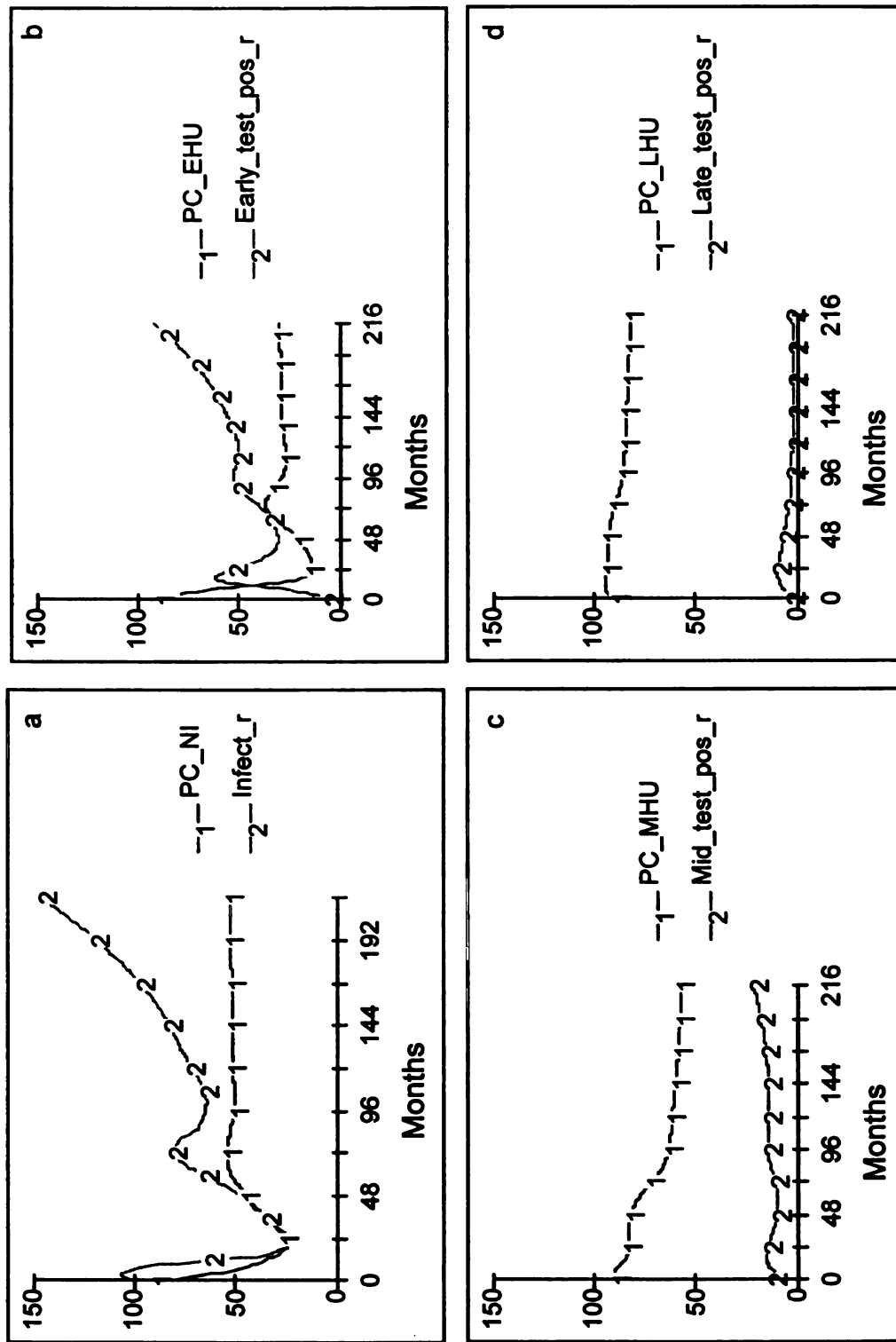
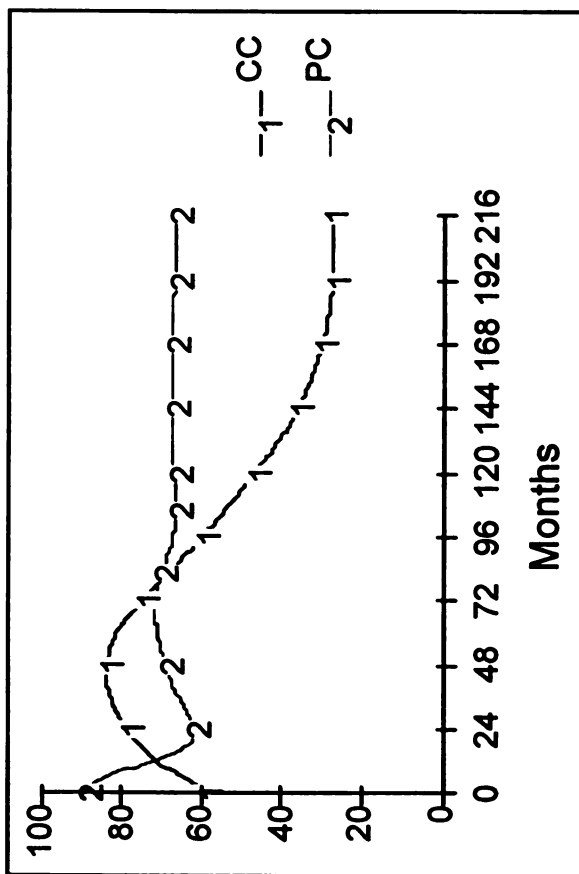


Figure 5.22 - Prevention complacency process simulations: Subpopulation comparisons of (a) prevention complacency among newly infected persons and HIV infection rate; (b) prevention complacency among early stage undiagnosed persons and early HIV testing rate; (c) prevention complacency among mid-stage undiagnosed persons and mid-stage HIV testing rate; and (d) prevention complacency among late stage undiagnosed persons and late HIV testing rate



**Figure 5.23 - Prevention complacency process simulations:
Aggregate prevention complacency and aggregate care
complacency**

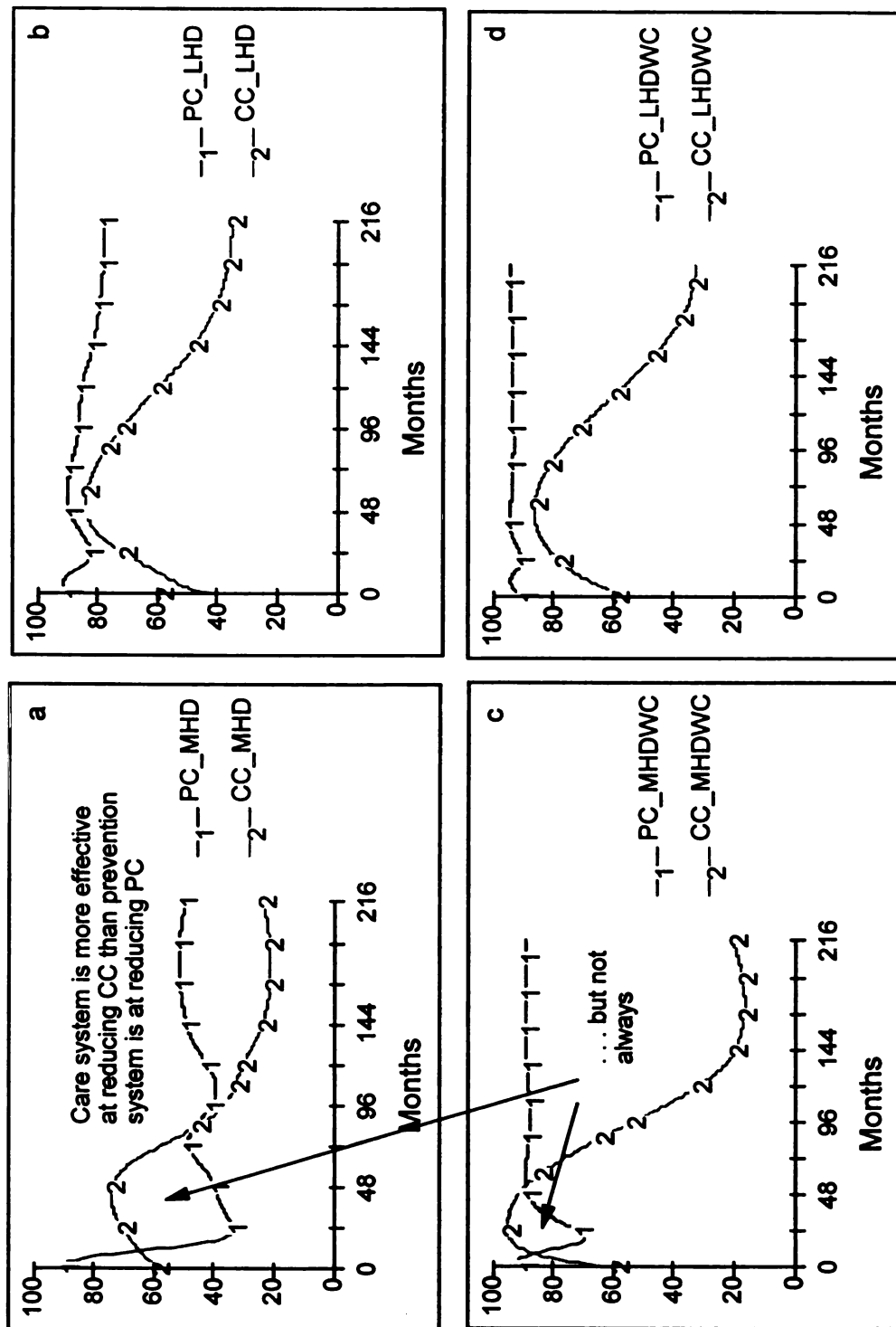


Figure 5.24 - Prevention complacency process simulations: Subpopulation comparisons of prevention and care complacency for (a) mid-stage diagnosed persons; (b) late stage diagnosed persons; (c) mid-stage persons with care; and (d) late stage persons with care

testing-taking behavior and HIV infection rates may also be related to the causal effects of HIV/AIDS-related fear that permeated the earlier period of the epidemic.

In Figure 5.18 graph (c), aggregate perceived treatment efficacy (PTE) shows itself as the inverse of aggregate prevention complacency (PC). Aggregate perceived treatment efficacy (PTE) stays substantially lower than aggregate prevention complacency (PC) across the entire time horizon. Self-concept (SC) moves in parallel with prevention complacency (PC), but like perceived treatment efficacy (PTE), at a substantially lower level. Patterns of change among three constructs suggest that altering any of these, for the better or the worse, would have a quick and proportional effect on the other two.

Figure 5.19 shows prevention complacency (PC) disaggregated by subpopulation. In general, prevention complacency (PC) is much higher among late stage persons with care (PC MHD, PC LHD) than it is for persons in other subpopulations. Figure 5.20 focuses on diagnosed and/or with care subpopulations. It shows, to some extent, 'surprise' or counterintuitive behavior between self-concept (SC) and prevention complacency (PC). As self-concept (SC) decreases, so does prevention complacency (PC). Keeping in mind that this trend is most clear during the 'discovery' period, the lowering of self-concept (SC) may be attributed to fear, which in turn is lower complacency about HIV. In general, what was exhibited appears to be a matter of loop dominance between the 'AIDS is over' feedback structure and the 'We're worth it' feedback structure during the 'discovery' and 'mobilization' periods of the epidemic.

Figure 5.22 indicates that, to the extent that prevention complacency (PC) can be decreased, infection rates (and subsequent testing rates) can also be decreased. However,

as seen in graph (b) if HIV incidence rates grow too quickly, the positive benefits of reduced prevention complacency (PC) become difficult to recognize.

The last two figures in the series of simulations for the prevention complacency process allow a closer look at how prevention complacency (PC) and care complacency (CC) move relative to each other over the model's time horizon. Both Figure 5.23 and 5.24 show that, as noted previously in the text describing the hypothesized and simulated reference mode for 'complacency,' if the average of aggregate prevention complacency (PC) and aggregate care complacency (CC) is taken across the entire time horizon, the resulting curve does, in fact, approach the shape that was originally hypothesized, although it still does not drop and recover as quickly as was expected. Yet, this output calls attention to the fact that they are two separate constructs with different modes of behavior.

Figure 5.24 shows how these curves move relative to each other when disaggregated by the four diagnosed subpopulations. Note that each of the graphs of prevention complacency (PC) reveal a hint of the originally hypothesized 'complacency' curve shape early on in the epidemic, but then flatten out. If just the prevention complacency (PC) curves are considered, the curve in graph (a) shows the closest match to what was hypothesized. If just the care complacency (CC) curves are considered, the curve in graph (c) shows the closest match to what was hypothesized. Again, though, if the average of the two curves in graph (c) is taken, the hypothesized reference mode appears to be almost perfectly reproduced. Nearly the same can be said for late stage persons in care, as seen in graph (d).

Community Empowerment Process

As its causal loop diagram suggests, the community empowerment process is, by far, the most elaborate dynamic structure discovered in the modeling process (see Figure 5. 25). It is comprised of four balancing loops (B3, B4, B5, B6) and just one reinforcing loop (R5) that, diagrammatically, resemble a three-leaf clover. Loop R5 includes the three theoretical parts of the psychological empowerment construct, as defined by Zimmerman (1995), namely self-concept (SC), system awareness (SA), and system change action (SCA). Each of the balancing loops (B3, B4, B5, and B6) address the dynamic relationship between satisfaction and system change action (SCA) for prevention (SPSQ) and care (SCSQ), respectively.

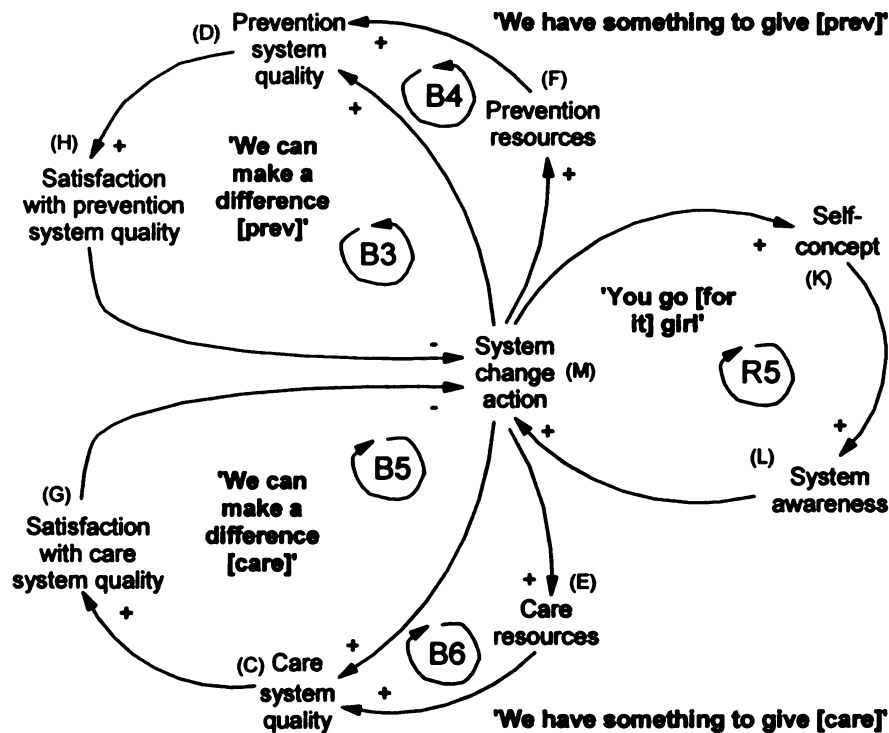


Figure 5.25 - Causal loop diagram for community empowerment process

Feedback structure. This structure's only reinforcing loop, loop R5, might best be referred to as the heart of the community empowerment process. The title of the narrative for R5 is 'you go [for it], girl.' To the extent that self-concept (SC) is strengthened, system awareness (SA) is strengthened. In the model, either an improved understanding of the system (SA) or a strengthened self-concept (SC) could bring about action-oriented behavior (i.e., SCA).

R5, however, is affected by four balancing loops (B3, B4, B5, and B6). Collectively, these loops determine the extent to which system change action (SCA) increases, decreases, or stays flat over time. Loops B3 and B5 represent situations where members of a subpopulation personally get involved, or participate, in system change action (SCA). For example, these loops represent the extent to which subpopulations are working or volunteering as service providers to the community. B3 describes the level of such activity for the prevention side. B5 describes the level of such activity for the care side.

The title of the narrative for B3 and B5 could be 'somebody's got to do it' or 'we can make a difference.' Note that what underlies the extent to which system change action (SCA) is reinforced or not is a function of the level of satisfaction with the system (SPSQ and SCSQ). As discussed previously in Chapter 4, HIV positive core key informants in the study, many of whom are service providers to the HIV community, described how it was often a profound sense of dissatisfaction with their circumstance and/or the circumstance of the community, that motivated them to get involved to make change.

Loops B4 and B6 represent similar dynamics to loops B3 and B5, although the

action that is generated through B4 and B6 is more about participation in planning and/or advocacy to obtain greater resources on behalf of persons in need of prevention and/or care services. The good title of the narrative for these loops might be 'we have something to say.' System change action (SCA) would be expected to influence the level of resources allocated to address prevention and care in the community, for example. Here again, the reinforcing mechanism is dissatisfaction. To the extent that persons are content with the status quo, they would not be expected to instigate any appreciable level of change in the system.

Model Behavior. A series of six figures present selected simulations of the community empowerment process (see Figures 5.26 to 5.31). Figure 5.26 shows aggregate levels of system awareness (SA), self-concept (SC), and system change action (SCA) in graph (a), aggregate system change action (SCA) compared with care system quality (CSQ) and prevention system quality (PSQ) in graph (b), aggregate system change action (SCA) compared with aggregate satisfaction with care system quality (SCSQ) and aggregate satisfaction with prevention system quality (SPSQ) in graph (c), and aggregate levels of prevention resources (PR) and care resources (CR) in graph (d). In general, the aggregated empowerment constructs (SA, SC, and SCA) all seem to peak around month 60 (i.e., December 1988), and then stay level at a moderately low level of impact.

The peak, which was most pronounced for system change action (SCA), does appear to be influenced by visibly lower levels of satisfaction (for both SCSQ and SPSQ) in the months immediately preceding it. Moreover, note that care system quality (CSQ) and prevention system quality (PSQ) were increasing relatively quickly over the same

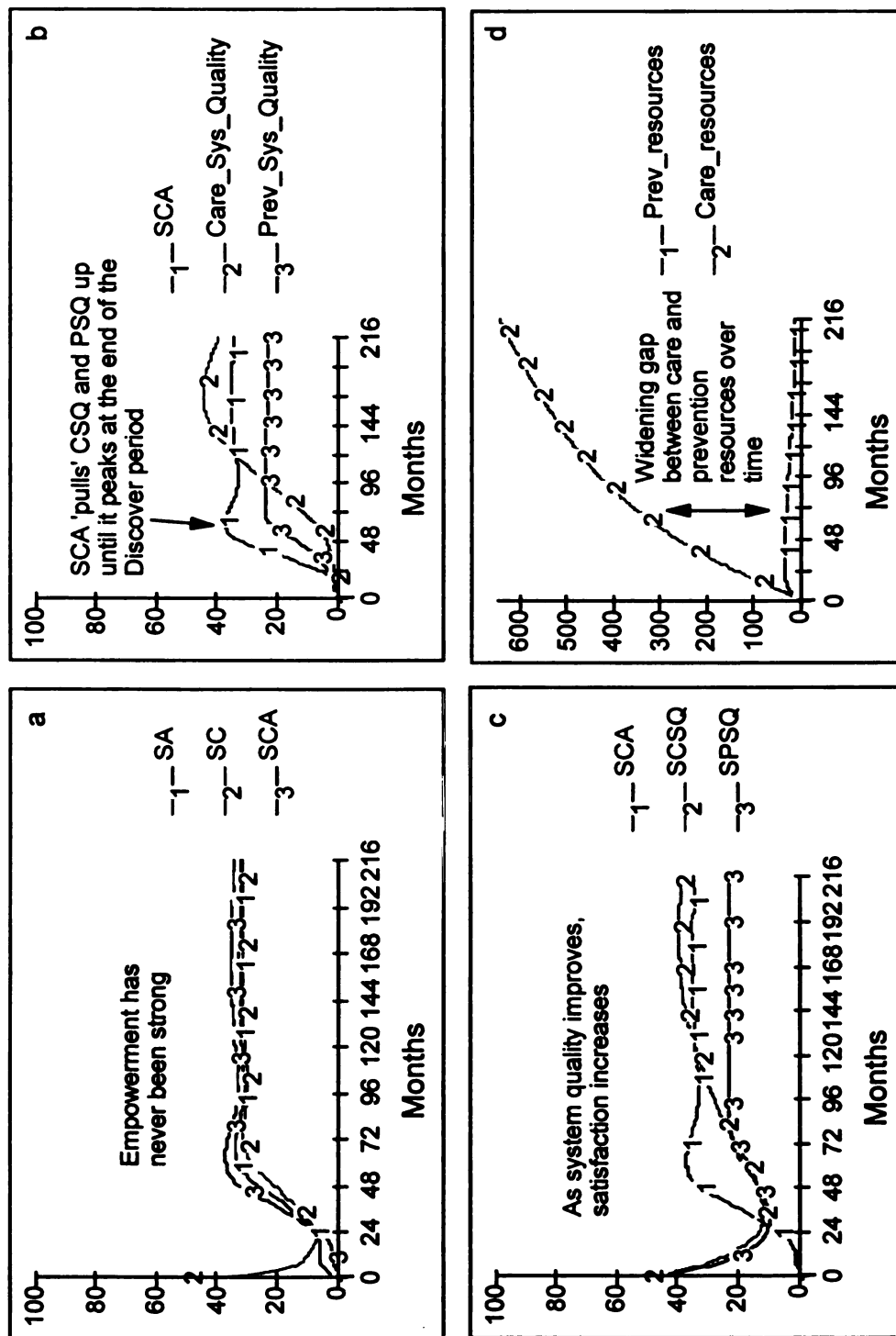


Figure 5.26 - Community empowerment process simulations: (a) Aggregate system awareness, aggregate self-concept, and aggregate system change action; (b) aggregate system change action, care system quality and prevention system quality; (c) aggregate system change action, aggregate satisfaction with care system quality, and aggregate satisfaction with prevention system quality; and (d) care resources and prevention resources

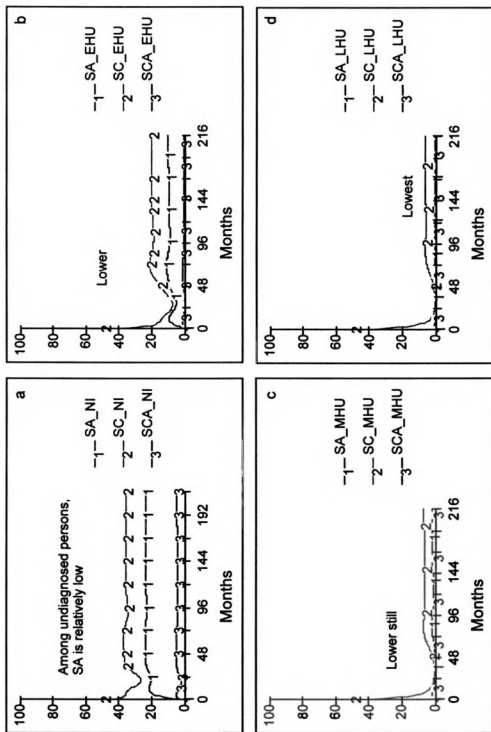


Figure 5.27 - Community empowerment process simulations: Subpopulation comparisons of system awareness, self-concept, and system change action for (a) newly infected persons; (b) early stage undiagnosed persons; (c) mid-stage undiagnosed persons; and (d) late stage undiagnosed persons

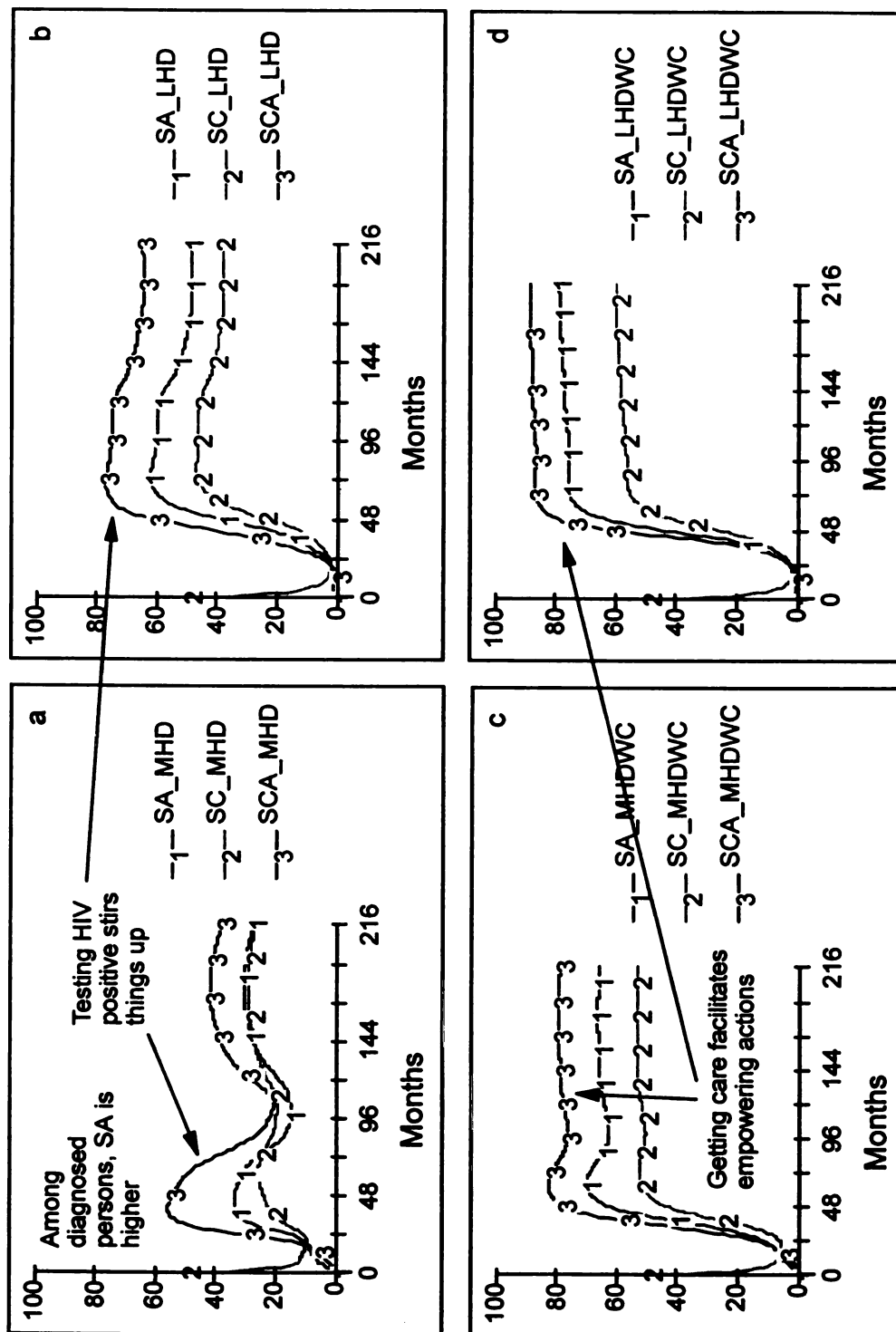


Figure 5.28 - Community empowerment process simulations: Subpopulation comparisons of system awareness, self-concept, and system change action for (a) mid-stage diagnosed persons; (b) late stage diagnosed persons; (c) mid-stage persons with care; and (d) late stage persons with care

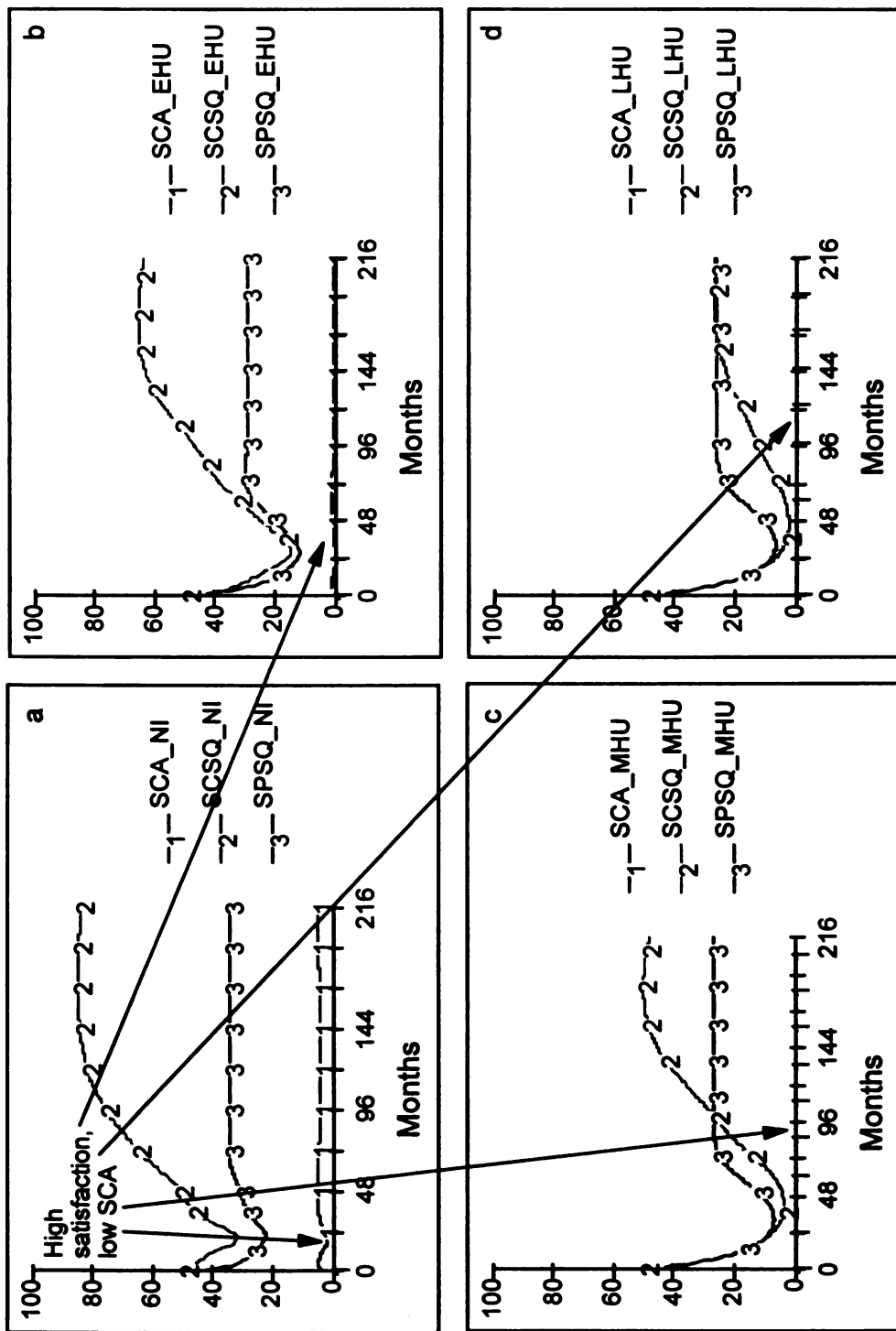


Figure 5.29 - Community empowerment process simulations: Subpopulation comparisons of system change action, satisfaction with care system quality, and satisfaction with prevention system quality for (a) newly infected persons; (b) mid-stage undiagnosed persons; (c) early stage undiagnosed persons; and (d) late stage undiagnosed persons

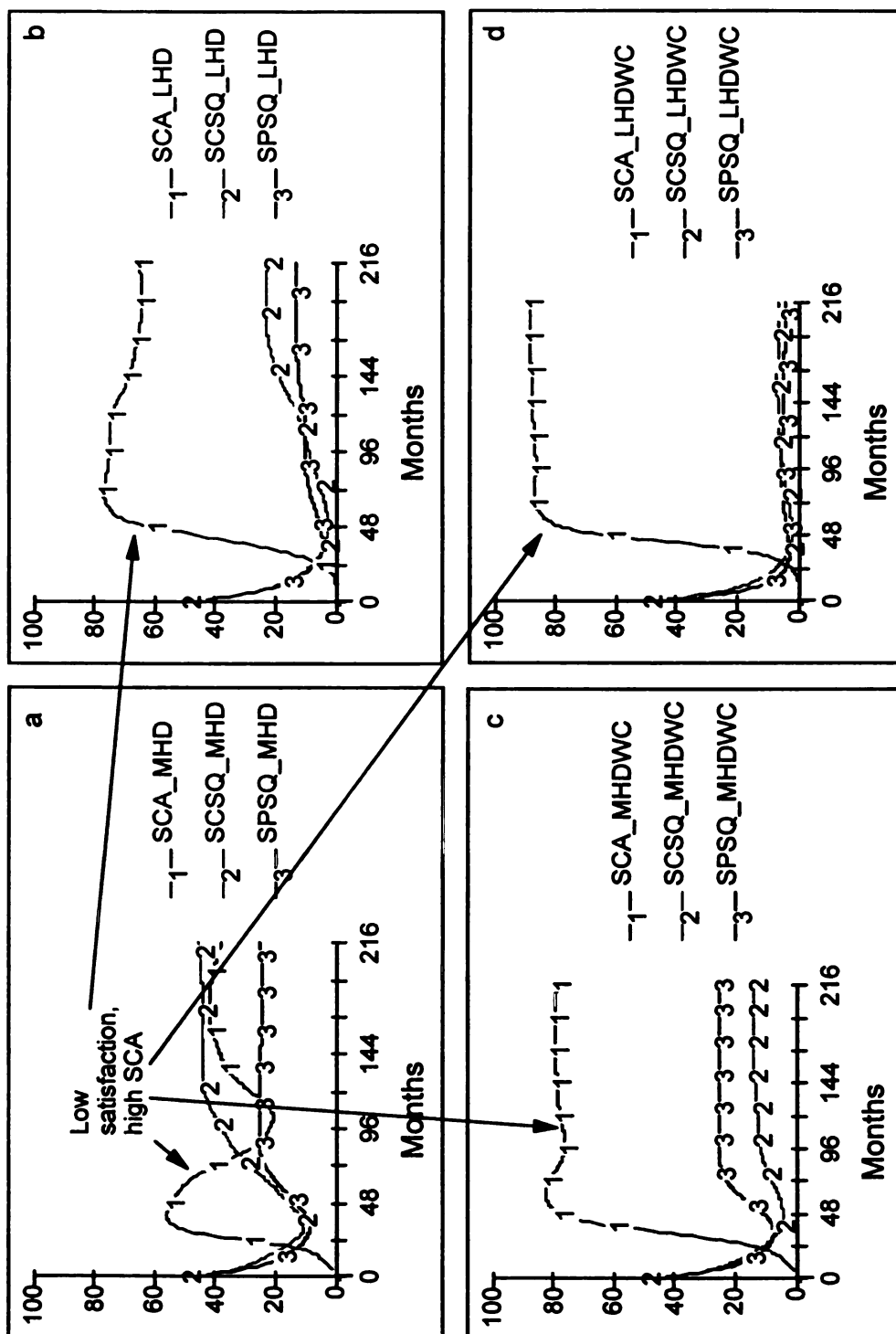


Figure 5.30 - Community empowerment process simulations: Subpopulation comparisons of system change action, satisfaction with care system quality, and satisfaction with prevention system quality for (a) mid-stage diagnosed persons; (b) late stage diagnosed persons; (c) mid-stage persons with care; and (d) late stage persons with care

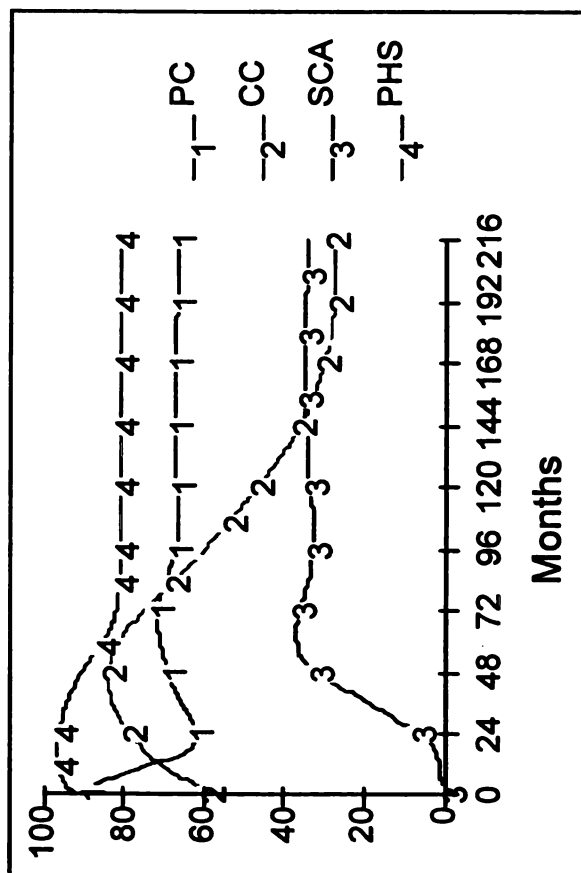


Figure 5.31 - Community empowerment process simulations:
Aggregate prevention complacency, aggregate care
complacency, and aggregate perceived HIV stigma with
aggregate system change action

period that system change action (SCA) was increasing relatively quickly (i.e., months 0 to 72; December 1983 to December 1989). Thereafter, prevention system quality (PSQ) stays flat. In contrast, care system quality (CSQ) continues, to improve until approximately month 180 (i.e. December 1998). The continued rise in care system quality (CSQ) was apparently tied to the rapidly increasing level of care resources (CR) that are being pumped into HIV/AIDS treatment services from the 'medicalization' period forward.

Figures 5.27 and 5.28 provide a disaggregated view of the dynamics of the empowerment meta-construct. Figure 5.27 suggests that system change action (SCA) was very low among all undiagnosed persons across the model time horizon. Newly infected and early stage HIV disease persons show relatively higher levels of all three parts of the empowerment construct compared to mid-stage and late stage undiagnosed persons. Very different model behavior is shown in Figure 5.28, which features system awareness (SA), self-concept (SC), and system change action (SCA) for diagnosed persons and persons in care. Interestingly, persons at the late stage of HIV disease, whether in care or not, show appreciably higher level of empowerment, with system change action (SCA) achieving higher levels than system awareness (SA) or self-concept (SC). Similar dynamics for mid-stage persons in care. Among mid-stage diagnosed persons, the pattern of empowerment is more erratic. System change action (SCA) hits a sharp peak at month 48 (i.e., December 1987), then falls until month 96 (i.e., December 1991) and recovers somewhat, but ultimately ebbs by the end of the time horizon (i.e., December 2001). It was also noted that testing HIV positive (i.e., being diagnosed; MHD and LHD) appears to facilitate system change action (SCA). Similarly, gaining access to care services

(MDHWC and LHDWC) also seems to lead to empowering system change action (SCA).

Figures 5.29 and 5.30 provide a disaggregated comparison of system change action (SCA) and the two satisfaction constructs (SCSQ and SPSQ). Figure 5.29 shows the results for undiagnosed persons. Each of the graphs (a to d) indicate that a relatively high level of system satisfaction has been suppressing system change action (SCA). The story appears dramatically different among diagnosed subpopulations. Figure 5.30 graph (b to d) show that system change action (SCA) zooms way up as a result of very low levels of satisfaction with the system (SCSQ and SPSQ), although this pattern is erratic for mid-stage diagnosed persons as shown in graph (a).

Last, Figure 5.31 provides a general view of the core of the current study's conceptual model, as first presented in Figure 2.1. Aggregate system change action (SCA) is shown with aggregate prevention complacency (PC), care complacency (CC), and perceived HIV stigma (PHS). The graph indicates that increases in system change action (SCA) seem to be associated with slight decreases in perceived HIV stigma (PHS), moderate decreases in care complacency (CC), and slight decreases (early on) in prevention complacency (PC). Overall, only care complacency (CC) has shown a generally favorable trend with respect to HIV/AIDS-related interventions since the inception of the epidemic.

Resource Allocation Process

The resource allocation process is the fifth and final key dynamic process featured in the study. Its causal loop diagram is shown in Figure 5.32. The resource allocation process is comprised of just two loops, both of which are dynamically reinforcing (R6 and R7). It is a direct adaptation of the *systems thinking archetype* coined "Success to the

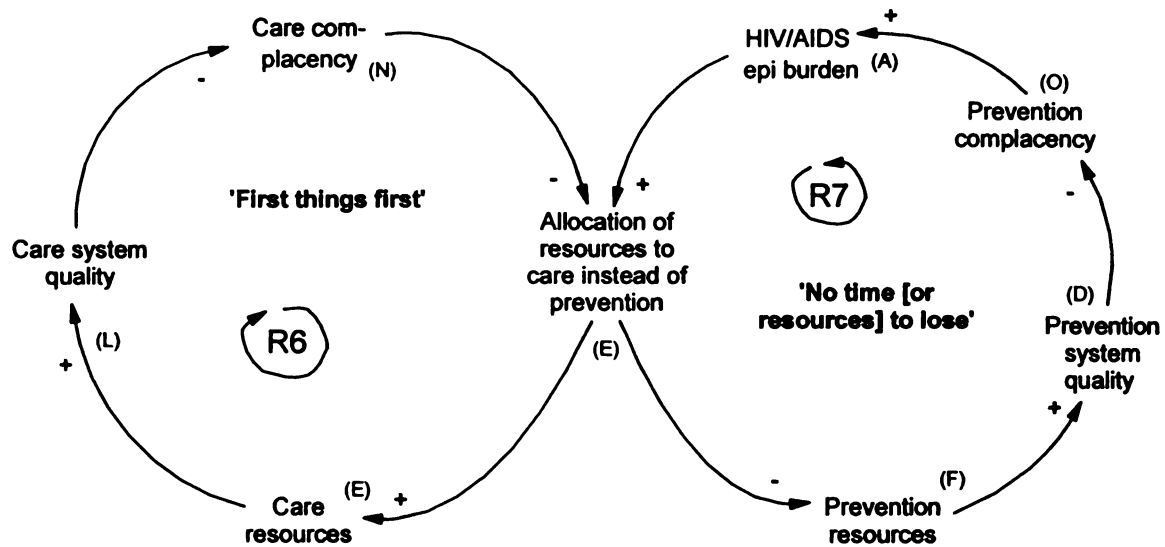


Figure 5.32 - Causal loop diagram for resource allocation process

Successful” by Senge (1990). In general, the archetype fits situations where two activities, or processes, compete for limited support, or resources. In Senge’s words, “the more successful one becomes, the more support it gains, thereby starving the other” (p. 385). Note that the two loops shown in Figure 5.32 share the *allocation of resources to care instead of prevention* variable (hereafter abbreviated as ‘care allocation’). Note that care allocation is not referred to as a construct. In the study, constructs are accumulation variables, or stocks. Instead, care allocation is an auxiliary variable. Nonetheless, it is a key variable in this key dynamic process. It was used to determine the proportion of total available resources that were slated for care services, as opposed to prevention services, in the community.

Feedback structure. Loop R6 and R7 show how an increase in the number of newly infected persons in the system (Epi burden) initiated allocation of resources to care and, for the most part, away from prevention. The title of the narrative for R6 could be

‘first things first,’ reflecting the compelling circumstance of knowing that persons are testing positive and are in need of instrument assistance. Over time, the prevention side of the system suffers, probably reaching a point where funding and staffing levels are so bare bone that little or no prevention system quality remains.

R7’s narrative title might be ‘no time [or funds] to lose.’ In this loop of the model, epi burden continues to rise because higher and higher levels of prevention complacency (PC) affect the HIV infection rate, which further accelerates a call for more care resources. Note that R6 could potential operate to decrease funding allocations to care relative to prevention, but only to the extent that marginal increases in the quality of the care system (CSQ) do not effectively reduce care complacency (CC).

Model Behavior. Four figures present simulations of the resource allocation process (see Figures 5.33 to 5.36). In graph (a), Figure 5.33 shows how prevention and care resources grew as the result of proportional service demands for prevention and care, as shown in graph (b). Graph (c) shows that demand for care relative to prevention triggers increased allocation of resources (e.g., money, people, space) to care instead of prevention. Because both prevention complacency (PC) and care complacency (CC) play important roles in determining the dynamics of resource allocation, their aggregate levels are shown for the purpose of comparison in graph (d). Note that system quality (PSQ and CSQ) are antecedent to care complacency (CC) and prevention complacency (PC). Over time, a decreasing allocation of resources to prevention affects prevention system quality (PSQ), which in turn decreases prevention complacency (PC). A similar trend was observed for care complacency (CC), which stays higher than prevention complacency (PC) after the Mobilization period. This set of graph shows that, as hypothesized, a

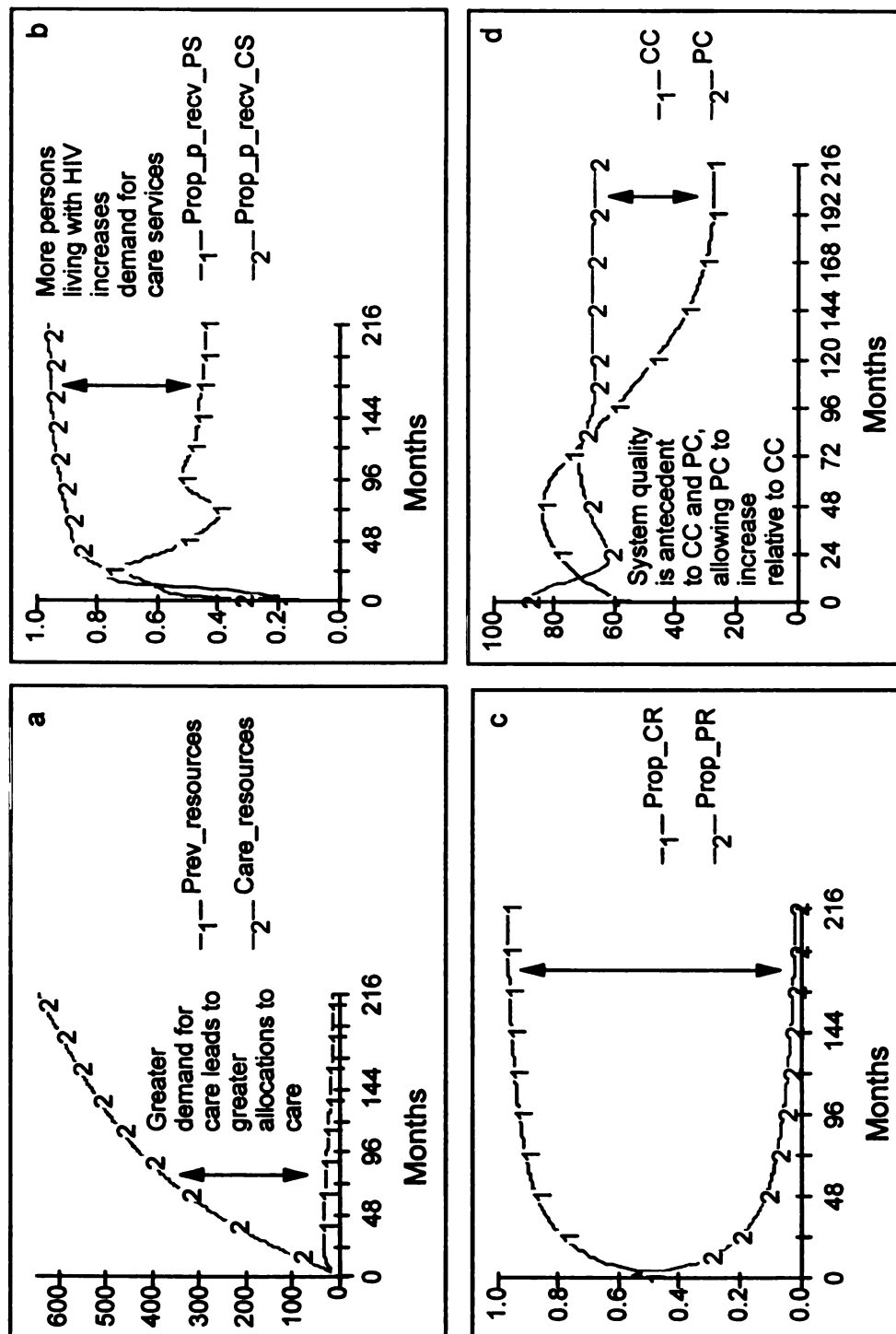


Figure 5.33 - Resource allocation process simulations: Comparisons of (a) prevention resources and care resources; (b) proportion of persons receiving prevention services and proportion of persons receiving care services; (c) proportion of resources allocated to care and proportion of resources allocated to prevention; (d) aggregate care complacency and aggregate prevention complacency

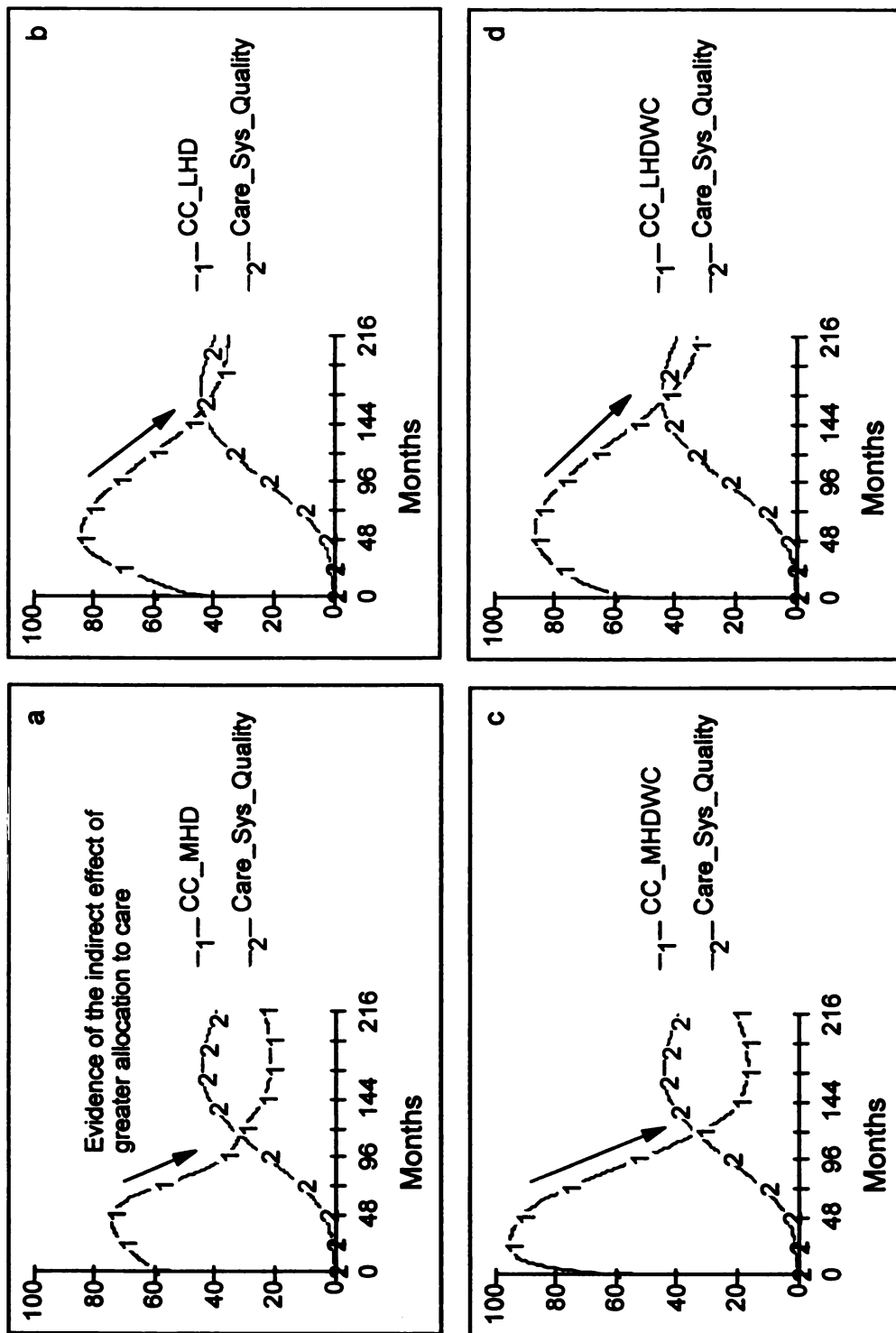


Figure 5.34 - Resource allocation process simulations: Subpopulation comparisons of care complacency and care system quality for (a) mid-stage diagnosed persons; (b) late stage diagnosed persons; (c) mid-stage persons with care; and (d) late stage persons with care

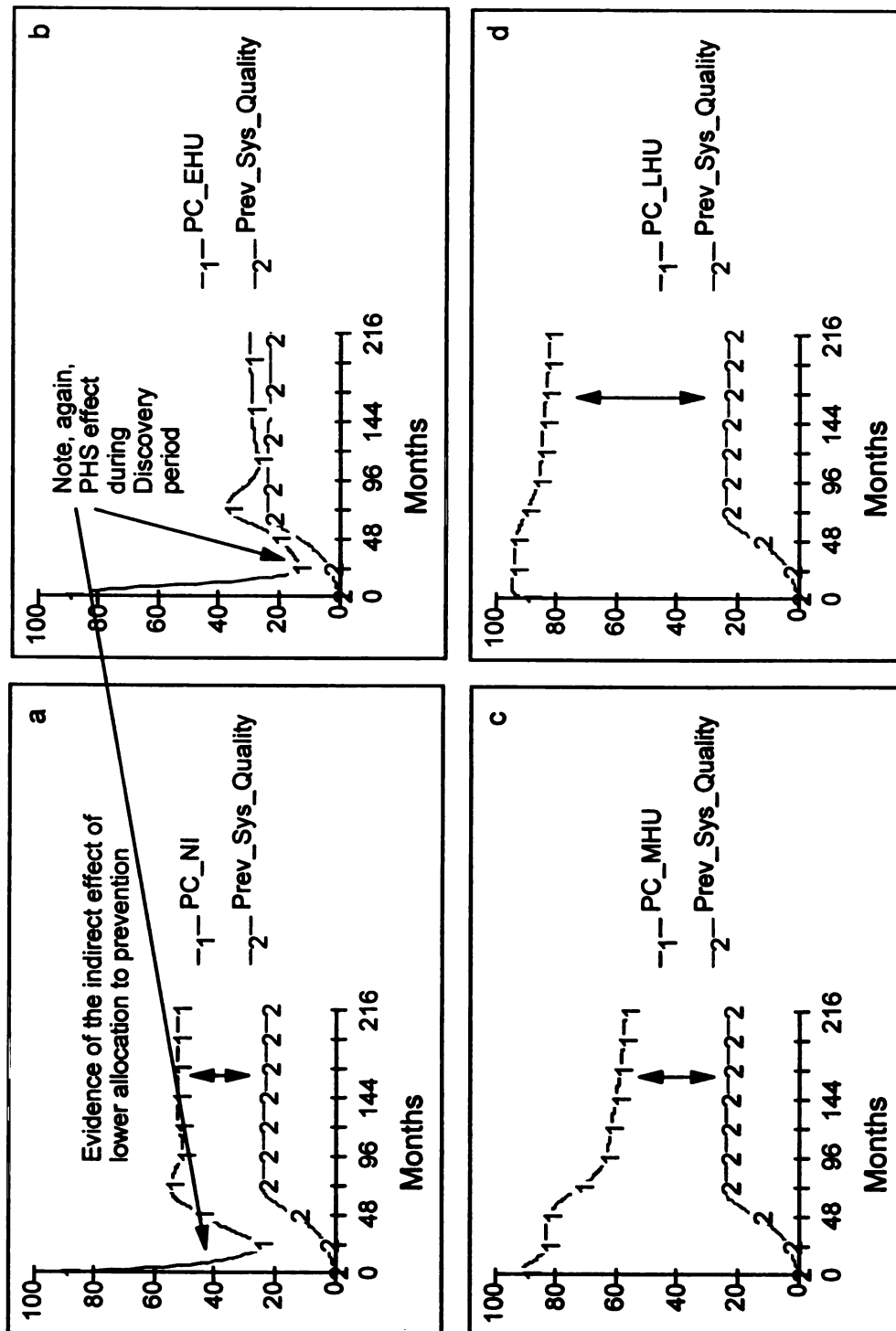


Figure 5.35 - Resource allocation process simulations: Subpopulation comparisons of prevention complacency and prevention system quality for (a) newly infected persons; (b) early stage undiagnosed persons; (c) mid-stage undiagnosed persons; and (d) late stage undiagnosed persons

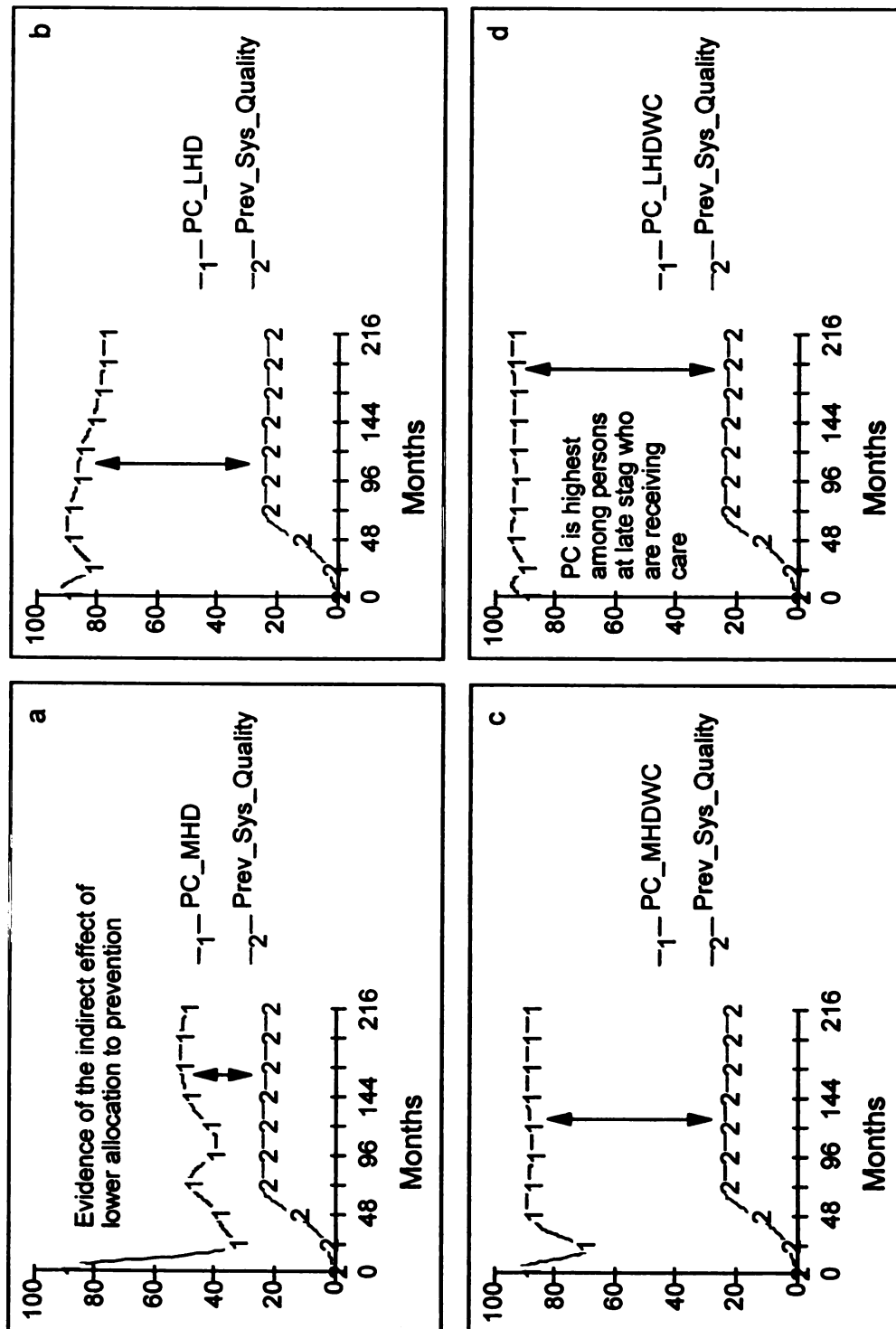


Figure 5.36 - Resource allocation process simulations: Subpopulation comparisons of prevention complacency and prevention system quality for (a) mid-stage diagnosed persons; (b) late stage diagnosed persons; (c) mid-stage persons with care; and (d) late stage persons with care

growing demand for care services pulled resources away from prevention over time. In short, the more persons there are living with HIV/AIDS, the greater the demand for care services.

Figure 5.34 compares case system quality (CSQ) with care complacency (CC) among diagnosed persons. All graphs indicate that care complacency (CC) was reduced as a result of improvement in care system quality (CSQ), but most dramatically for persons at the mid-stage of HIV disease (MHD) than it does for persons at the late-stage of HIV disease (LHD), as shown in graphs (a) and (c). Figures 5.35 and 5.36 show the same dynamics in terms of prevention. In Figure 5.35, graph (a) shows that prevention system quality (PSQ) appears to have had little or no effect on prevention complacency (PC) among newly infected persons (NI), except very dramatically, very early on in the epidemic (i.e., until month 24; December 1985). Graph (b) shows a similar pattern for early stage undiagnosed persons. In contrast, graphs (c) and (d) reveal a steady, but slow, reduction in prevention complacency (PC) among mid-stage (MHD) and late stage undiagnosed (LHD) persons.

Among diagnosed person and persons in care (MHDWC and LHDWC), a different pattern of effect is simulated (see Figure 5.36). Mid-stage diagnosed persons (MHD), as shown in graph (a), decreased their prevention complacency (PC) dramatically early on, which corresponds with a period of relatively rapid improvement in prevention system quality (PSQ). Graphs (b to d) indicate that prevention system quality (PSQ) was not sufficient enough to impact persons in care or persons diagnosed at the late stage of their HIV infection.

CHAPTER 6

DISCUSSION

Summary of Results

For the purpose of fostering a greater understanding about the psychosocial dynamics of HIV/AIDS prevention and care in the community, the current study produced a system dynamics model comprised of fifteen constructs, which were simulated over a twenty-year time horizon, from the epidemic's inception (circa 1981) to the present (2001). In particular, the psychosocial dynamics of perceived stigma, complacency, and [dis]empowerment were studied in relation to the epidemiology of HIV/AIDS in Michigan. Applying a 'systems approach,' the study was informed by the results of an extensive qualitative research project that explored the current and emerging needs of persons living with HIV/AIDS (PLWHA) as well as by the insight and knowledge of a group of ten (N=10) core key informants from Michigan's HIV community.

The underlying dynamics of the problem focus in the study were expressed via a set of five key causal processes. These processes included (1) the perceived stigma process; (2) the care complacency process; (3) the prevention complacency process; (4) the community empowerment process; and (5) the resource allocation process. Causal loop diagrams of these key processes as well as descriptive narratives and simulation

output of the model's behavior over time were used to explain and explore the base case model's system of 13 feedback structures.

Collectively, the key causal processes offer insight into how stigma, complacency, and [dis]empowerment affect the dynamics of prevention and care in the community (i.e., research questions 1, 2, and 3). Similarly, the key dynamic processes offer insight into how goals of a 'care system' can work either for or against the goals of a 'prevention system,' and *visa versa* (i.e., research question 4).

General Insights

By examination of the structure of the base case model, it can be seen that two behavioral constructs from the *psychosocial vulnerability* domain, namely prevention complacency (PC) and care complacency (CC), directly control the rate at which persons are entering (i.e., becoming infected with HIV) and exiting (i.e., eventually dying of complications due to AIDS) the *HIV/AIDS intervention* domain. To the extent that prevention complacency (PC) and care complacency (CC) can both be kept low, HIV/AIDS prevalence would decrease, or at least stabilize, over time, which would constitute a welcomed trend within the *epidemiological burden* domain.

Results suggest a need to intervene more aggressively on the prevention side to reduce prevention complacency (PC). Recall that, overall, aggregate care complacency (CC) was the only construct that revealed a desirable, downward trend over the model's time horizon. Review of simulated output for disaggregated prevention complacency (PC) show that all epidemiological subpopulations are exhibiting high levels of risk behavior. Interestingly, newly infected persons (NI), early stage undiagnosed persons (EHU), and mid-stage diagnosed persons (MHU) were shown to have the lowest levels of

prevention complacency (PC). Subpopulations at the last stage of HIV disease who were receiving care services showed the highest levels of prevention complacency (PC) per person over time. This may be attributed to a belief that receiving treatments for HIV/AIDS reduces the risk of transmitting HIV to an uninfected person, hence rationalizing unsafe sexual or drug use behaviors.

Additional insight into how best to pursue a strategy that effectively lowers both prevention complacency (PC) and care complacency (CC) is informed by the structure of the two key dynamics processes that are named after them (i.e., the prevention complacency process and the care complacency process). Comparison of these two key causal processes show that they are comprised of the same variables, but vary in their feedback structure. Perceived treatment efficacy (PTE) and self-concept (SC) are both antecedent to prevention complacency (PC) and care complacency (CC), but increasing perceived treatment efficacy (PTE) is shown to have an undesirable effect on prevention complacency (PC). In contrast, increases in self-concept (SC) over time have a desirable effect on both prevention complacency (PC) and care complacency (CC). Therefore, interventions that effectively boost self-concept (SC) may bring about the desired dynamic effect of simultaneously reducing prevention complacency (PC) and care complacency (CC).

Recall that self-concept (SC) is one of three constructs that comprise the empowerment meta-construct in the community empowerment process. To see how best to boost self-concept (SC), an appreciation of the challenges related to sustaining high community empowerment is needed. Simulation output from the base case model showed that self-concept (SC), system awareness (SA), and system change action (SCA) are

relatively low for all undiagnosed persons. In contrast, they are substantially higher among late stage diagnosed persons (LHD) and late stage persons with care (LHDWC). These results may imply that 'empowerment interventions' could be informed, if not actually carried out, by members of these epidemiological subpopulations.

The finding that system change action (SCA) is driven by low levels of satisfaction with system quality suggests that living with HIV/AIDS is not easy, even when receiving appropriate care services. It is somewhat perplexing, however, that the same subpopulations (i.e., diagnosed persons and persons in care) can be credited with 'seeing' and 'pressing' for constructive change within the system can also be distinguished as showing the highest levels of prevention complacency (PC).

One explanation for low self-concept (SC), low system change action (SCA), and high prevention complacency (PC) is high perceived HIV stigma (PHS). In particular, recall that perceived HIV stigma (PHS) is directly antecedent to self-concept (SC). Although the HIV community has demonstrated an awareness of the negative effects of perceived HIV stigma (PHS), very high, sustained levels of this construct suggest that efforts to date have not been effective. In short, interventions that effectively impact prevention complacency (PC) and care complacency (CC) may require a direct effort to manage the dynamics of perceived HIV stigma (PHS).

Base Case Model Validity

Results of the model validation process, as informed by six guidelines suggested by Coyle (1996), were favorable. A comparative analysis of *simulated* to *empirically grounded* reference modes showed that the base case model effectively reproduced trends in HIV/AIDS prevalence and mortality, prevention and care funding, prevention and care

service system quality, and HIV/AIDS-related stigma. Questionable, yet plausible, model behavior was found for HIV incidence and complacency.

With respect to HIV incidence, recall that simulation over the time horizon from 1983 to 2001 starts out at approximately 1,250 persons per year, but drops precipitously within two years (i.e., 1985). It then begins to climb again, quickly, generating peak at month 72 (i.e., 1989) at approximately 1,000 persons per year, then dropping to about 800 persons by month 96 (i.e., 1991). Thereafter, the simulated incidence curve climbs steadily, reaching an estimate of approximately 1,600 new cases per year by month 216 (i.e., 2001).

Over the period from 1990 through 1996, MDCH's Bureau of Epidemiology estimated that HIV incidence in Michigan was between 1,100 and 1,200 persons per year (MDCH, 2000a; MDCH, 2001). As of 1999, however, MDCH estimates dropped to approximately 825 persons (MDCH, 2001). The upward trend of the simulated curve and the downward trend of the empirical data is what's most concerning regarding model validation. Nevertheless, despite the discrepancies of shape and magnitude, the simulated curve is not unreasonable. Moreover, it is important to point out that the HIV community in Michigan has never seen any estimation of incidence for the state for the years 1983 to 1990.

With respect to HIV/AIDS-related complacency, note that the model-building process ultimately identified this construct's two dimensions, namely: (1) prevention complacency [PC] and (2) care complacency [CC]. Neither the simulated curves for aggregate prevention complacency nor aggregate care complacency fit well with the originally hypothesized reference mode of 'complacency.' Recall that the simulated

reference mode for aggregate prevention complacency expressed a similar shape to the hypothesized reference mode, but not if the entire simulated time horizon was considered. However, in subsequent simulation analyses, care complacency for mid-stage and late stage persons in care generated a curve that was much closer in shape and magnitude to the hypothesized one.

Building Confidence in the Model

Although results support the validity of the base case model, additional tests focusing on finer aspects of structure and behavior will need to be carried out in order to fully assess the model's soundness and usefulness as a policy tool. Recall that the ultimate criterion of model validity, per Forrester and Senge (1980), is *confidence*, which is achieved as the model is applied and as output is reviewed and interpreted by members of its target audience. They write:

We believe that confidence is the proper criterion because there can be no proof of the absolute correctness with which a model represents reality. There is no method for proving a model to be correct. Einstein's theory of relativity has not been proven correct; it stands because it has not been disproven, and because there is shared confidence in its usefulness. Likewise, one tests a system dynamics model against a diversity of empirical evidence, seeks disproofs, and develops confidence as the model withstands tests (p. 211).

Towards this end, initial feedback from members of Michigan's HIV community acknowledged that information from the base case model has already provided deeper insight into the phenomena of HIV/AIDS prevention and care. This sentiment was voluntarily reported to the system dynamicist at the conclusion of his presentation of the study's findings at a community meeting in mid-January 2002. The presentation was just one opportunity to dialogue about the implications of the behavior exhibited by the base

case model. Additional meetings such as this one are essential if greater understanding and confidence in the model is to be affirmed.

Having confidence in a model, however, is inherently about choosing between competing models. Forrester and Senge (1980) note that, in some cases, a model is selected despite recognized deficiencies because alternative models failed to inspire a higher level of confidence. To date, Michigan's HIV community has neither been given the opportunity to suggest alternative models nor has the system dynamicist been able to offer alternative models. However, plans are underway to hold additional interviews and meetings with community members from Michigan over the next 12 months, and some interest in adapting the model to fit data from other states, such as New York, has been registered.

In consideration of the need to develop competing models, Saeed (2001) proposes a multiple case study design whereby similar information from different settings is modeled and evaluated in a comparative manner. For example, the study's base case model could be modified to fit trends in key reference modes for comparable state, such as Wisconsin, or for a specific subpopulation, such as African American men who have sex with men. In addition, important additional structures such as quality of community leadership, which was identified as a need in Michigan's SCSN, could be explicitly added to the model. The modified model's behavior could then be compared to the original base case model's behavior, and the extent to which each modification added to the confidence level of its target audience could be assessed.

One clear indication of sufficient model confidence, and therefore sufficient model validity, is the actual design and implementation of interventions that are informed

by the system dynamics model. Before this would be expected to occur, policy analyses carried out in collaboration with the HIV community will need to be completed. Given that a validated base case model was produced in the current study, step 5 of the process of *modeling for understanding* can commence. Towards that end, a number of insights about possible policy experiments, or tests, for improved HIV/AIDS prevention and care have been identified. These are presented below.

Preliminary Policy Review

Interpretation of simulation data suggested a number potentially compelling policy experiments. A review of model behavior from each of the five key causal processes was used to inform a preliminary assessment of policy implications for specific epidemiological subpopulations. These are presented below.

Perceived Stigma Process

Model simulations showed that perceived HIV stigma (PHS) affected undiagnosed persons most severely. These subpopulations included newly infected persons (NI), early stage HIV undiagnosed persons (EHU), mid-stage HIV undiagnosed persons (MHU), and late stage HIV undiagnosed persons (LHU). In comparison, diagnosed persons and persons in care were also impacted by perceived HIV stigma (PHS), yet being engaged with the care system as a PLWHA, even if the interface with the system was little more than obtaining an HIV antibody test, appeared to have the effect of dampening, or lowering, perceptions of being stigmatized due to HIV. Note that among these subpopulations, self-concept (SC) dropped to a low by month 24 (i.e., 1985), but then recovered rapidly for all groups. Mid-stage diagnosed persons (MHD) do not, however, recover to the level that late stage diagnosed persons or persons in care

(MHDWC and LHDWC) do. This potential psychological 'buffering' effect of being in care was dramatically represented for persons at the later stage of HIV disease. In addition, the leveling off of prevention system quality (PSQ), which appears to have been a result of the 'medicalization' period during which attention and resources were reallocated away from prevention services, may have also played a role in keeping perceived HIV stigma (PHS) relatively high for subpopulations.

Generally, results indicated a need to address low self-concept (SC), particularly among undiagnosed persons, by either intervening to reduce perceived HIV stigma (PHS) or to boost self-concept (SC). If self-concept (SC) could be boosted sufficiently, system change action (SCA), in turn, could effectively strengthen prevention system quality (PSQ) and thereby effectively reduce perceived HIV stigma (PHS). In the meantime, strategies that are designed to encourage HIV testing so that persons who are undiagnosed can move into a care-receiving situation should be given priority. One way to do this may be to begin to aggressively promote HIV prevention outreach by PLWHA, who are by definition known to be 'in care' [an example of system change action! (SCA)], to those who are positive yet undiagnosed.

Care Complacency Process

By definition, the care complacency process directly affected diagnosed persons only [i.e., mid-stage HIV diagnosed persons (MHD), late stage HIV-diagnosed persons (LHD), mid-stage HIV diagnosed persons with care (MHDWC), and late stage HIV diagnosed persons with care (LHDWC)]. Because lower perceived treatment efficacy (PTE) appears to reduce care complacency (CC), causal dynamics associated with this process indicated a need for *care education programs* that help clients maintain a

circumspect attitude about the potential benefits of existing treatments for HIV/AIDS. However, such education programs should be careful to not allow perceived treatment efficacy (PTE) to drop too low. Although prospects of effective treatments, even a cure, may be small, available treatments for HIV have been efficacious since the mid-1990s. In such situations, PLWHA may 'lose faith' in the system as a whole, which would reinforce higher care complacency (CC) up and, in turn, care dropout rates.

Prevention Complacency Process

The need for effective prevention interventions is, in many ways, more salient today than ever before. Consistent with the common wisdom of HIV prevention experts, newly infected persons (NI) and early HIV undiagnosed persons (EHU) should be targeted to address relatively low levels of prevention complacency (PC), which the model indicates are still leading to HIV infection. Of course, the model clearly reminds us that HIV infection occurs only after exposure, through unprotected sex or drug use, to the virus in an already positive individual. For this reason, especially considering the continually growing number of PLWHA and considering the effect of the 'nothing to lose' phenomena identified in the model, all diagnosed persons as well should be involved in prevention complacency-reducing programs.

The 'nothing to lose' phenomena may be increasingly difficult to beat, particularly in the United States and other affluent, industrialized parts of the world, where HIV/AIDS has come to be viewed as a chronic illness (as opposed to an acute illness), which may have the effect of inflating perceived treatment efficacy (PTE). As a case in point, increasing rates of HIV infection have recently been observed among young gay men. Valleroy, Secura, MacKellar and Behel (2001) found that, in a recent

CDC-funded study conducted in six U.S. cities, one in ten gay and bisexual men (23 to 29 years of age; N=2401) was HIV-positive and that, among African American gay and bisexual men, one in three was HIV-positive. Of the 293 persons who were identified as HIV-positive in the study, only n=85 (29%) knew they were infected before they were tested for the purposes of the study. It was also found that n=66 (23%) of those who were HIV-positive were receiving medical care for HIV and that n=52 (18%) were taking anti-retroviral drugs. Moreover, during the past 6 months, 93% of the all men in the sample had had oral or anal sex with at least one other man. The prevalence of reported unprotected anal sex during this same, 6-month period was 46%. In the short run, before more effective, comprehensive prevention programs can be put into place, HIV/AIDS service providers should aggressively target newly (NI) and early stage HIV undiagnosed persons (EHU) with information about the how pervasive prevention complacency (PC) is among those who actually know they are HIV-positive.

Community Empowerment Process

The community empowerment process, comprised of its three dimensions of system awareness (SA), self-concept (SC), and system change action (SCA), arguably revealed some of the most enlightening dynamics and potential for HIV/AIDS policy innovation relative to the four other processes. Model behavior showed that undiagnosed persons [i.e., newly infected persons (NI), early HIV undiagnosed persons (EHU), mid-stage diagnosed persons (MDU), and late stage HIV undiagnosed persons (LHU)], relative to persons who knew their HIV status and were receiving care, were shown to be highly disempowered with respect to creating any form of constructive change within the prevention and care systems.

The model suggested a need to promote greater *system change action* as a lever for *empowerment* of PLWHA. In particular, the model suggested a need for interventions that help undiagnosed persons learn about their serostatus and become engaged in a program of care as quickly as possible. Once within the care system, model behavior indicated that PLWHA appear to exhibit higher levels of system change action which, in turn, can dramatically improve the quality of both prevention (PSQ) and care (CSQ) over time. However, the dynamic structure that facilitates system change action was dependent upon high levels of PLWHA *dissatisfaction*, or frustration, with the quality of HIV/AIDS available services. With respect to this finding, it is suggested that future policy analyses explore ways of sustaining PLWHA system change action that are not dependent upon high levels *dissatisfaction* with services.

Resource Allocation Process

Dynamics attributed to the final key causal process to be reviewed, the resource allocation process, indicated that all subpopulations in the model can have a potential impact on the unbalanced allocation processes that is so clearly at work in the HIV/AIDS epidemic. In addition, although service providers were not explicitly included in the model, they are implicitly included for intervention. In particular, there is a need to devise policy that generates constructive, tangible *demand for prevention services*. If an increase in demand for prevention services can be realized, the proportion of resources allocated to prevention system would increase over time, which ought to increase prevention system quality (PSQ) and, subsequently, decrease prevention complacency (PC). Care clients and providers may be the most effective facilitators of this initiative

because of their first-hand knowledge about why prevention interventions have failed in the past.

The imbalance is evidently created by a combination of new treatments that have extended longevity for many persons living with HIV/AIDS (PLWHA) combined with continued addition of newly infected persons to the system. As the allocation process shows, this has rapidly increased the demand for HIV/AIDS-related care services and for the federal and state resources needed to cover them (Foster et al., 1999; IOM, 2001). Over time, the model shows that diminishing prevention system quality (PSQ), due to allocating to care (as opposed to prevention), will have the impact of increasing rates of new HIV infection, which would further increase demand for care, a point that many other community research projects have affirmed (Gibb, Ades, Gupta, & Sculpher, 1999; Gopal, 2000; IOM, 2001; Moore & Chaisson, 1997).

Future Research

Further analyses to identify the most effective ‘levers’ of change within the model and policy tests that explore how best to affect system performance to achieve the overarching goals of (1) reducing new HIV infections among all susceptible groups, (2) improving health and well-being among all PLWHA, and (3) increasing efficiency and sustainability of HIV/AIDS-related services constitute important future work.

Building upon the insight gained from the preliminary policy review of each of the key causal processes, future research will use the base case model to carry out ‘experiments in policy innovation’ (i.e., step 5 of the process of *modeling for understanding*) of interest to the HIV community in Michigan as well as other communities affected by the epidemic. Three possible directions for policy innovation

using the base case model are described below.

Integrating Prevention and Care Services

Results of the current study call attention to the interdependencies of prevention and care. In particular, it was found that getting persons who become HIV positive into care services as soon as possible generates gains in the quality of both prevention and care service systems. In terms of actual types of services, an obvious structural link between prevention and care is HIV testing. It is through testing that persons learn not only about their personal serostatus, but also about available services for both prevention and care.

A variety of service interventions already in practice in many states, including Michigan, directly focus on improving HIV testing. These include: (1) HIV counseling and testing programs, (2) partner notification and referral services, and (3) prevention case management (AED, 1999; Agranoff & Lindsay, 1983; Eilbert & Hines, 1996; Finkelstein et al., 2000; HRSA, 1998). Policy analyses that explores how to facilitate effective collaboration among the designers and providers of these three types of services may yield highly favorable results in terms of reducing both prevention complacency (PC) and care complacency (CC), the two constructs which are ultimately driving changes in epidemiological burden and other aspects of psychosocial vulnerability.

Affirming Diversity

Another potential direction for policy innovation is to use the model to design prevention and care interventions that are 'culturally aware.' Difficulties associated with cultural awareness may be in close proximity to difficulties associated with continued high levels of perceived HIV stigma (PHS) among affected by HIV/AIDS. Recall that

HIV/AIDS stigma was defined as having multiple sources, including race, gender, and sexual orientation. Introducing 'cultural awareness-building' structures to the model to counteract high levels of perceived HIV stigma (PHS) present a compelling research direction.

The need for improved cultural awareness was recognized as one of the major barriers to quality HIV services identified in Michigan's SCSN (Lounsbury, 2001b). In particular, the SCSN stated that issues of cultural difference among clients and providers affected service seeking and service delivery, and that difficulties due to matters of history (history of strained race relations between blacks and whites); religion (outreach to black churches, Muslim communities); language (Spanish, Arabic, hearing impaired/deaf); gender (needs of women relative to men); sexual orientation (including lesbian, gay, bisexual, heterosexual, and transgendered persons); and social privilege (socioeconomic and formal education), among others, needed to be assertively addressed.

Research on diversity suggests that improved cultural awareness can be fostered by creating settings that are supportive of diversity (Bond & Pyle, 1998; Foster-Fishman & Keys, 1997; Jackson, May, & Whitney, 1995; Kelly, Azelton, Burzette, & Mock, 1994; Trickett, 1996). Settings that are supportive of diversity also tend to promote open communicate about each other, ideas, attitudes, and values. Often this is blocked due to a pre-judgment on the part of one group relative to another. There is need to create a climate of inclusion wherever matters of HIV/AIDS are addressed. Facilitating such a climate, however, is a mutual responsibility. With this issue in mind, the base case model could be modified to explore the psychosocial dynamics of HIV/AIDS among different demographic subpopulations (e.g., SES, age, gender, race, and/or sexual identity) where

particular interventions designed to facilitate open communication and reduce pre-judgment were put into place.

Facilitating Participatory Action

Results from the study strongly underscore the potential for constructive change through the empowerment of the end-user, or 'clients,' of HIV services. This suggests policy analyses that further explore the benefits (as well as costs) of participatory approaches to HIV prevention and care (Cancian & Armstead, 1992; Cornwall & Jewkes, 1995; Macualay et al., 1999; Nelson, Ochacoka, Griffin, & Lord, 1998; Selener, 1997; Smith, 1997; Travers, 1997; Williams, Bond, & Menzies, 2000). The effect of empowering persons living with HIV/AIDS was found to be a potentially robust mechanism for improved system quality. With this in mind, a reaffirmation of the set of principles referred to as the tenets of the 'New Public Health' is suggested. As noted in the introduction of this manuscript, the 'New Public Health' initiative was shaped around the theme of community empowerment. Ashton and Seymour (1988) summarized the principles of the initiative as follows:

1. *Build public policies that support health.* Health promotion goes beyond health care and makes health an agenda item for policy makers in all areas of governmental and organizational action. Health promotion requires that the obstacles to the adoption of health promoting policies be identified in non-medical sectors together with ways of removing them. The aim must be to make the healthier choices easier.
2. *Create supportive environments.* Health promotion recognizes that both at the global level and at the local level human health is bound up with the way in which we treat nature and the environment. Societies that exploit their environments without attention to ecology reap the effects of that exploitation in ill-health and social problems. Health cannot be separated from other goals and changing patterns of life. Work and leisure have a definite impact on health. Health promotion, therefore, must create living and working conditions that are safe, stimulating, satisfying and enjoyable.

3. *Strengthening community action.* Health promotion works through effective community action. At the heart of this process are communities having their own power and having control of their own initiatives and activities. This means that professionals must learn new ways of working with individuals and communities – working for and with rather than on them.
4. *Develop personal skills.* Health promotion supports personal and social development through providing information, education for health and helping people to develop the skills that they need to make healthy choices. By doing so it enables people to exercise more control over their own health and over their environments, making it possible for people to learn throughout life, to prepare themselves for all of its stages and to cope with chronic illness and injuries. This has to be assisted in the school, at home, at work, and in community settings.
5. *Reorientate health services.* The responsibility for health promotion in the health services is shared among individuals, community groups, health professionals, medical care workers, bureaucracies and governments. They must work together towards a health care system which contributes to the pursuit of health (pp. 25-26).

Using the base case model, an accommodation of additional structures to represent one or more of these points could be analyzed in the context of its current three-dimensional empowerment construct [Self-concept (SC), system awareness (SA), and system change action (SCA)]. Results would further inform the HIV community about ways of developing effective participatory action.

Conclusion

The ‘systems approach’ used in this study represents a uniquely qualitative and participatory way of fostering in-depth thinking about HIV/AIDS prevention and care. It constitutes one effort to demonstrate how policy applications can be incorporated into the field of community psychology and how the underlying notion of *change* can be explicitly examined and interpreted, even in the context of highly complex problems. It is concluded that the process of *modeling for understanding* successfully generated an explicit picture of the dynamic complexity of the psychosocial context of HIV/AIDS

prevention and care. It is also concluded that the 'systems approach' helped to create space for the candid exchange of ideas about how to effectively intervene in the course of the epidemic and that it increased the potential of the community to work together in the future in a manner of enlightened collective action.

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**UNDERSTANDING THE DYNAMICS OF PREVENTION, CARE, AND
EMPOWERMENT: A SYSTEMS APPROACH TO HIV/AIDS POLICY INNOVATION**

VOLUME II

By

David William Lounsbury

A DISSERTATION

Submitted to
Michigan State University
In partial fulfillment of the requirements
For the degree of

DOCTOR OF PHILOSOPHY

Department of Psychology

2002

APPENDICES

**MICHIGAN STATE
UNIVERSITY**

APPENDIX A

August 10, 2000

TO: Ralph LEVINE
129 Psychology Research

RE: **IRB# 00-482 CATEGORY:2-F**

APPROVAL DATE: August 10, 2000

TITLE: DEVELOPING THE '2000-2001 STATEWIDE COORDINATED STATEMENT OF NEED' (SCSN) - IDENTIFYING GAPS AND BARRIERS IN CARE SERVICES FOR PERSONS AFFECTED BY HIV/AIDS

The University Committee on Research Involving Human Subjects' (UCRIHS) review of this project is complete and I am pleased to advise that the rights and welfare of the human subjects appear to be adequately protected and methods to obtain informed consent are appropriate. Therefore, the UCRIHS approved this project.

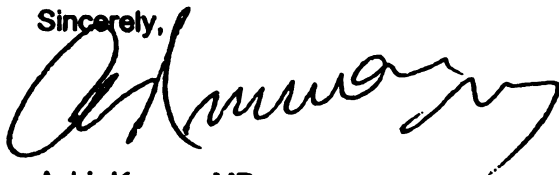
RENEWALS: UCRIHS approval is valid for one calendar year, beginning with the approval date shown above. Projects continuing beyond one year must be renewed with the green renewal form. A maximum of four such expedited renewals possible. Investigators wishing to continue a project beyond that time need to submit it again for a complete review.

REVISIONS: UCRIHS must review any changes in procedures involving human subjects, prior to initiation of the change. If this is done at the time of renewal, please use the green renewal form. To revise an approved protocol at any other time during the year, send your written request to the UCRIHS Chair, requesting revised approval and referencing the project's IRB# and title. Include in your request a description of the change and any revised instruments, consent forms or advertisements that are applicable.

PROBLEMS/CHANGES: Should either of the following arise during the course of the work, notify UCRIHS promptly: 1) problems (unexpected side effects, complaints, etc.) involving human subjects or 2) changes in the research environment or new information indicating greater risk to the human subjects than existed when the protocol was previously reviewed and approved.

If we can be of further assistance, please contact us at 517 355-2180 or via email: UCRIHS@msu.edu. Please note that all UCRIHS forms are located on the web: <http://www.msu.edu/user/ucrihs>

Sincerely,



Ashir Kumar, MD
Interim Chair, UCRIHS



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AK: rj

cc: David Lounsbury
129 Psychology Research

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APPENDIX A (continued)

SCSN Key Informant Interview Procedure

Key informant interviews will play an important role in the 2001 *SCSN* data collection process. A series of brief (30 to 40 minute), face-to-face or telephone interviews will be conducted with persons who have been identified by MHAC's SCSN Committee as persons well-acquainted with one or more HIV/AIDS care or prevention projects, organizations, or services available in Michigan. The following outlines this data collection procedure:

1. Each potential key informant selected by the SCSN committee will be contacted by David Lounsbury (hereafter referred to as the 'SCSN consultant') by telephone in order to explain the SCSN process to the informant, affirm his or her willingness to be interviewed, and to arrange a convenient date and time for either a telephone or face-to-face interview.
2. If the potential key informant agrees to participate, a mutually convenient date, time, and place will be arranged for the interview. In addition, the potential key informant will be asked to provide the SCSN consultant with a address or fax number for the purpose of mailing or faxing a 'letter of confirmation' (attached), two (2) copies of the 'informed consent' sheet (attached), and (if mailed) one (1) postage paid reply envelope. The potential informant will be asked for permission to pass his or her name and contact information passed to Traci Goulding, MDCH/HAPIS administrative assistant, who will be responsible for generating and sending the 'letter of confirmation' and the two copies the 'informed consent' sheet. The letter will be signed by Deb Szwejda (MDCH/HAPIS Manager and SCSN Committee Co-chair) and will request that the potential key informant sign and return one copy of the 'informed consent' sheet to MDCH/HAPIS before the date and time of their interview. Note that Traci Goulding and Deb Szwejda have agreed to maintain strict confidentiality regarding key informant names and contact information they become aware of throughout the key informant interview process. All letters of confirmation and informed consent sheets will be stored in a locked file cabinet and/or in a password-protected computer file maintained by Traci Goulding at MDCH/HAPIS.
3. The SCSN consultant will then attempt to conduct the interview as arranged. It is expected that, in most cases, interviews will be conducted by telephone. If for whatever reason the key informant is not available at the agreed upon time, or if he or she is not able to produce a signed consent form, the SCSN consultant will schedule a new date, time, and place for the interview. Traci Goulding will be notified of any rescheduled interviews. The SCSN consultant will continue to attempt to conduct the interview until it is complete or until it is too late to make use of the interview content for the development of the *SCSN*.
4. Per permission by the key informant, interview sessions will be audiotaped and transcribed by the SCSN consultant (David Lounsbury). Audiotaping and transcribing will help ensure that information you provide will be recorded completely and accurately. Key informant will be provided with a copy of their transcribed interview session, if they so desire. The entire interview is expected to last approximately 30 minutes.
5. Available transcripts will then be coded for general themes regarding the needs of PLWHA.
6. A final draft of the 2001 *SCSN* will be automatically mailed to all key informants for their personal approval and/or comments before it is finalized and approved by MHAC.

The (1) SCSN consultant's introduction telephone script, (2) letter of confirmation, and (3) SCSNProcess Key Informant Interview Guide are presented on the following pages.

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APPENDIX A (continued)

<SCSN consultant's general introduction telephone script>

Hello,

May I speak with <name of potential key informant>?

My name is David Lounsbury. I am working on a project to develop an updated Statewide Coordinated Statement of Need Committee for persons living with HIV/AIDS in Michigan. I am working with the Michigan Department of Community Health's HIV/AIDS Intervention and Prevention Section and the Michigan HIV/AIDS Council, a community-based planning body. This is the third such Coordinated Statement of Need that has been generated in for our state since 1996.

I am calling you today to see if you would be willing to arrange a phone [or if Lansing-based, a face-to-face] interview with me regarding your opinions of the needs of persons affected by HIV/AIDS in the state of Michigan. The interview is expected to be as short as 30 minutes, but it can be longer if you wish.

[If no] Well, OK, I understand. Is there someone else at your agency or organization whom you think would be useful to interview?

[If no] OK. I understand. Thanks for speaking with me. If you have questions later or if you reconsider, please give me a call back. My direct office line is 517 374-1117.

[If yes] Great! When would be a good time to arrange the interview? Is it easiest for me to call you at this phone number, or do you have another that you would prefer me to use?

To confirm our arrangement and to fully inform you about the purpose and process of this interview, you will receive a letter from Deb Szwejda at MDCH/HAPIS with two copies of an informed consent sheet. You will need to return one copy to me at MDCH/HAPIS. I can have it mailed to you or faxed to you. Which would you prefer? Keep in mind that any contact formation that you provide will be kept confidential by me, Deb Szwejda, and by her administrative assistant, Traci Goulding. Also, to show you what I would like to talk about in the interview, I am going to send you a copy of the interview questions.

What contact information would you like to provide for me at this time? [Write down info.]

Do you have any questions for me know? [Answer questions, if any] OK. Talk with you soon. Thanks. Bye.

APPENDIX A (continued)

<on MDCH/HAPIS letterhead>

Deb Szwejd, Manager

HIV/AIDS Intervention and Prevention Section (HAPIS)

Michigan Department of Community Health

2479 Woodlake Circle, Suite 300

Okemos, Michigan 48864

<July 13, 2000>

Dear <Mr./Ms./Dr>:

This letter confirms your interview date with our Statewide Statement of Need (SCSN) consultant, David Lounsbury. Your input is very valuable to us, and we are glad that you have agreed to participate. To show you what David would like to discuss in the interview, a copy of the interview questions and an outline of various 'service domains' have been enclosed. Also, two copies of the informed consent sheet are enclosed. **Please review the enclosed INFORMED CONSENT sheet. Check the appropriate boxes regarding confidentiality and the option of allowing audio tape recording, then return one signed, dated copy to David at HAPIS before the scheduled interview date.** For your convenience, a reply envelope has also been enclosed. Keep the other copy for your records.

According to our schedule, David has arranged to interview you [either] by phone [or] at <setting> on <day of week>, <fill in date> at <fill in time of day>. If this is incorrect or if this is no longer convenient for you, please contact David as soon as possible by phone (517 374-1117) or e-mail (Lounsbu1@msu.edu). He will be glad to reschedule for you.

Again, thank you for your participation!

Sincerely,

Debra Szwejd, Manager
HAPIS

Enclosures: 1 copy of interview questions; 2 copies INFORMED CONSENT; 1 reply envelope

Part 1

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APPENDIX A (continued)

SCSN Process Key Informant Interview Guide

Part 1 - Introduction

[To be read/paraphrased] My name is David Lounsbury. I am a graduate student at Michigan State University. I am working on my doctorate in Community Psychology. My research focus is community capacity building in response to the problem of HIV/AIDS. Recently I started working with MDCH/HAPIS and with MHAC's Statewide Coordinated Statement of Needs Committee as short-term consultant brought in to assist with the process of developing an updated **Statewide Coordinated Statement of Need** for Persons Living with HIV/AIDS (PLWHA) in Michigan for the 2000-2001 planning cycle.

The interview we are about to do is part of that joint process of revising and updating the SCSN. Are you still available to do the interview now?

The 2000-2001 SCSN is the third such document to be generated for Michigan. The SCSN process is designed to facilitate a comprehensive, statewide review of currently available information or data about (1) epidemiological trends, (2) ongoing and emerging needs of people and communities affected by HIV/AIDS, and (3) HIV/AIDS service gaps or barriers.

Information and data from (1) statewide and regional needs assessments, (2) various types of planning or policy documents, (3) other relevant reports, and (4) key informant interviews, will be used to develop the 2000-2001 SCSN and to aid in future analysis and/or planning activities designed to identify strategies that can effectively narrow or eliminate service gaps or barriers for persons and communities affected by HIV/AIDS.

In the interview you are being asked to talk about your knowledge of the current and emerging needs of persons living with, and/or affected by, HIV/AIDS in Michigan. Have you had a chance to review the copy of the questions you were sent?

Are you aware that you may choose to either speaking strictly confidentially or speaking as an identified source? If you choose to speak strictly confidentially, your name (and/or any other information that may identify you as a source) will not be associated with any information you provide. If you choose to speak as an identified source, your name will be listed as a supportive reference to the SCSN document and may also be cited in the text of the document when and if information you provide is paraphrased or directly quoted. Do you have any questions about this?

With your permission, I would like to audiotape this interview, and then to transcribe it. Audiotaping and transcribing will help ensure that information you provide will be recorded completely and accurately. If, for whatever reason, you would like to review a copy of your transcribed interview session, one will be promptly provided. Do you have any questions about this?

The entire interview is expected to last 30 to 40 minutes. Is this still a good time for you?

APPENDIX A (continued)

Part 2 - Interview Items

1. Tell me about how you are involved with Michigan's response to HIV/AIDS.
 - a. Probe: What experiences, opportunities have allowed you to become familiar with Michigan's HIV prevention programs and HIV/AIDS care services?
 - b. Probe: Which service domains have you been most involved with and how are you currently working with them? (e.g., primary care, case management, substance abuse, other STDs, mental health)?
 - c. Probe: How long have you been working in this/these capacities?
 - d. Probe: How have you been involved with Michigan's Regional CARE Consortia or Regional Community Planning Groups for HIV prevention?
2. How are HIV/AIDS care services meeting/not meeting the needs of persons affected by HIV/AIDS in Michigan today?
 - a. Probe: What gaps in services do you believe still exist?
 - b. Probe: What kinds of barriers do you think inhibit persons from accessing care (or prevention) services?
 - c. Probe: Are there any needs that you would consider new or 'emerging'?
3. Considering the service domains that you are most familiar with, what would you like to change or add to HIV/AIDS services in Michigan?
 - a. Probe: Are there other service domains (e.g., housing, substance abuse) that you are familiar with?
 - b. Probe: What would you change or add about considering these?
4. What is your vision for delivery of care services to persons affected by HIV/AIDS in Michigan?
 - a. Probe: How does this link with delivery of prevention services?
 - b. Probe: How does your vision speak to the issue of the need for cross-title, cross-domain, cross-community collaboration?
5. Is there anything else you would like tell me regarding the needs of persons or communities affected by HIV/AIDS in Michigan?
6. Well, that's everything I wanted to ask. Do you have any questions or additional comments for me?
 - a. Probe: Is there any part of the interview that you would like to review or disallow?
 - b. Probe: If you were conducting this interview about Michigan's response to HIV/AIDS, would you add any other questions?
 - c. Probe: If I need clarification about any of the information you have provided today, may I contact you again?
 - d. Probe: Once I have transcribed your interview, would you like to review a copy of it? Keep in mind that you will automatically get a copy of the final draft of the SCSN in the mail for your personal review and comment. If you feel I have incorrectly cited you in the document, I will make the necessary changes per your instructions.

Thank you very much for you time.

APPENDIX A (continued)

Informed Consent

The Michigan Department of Community Health's HIV/AIDS Intervention and Prevention Section (MDCH/HAPIS) and the Michigan HIV/AIDS Council (MHAC) have jointly initiated a process to revise and update its **Statewide Coordinated Statement of Need (SCSN)** for Persons Living with HIV/AIDS (PLWHA) in Michigan. The 2000-2001 SCSN is the third such document to be generated for Michigan since the inception of the HIV/AIDS epidemic. The SCSN process is designed to facilitate a comprehensive, statewide review of currently available information or data about (1) epidemiological trends, (2) ongoing and emerging needs of people and communities affected by HIV/AIDS, and (3) HIV/AIDS service gaps or barriers.

Information and data from (1) statewide and regional needs assessments, (2) various types of planning or policy documents, (3) other relevant reports, and (4) key informant interviews, will be used to develop the 2000-2001 SCSN and, where appropriate, to aid in future analysis and/or planning activities designed to identify strategies and/or policies that can effectively narrow or eliminate service gaps or barriers for persons and communities affected by HIV/AIDS.

You have been selected by SCSN committee of the MHAC as a potential 'key informant' regarding the needs of PLWHA in Michigan, and we would like to invite you to express your knowledge and opinions about this topic during a brief telephone (or, in some cases, face-to-face) interview session. The following outlines the general purpose and procedure for the interview:

1. You are being asked to talk about your knowledge of the current and emerging needs of persons living with, and/or affected by, HIV/AIDS in Michigan. A copy of the questions that you will be asked is enclosed.
2. As a participant in the SCSN process, your privacy will be protected to the maximum extent allowable by law. Please keep in mind that taking part in this interview is completely voluntary. You may refuse to answer any question or any part of a question and you may withdraw from the interview at any time.
3. If you choose to participate in the interview, you have the choice of either speaking strictly confidentially or speaking as an identified source. If you choose to speak strictly confidentially, your name (and/or any other information that may identify you as a source) will not be associated with any information you provide. If you choose to speak as an identified source, your name will be listed as a supportive reference to the SCSN document and may also be cited in the text of the document when and if information you provide is paraphrased or directly quoted. Note that you may still indicate, at any time, that any information you provide be treated strictly confidential (i.e., it will be spoken 'OFF THE RECORD').
4. If you permit, your interview session will be audiotaped and transcribed by the SCSN consultant (David Lounsbury). Audiotaping and transcribing will help ensure that the information you provide will be recorded completely and accurately. If you would

APPENDIX A (continued)

like to review a copy of your transcribed interview, one will be promptly provided. Any revisions or changes you may like to suggest will be accommodated if brought to the SCSN consultant's attention within a reasonable period of time (e.g., 10 calendar days after the transcript is mailed to you).

5. The entire interview is expected to take approximately 30 minutes of your time, but may be longer if you wish.
6. A final draft of the 2000-2001 SCSN will be automatically mailed to you for your personal approval and/or comments before it is finalized and approved by MHAC. Once approved by MHAC, the 2000-2001 SCSN will be disseminated broadly among Michigan's HIV/AIDS service providers, regional and statewide planning bodies, communities of PLWHA, other HIV/AIDS-related organizations, federal agencies, and the public-at-large.
7. If you have any questions or concerns about your involvement in this process either now or at any point of time in the future, please contact either the SCSN consultant [David Lounsbury, (517) 374-1117], the SCSN Committee Co-chairs [Debra Szwejd, (517) 241-5900 or Aryc Mosher, (517) 335-8165].
8. In addition, if you have any questions or concerns about your rights and/or role as a subject of research either now or at any point of time in the future, please contact the Chair of Michigan State University's Committee on Research Involving Human Subjects [David E. Wright, Ph.D., (517) 355-2180].

Per point number 3 above, please select one of the following options by checking the appropriate box:

I wish to speak strictly confidentially

I wish to speak as an identifiable source

Also per point number 3 above, please select one of the following options by checking the appropriate box:

I wish to speak with audiotape recording

I wish to speak without audiotape recording

To acknowledge that you have read and understand all of these points, and to acknowledge that you freely consent to participate, please sign and date this form below.

Signature

Date

Telephone interviewees must return this form to David Lounsbury by U.S. mail service or by fax before their scheduled date and time of interview to the following address:

David Lounsbury, M.A., SCSN Consultant
Michigan Department of Community Health
HIV/AIDS Prevention and Intervention Section
2479 Woodlake Circle, Suite 300
Okemos, Michigan 48864
517 241-5911 fax

**MICHIGAN STATE
UNIVERSITY**

APPENDIX B

May 15, 2001

TO: Ralph LEVINE
314 Natural Resources

RE: IRB# 01-285 CATEGORY: EXPEDITED 2-F

APPROVAL DATE: May 14, 2001

**TITLE: UNDERSTANDING THE DYNAMICS OF PREVENTION, CARE, AND
EMPOWERMENT: A SYSTEMS APPROACH TO HIV/AIDS POLICY
INNOVATION**

The University Committee on Research Involving Human Subjects' (UCRIHS) review of this project is complete and I am pleased to advise that the rights and welfare of the human subjects appear to be adequately protected and methods to obtain informed consent are appropriate. Therefore, the UCRIHS approved this project.

RENEWALS: UCRIHS approval is valid for one calendar year, beginning with the approval date shown above. Projects continuing beyond one year must be renewed with the green renewal form. A maximum of four such expedited renewals possible. Investigators wishing to continue a project beyond that time need to submit it again for a complete review.

REVISIONS: UCRIHS must review any changes in procedures involving human subjects, prior to initiation of the change. If this is done at the time of renewal, please use the green renewal form. To revise an approved protocol at any other time during the year, send your written request to the UCRIHS Chair, requesting revised approval and referencing the project's IRB# and title. Include in your request a description of the change and any revised instruments, consent forms or advertisements that are applicable.

PROBLEMS/CHANGES: Should either of the following arise during the course of the work, notify UCRIHS promptly: 1) problems (unexpected side effects, complaints, etc.) involving human subjects or 2) changes in the research environment or new information indicating greater risk to the human subjects than existed when the protocol was previously reviewed and approved.

If we can be of further assistance, please contact us at (517) 355-2180 or via email: UCRIHS@msu.edu. Please note that all UCRIHS forms are located on the web: <http://www.msu.edu/user/ucrihs>

Sincerely,



Ashir Kumar, M.D.
Interim Chair, UCRIHS

AK: br

cc: David Lounsbury
129 Psychology Research



**OFFICE OF
RESEARCH
AND
GRADUATE
STUDIES**

University Committee on
Research Involving
Human Subjects

Michigan State University
246 Administration Building
East Lansing, Michigan
48824-1046

517/355-2180

FAX: 517/353-2976

Web: www.msu.edu/user/ucrihs

E-Mail: ucrihs@msu.edu

PO

[name]
[address]

May 21

Dear

This letter is
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Sincerely

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APPENDIX B (continued)

Policy Innovation Study Core Key Informant Interview Confirmation Letter

[name]
[address]

May 21, 2001

Dear «First_Name»:

This letter confirms our interview date, time, and place for the HIV/AIDS policy innovation study. According to my information, we are scheduled to meet on «Interview_Day», «Interview_Date» at «Interview_Time» in «Interview_Location» <along with [#] other key informants>. Should you need to make a change to these arrangements, please contact me as soon as possible by phone (517 374-1117) or e-mail (Lounsbul@msu.edu) and I will be happy to reschedule with you.

As I mentioned on the phone, the possibility of conducting our meeting jointly with one or two other participants is still open. Once I know more about who will participate in the study, I will be in contact with you to discuss our options. The decision to go with a small group interview format, however, remains entirely up to you.

Please review the enclosed *Informed Consent* sheet. Two copies have been provided. Retain one copy for yourself. Sign and date the other copy and drop it in the mail in time for it to reach me before our meeting on «Interview_Date». For your convenience, a reply envelope has been supplied.

I have also enclosed your copy of the *System Dynamics Modeling Workbook*. If you have time before we meet, you may wish to skim it. The introduction section provides a useful overview of the process we are about to start. You do not need to fill any part of it out before me meet. Keep in mind that I will only ask you to focus on a relatively small part of it, that is, you will not be required to fill out the entire workbook. Please bring your copy of the workbook with you to the interview session.

Thanks for your interest in the *HIV/AIDS Policy Innovation Study for Michigan*. It is a privilege to have the opportunity to work with you.

Sincerely,

David Lounsbury
Doctoral Student

Enclosures: 2 copies *Informed Consent* sheet with 1 reply envelope; 1 *System Dynamics Modeling Workbook*.

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APPENDIX B (continued)

HIV/AIDS Policy Innovation Study for Michigan Informed Consent

You have been asked to participate as a key informant in a research study to be conducted by David Lounsbury, a doctoral student at Michigan State University, about the ‘system dynamics’ of HIV/AIDS in Michigan (see Figure 1 on reverse side). As a key informant, your knowledge of HIV/AIDS-related issues in the state will be used to help inform the design of a computerized model that will help identify and test various policy innovations for improved HIV/AIDS prevention and care service delivery in the state. The overarching policy goals to be addressed by the study are: (1) reduction of new HIV infections among all susceptible groups, (2) improved health and well-being among all PLWHA, and (3) increased efficiency and sustainability of HIV/AIDS-related services.

The following items outline important points about participation in the current study:

1. You are one of a small number of persons (less than 10) who will comprise a group of ‘core key informants.’
2. All core key informants will be asked to participate in an in-depth interview to be conducted by David Lounsbury. Special workbooks have been designed to help you record your comments and responses and to facilitate information collection during the interview session. These workbooks will be collected at the end of your interview session, copied, and then promptly returned to you – unless you choose not to retain your workbook – in which case no copy will be made and the original will be kept by David Lounsbury. The workbook contents, whether original or copy, will be treated confidentially.
3. Interviews may be conducted either as individual sessions or as small group sessions, whichever is most convenient and agreeable for you. Individual key informant interviews are expected to take between 2.0 to 2.5 hours. Small group interviews are expected to take somewhat longer, about 2.5 to 3.0 hours. Meeting times and places will be arranged at your convenience.
4. As a participant in the study, your privacy will be protected to the maximum extent allowable by law. Any information you provide for the purposes of the study, either orally or in writing, will be kept confidential. In order to create a ‘safe space’ for free-flowing conversation and exchange of ideas, you must agree to keep confidential the identity of any other participating core key informant of whom you may learn. Note, however, that you – and you alone – may choose to disclose the fact of your own involvement in the study to others.
5. After the in-depth interview has been completed, David Lounsbury may wish to contact you and ask for your opinion or other feedback regarding analysis of the information obtained and analyzed for the current study.
6. Note, however, that you may choose to discontinue your involvement in the study at any time for any reason.
7. As compensation for your time and for other expenses you may incur as a result of your participation in the study, you will be offered \$50 payable in full upon completion of your initial interview session.
8. If you have any questions or concerns about your involvement in this process either now or at any point of time in the future, please feel free to contact David Lounsbury [517 374-1117] or his dissertation chair Ralph Levine, Ph.D. [517 332-2317].
9. If you have any questions or concerns about your rights and/or role as a research participant either now or at any point of time in the future, please feel free to contact the Chair of Michigan State University’s Committee on Research Involving Human Subjects, David E. Wright, Ph.D. [517 355-2180].

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APPENDIX B (continued)

To acknowledge that you have read all of these points, and to acknowledge that you freely consent to participate, please sign and date this form below.

Signature

Date

Return this form before your interview to the following address:

David Lounsbury, M.A.
Michigan State University
Department of Psychology
129 Psychology Research Building
East Lansing, MI 48824-1117

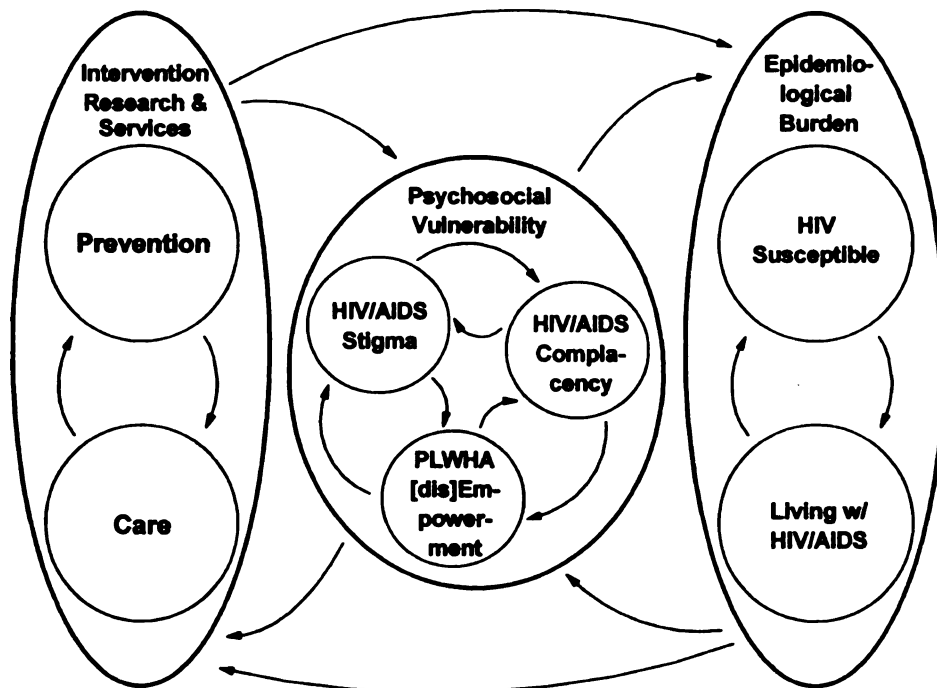


Figure 1 - Conceptual framework for the current study



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APPENDIX B (continued)

Core Key Informant Interview Guide (to be used with *System Dynamics Modeling Workbook*)

Date	Time	Location	CKI IDs

INTRODUCTION (10 minutes)

1. Begin session by welcoming the core key informant(s) to the session. If need be, facilitate introductions of self to less well-know key informants and/or of key informants to each other. Encourage participants to help themselves to snacks and beverages.
2. Review the content of the study's Informed Consent sheet. Ask if there are any questions.
3. Provide an update on the study (e.g., number of interviews completed, task completed, etc.).
4. Provide an overview of the current sessions objectives.
5. Refer to Workbook. Review content of the introduction section. Provide time for questions.

MODELING FOR UNDERSTANDING (25 minutes)

1. Refer to Figure 1 – The process of ‘modeling for understanding.’
2. Explain the process of the study. Provide examples as necessary. In particular, present a reference mode, one or more causal loop diagrams, one or more stock and flow diagrams.
3. Introduce the concept of a ‘robust’ system dynamics model.
4. Provide time for key informant(s) to fill out Comment Boxes 1 and 2.

CONCEPTUAL FRAMEWORK (15 minutes)

1. Refer to Figure 2 – Conceptual framework for the current study.
2. Ask key informant(s) to tell, in there own words, what they believe Figure 2 communicates.
3. Provide time for key informant(s) to fill out Comment Box 3.

‘MINI-MODELING’ EXERCISES (40 to 60minutes)

1. Introduce the three-step process of (1) visualizing, (2) describing, (3) discussing to stimulate deep thinking. Refer to Figure 3 – Common modes of behavior.
2. Present Tables 1, 2, and 3. Review the definitions of the key variables in each.

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APPENDIX B (continued)

'MINI-MODELING' EXERCISES (40 to 60minutes) (continued)

3. Explain the "I"s and "K"s Exercise, and then provide time for key informant(s) to mark their copy of the tables accordingly.
4. Review the concept of a reference mode and explain the proposed time horizon for the current study.
5. Provide time for key informant(s) to fill out Comment Box 4.
6. Help key informant(s) make a plan to complete the 'mini-modeling' exercise for selected key variables.
7. Ask key informant(s) to choose one key variable 'mini-modeling' exercise, then work through it with him/her.'
8. Provide time for key informant(s) to work independently. Assist as needed.

CONCLUSION (20 minutes)

1. Time permitting, facilitate discussion about the progress made by the key informant(s). Ask for their general impression of the session. What worked well? What didn't work well?
2. Discuss next steps in the research process.
3. Ask key informant(s) to turn in their workbooks. Explain how the information and comments they recorded in them will be processed. In some cases, key informant(s) may like to add more information to their workbooks. Organize and document a plan to accommodate their request.
4. Thank key informant(s) for attending. Distribute payment (\$50).

NOTES:

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APPENDIX B (continued)

Introductory Text from the *System Dynamics Modeling Workbook*

INTRODUCTION

About Your Participation

Welcome to the *HIV/AIDS Policy Innovation Study for Michigan*. Your willingness to participate as a **core key informant** is greatly appreciated. You are one of a small group of persons (less than 10) who will help carry out a unique research design that will apply 'a systems approach' to in-depth learning about complex problems.

Each core key informant will participate in an in-depth interview facilitated by David Lounsbury (Facilitating System Dynamicist). Interviews are likely to occur as individual key informant sessions, but that may also occur as small group interviews (i.e., 2 to 4 core key informants at a time), whichever is most agreeable for you and the other participants. Individual key informant interviews are expected to take between 2.0 and 2.5 hours. Small group interviews are expected to take somewhat longer, about 2.5 to 3.0 hours. In addition to your in-depth interview, there may be a need to follow-up to ask for your opinion or clarification about one or more points that arise as information obtained for the study is processed.

Because of the potentially sensitive nature of the topics we will be addressing in this study, it is imperative that you agree to keep the identity of other core key informants of whom you may learn strictly confidential throughout the course of the study and beyond. This assurance is believed to be necessary in order to create a 'safe space' for free-flowing conversation and comments within the context of the study. Note, however, that you may disclose the fact of your own involvement, but you cannot disclose the involvement of any other participating persons of whom you may be aware.

Experimentation in the Virtual World

System dynamics modeling is one way of applying 'a systems approach.' The process of creating and testing a system dynamics model can be likened to conducting an experiment in the **virtual world**, which can then be used to inform the design and execution of informed strategies, or policy actions, in the **real world**.

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APPENDIX B (continued)

Although system dynamics modeling is ultimately an exercise in applied mathematics, **it is not necessary that you be a mathematician – or that you even ‘like numbers’** – in order to fully participate in the current study. Mathematics is essentially the science of understanding patterns. As expressed by the contemporary mathematician Devlin (2000), patterns can be:

. . . real or imagined, visual or mental, static or dynamic, qualitative or quantitative, utilitarian or recreational. They arise from the world around us, form the depths of space and time, and from the workings of the human mind (p. 8).

For the purposes of the current study, all you need is a general appreciation for **how things change over time**. Your experience and expertise as a member of Michigan’s HIV/AIDS community (i.e., those persons actively involved in the design, delivery, consumption, or evaluation of HIV/AIDS prevention and/or care interventions) more than qualifies you to be a core key informant.

In general, system dynamics modeling aspires to make explicit patterns of change over time. In the current study, patterns that help inform innovative ways of taking action to address current and emerging challenges of HIV/AIDS in Michigan are the focus. Its objective is to better understand how to go about achieving three overarching policy goals, namely: (1) reduction of new HIV infections among all susceptible groups, (2) improved health and well-being among all PLWHA, and (3) increased efficiency and sustainability of HIV/AIDS-related services.

Using this Workbook

This workbook is intended to facilitate critical thinking and effective communication about the current and emergent challenges of HIV/AIDS in our communities. It is intended for your use during the first of two main interviews sessions. The workbook itself serves as a place to **try out and record your knowledge** (i.e., your ideas, strategies, impressions, and concerns about HIV/AIDS in Michigan). You may write anywhere in your workbook, and you may use pencil or pen, one color or many.

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APPENDIX B (continued)

The goal of your interview session is to stimulate **deep thinking** about the dynamic context of HIV/AIDS in Michigan. To facilitate this, a simple, three-step 'mini-modeling' exercise was adapted from Ford and Sterman's (1998) recommended procedure for 'expert knowledge elicitation.' The steps include: (1) **visualizing**, (2) **describing**, and (3) **discussing**. As a complete process, these three steps help to transform the tacit knowledge you have about the design, delivery, consumption, and/or evaluation of HIV/AIDS prevention and/or care interventions into a more explicit, tangible format. A more complete explanation with examples of how to go about your own 'mini-modeling' processes will be provided by David later in the interview session. Using notes taken during your interview session and using the information you choose to record in your workbook, a system dynamics model will be built and tested by David.

The remainder of this workbook is organized into three sections, namely: (1) ***Modeling for Understanding***, (2) ***Conceptual Framework***, and (3) ***'Mini-modeling' Exercises***. The section entitled ***Modeling for Understanding*** provides a generic overview of 'a system approach.' The section entitled ***Conceptual Framework*** depicts the hypothesized flow of information and materials among three aggregated 'system sectors.' The section entitled ***'Mini-modeling' Exercises*** presents a complete series of exercise pages, organized by 'model sector,' for a set of twenty key variables which have been hypothesized to be fundamental to the current study's conceptual framework.

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APPENDIX C

Generic Mathematical Structures Used in the Model Supply Chain

A supply chain is commonly used to describe a multi-staged process used to deliver something from point A to point B. What is delivered can be material (e.g., a computer, a care, money) or informational (e.g., an attitude, knowledge). In the current study, a supply chain structure was used to define HIV/AIDS epidemiological burden (Construct A). People, or persons, are what move through the supply chain, which represents stages, or delays, in the HIV disease process.

Figure C.1 shows the generic structure of a supply chain with its output. Three stocks (rectangles), each representing a stage in the process, are featured. The flow of material or information from one stock to another is determined by a particular rate (circles with valves). A particular time delay is associated with each rate. The behavior over time graph accompanying the figure shows that, relative to the other two stocks, material or information in the first stage stock accumulates to the highest level over the specified time horizon, followed by the Nth (third) stage stock, and then the second stage stock. These patterns of accumulation indicate that the time delay to leave the first stage (i.e., outflow minus inflow) is longer than the time delay to leave the second stage. However, the time to leave the Nth (third) stage is longer than the time to leave the second stage.

APPENDIX C (continued)

Generic Mathematical Structures Used in the Model
Supply Chain

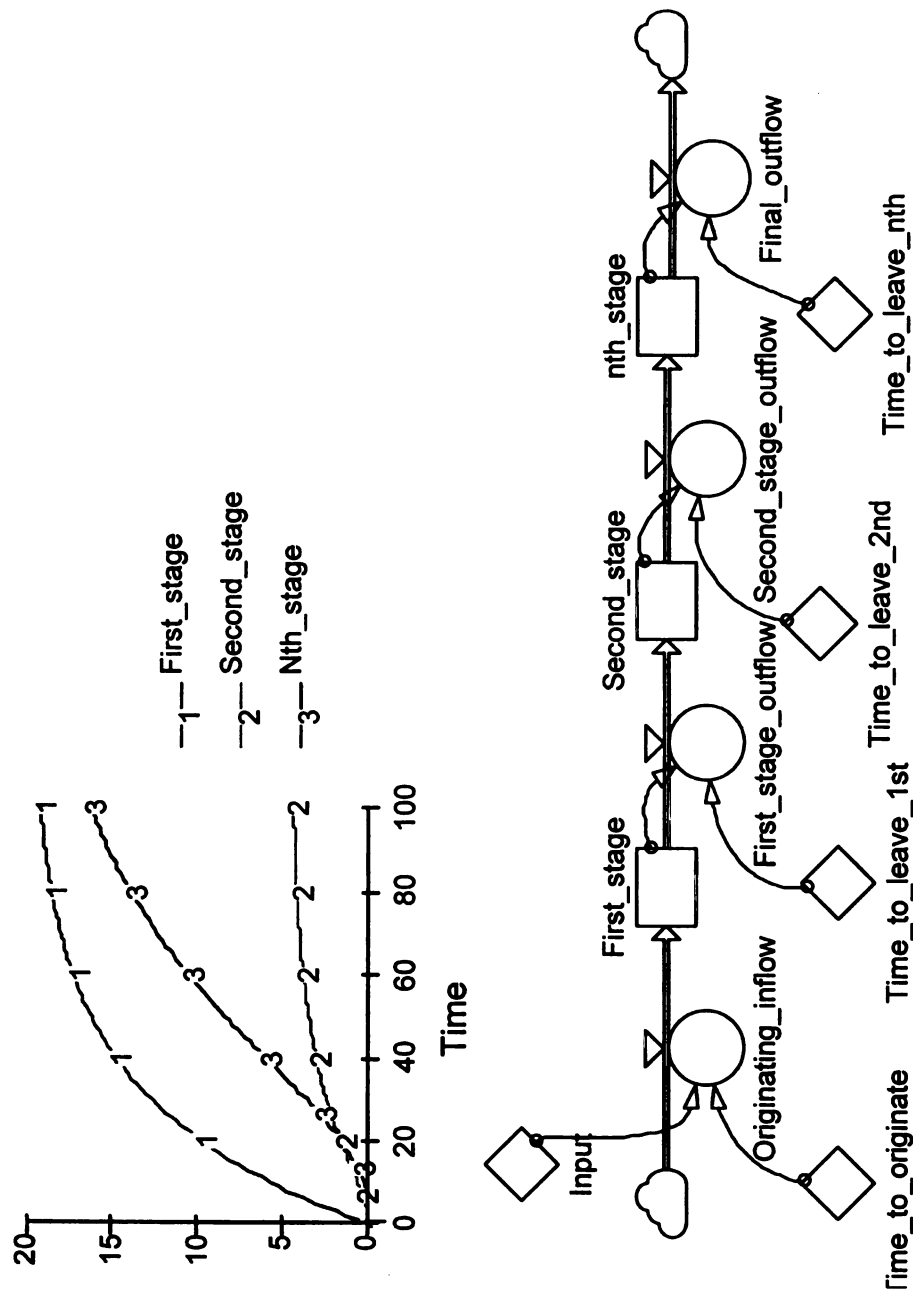


Figure C.1 - Generic supply chain structure with output

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APPENDIX C (continued)

Generic Mathematical Structures Used in the Model Classical Co-flow

The classical co-flow structure is used to keep track of an attribute of a stock variable as its level changes over time. For example, a system may include a disaggregated stock of persons, such as in the current study, but these stocks only indicate how many persons may be found at different ‘locations’ within the HIV/AIDS service system. They reveal nothing of their age, gender, income, ethnicity, education, or other characteristics that might be important for the model purpose. In the current study, only one attribute of interest has been modeled with the classical co-flow structure, namely HIV symptoms. The classical co-flow allows the modeler to simulate differing levels of symptoms for different subpopulations and to keep track of these averages as persons move through the system.

Figure C.2 shows the generic classical co-flow structure. Figure C.3 shows its accompanying output. In this simple example, there is just one stock and one attribute. If desired, additional attributes could be added. The stock level and the average attribute level are shown on the same behavior-over-time graph for the sake of comparison, although it should be noted that they are dimensionally incompatible. For example, if the stock was quantified in ‘persons,’ then the attribute would be quantified in ‘attribute units per person.’

Note that the defining structural element of the classical co-flow is the arrow linking the inflow rate to the increase in attribute rate and, similarly, the arrow linking the outflow rate to the decrease in attribute rate. In this way the attribute ‘tracks’ the stock, adjusting the total attribute accordingly for every change in the value of the stock. Note that the average attribute is an auxiliary equation that divides the total attribute by the stock.

APPENDIX C (continued)

Generic Mathematical Structures Used in the Model Classical Co-flow

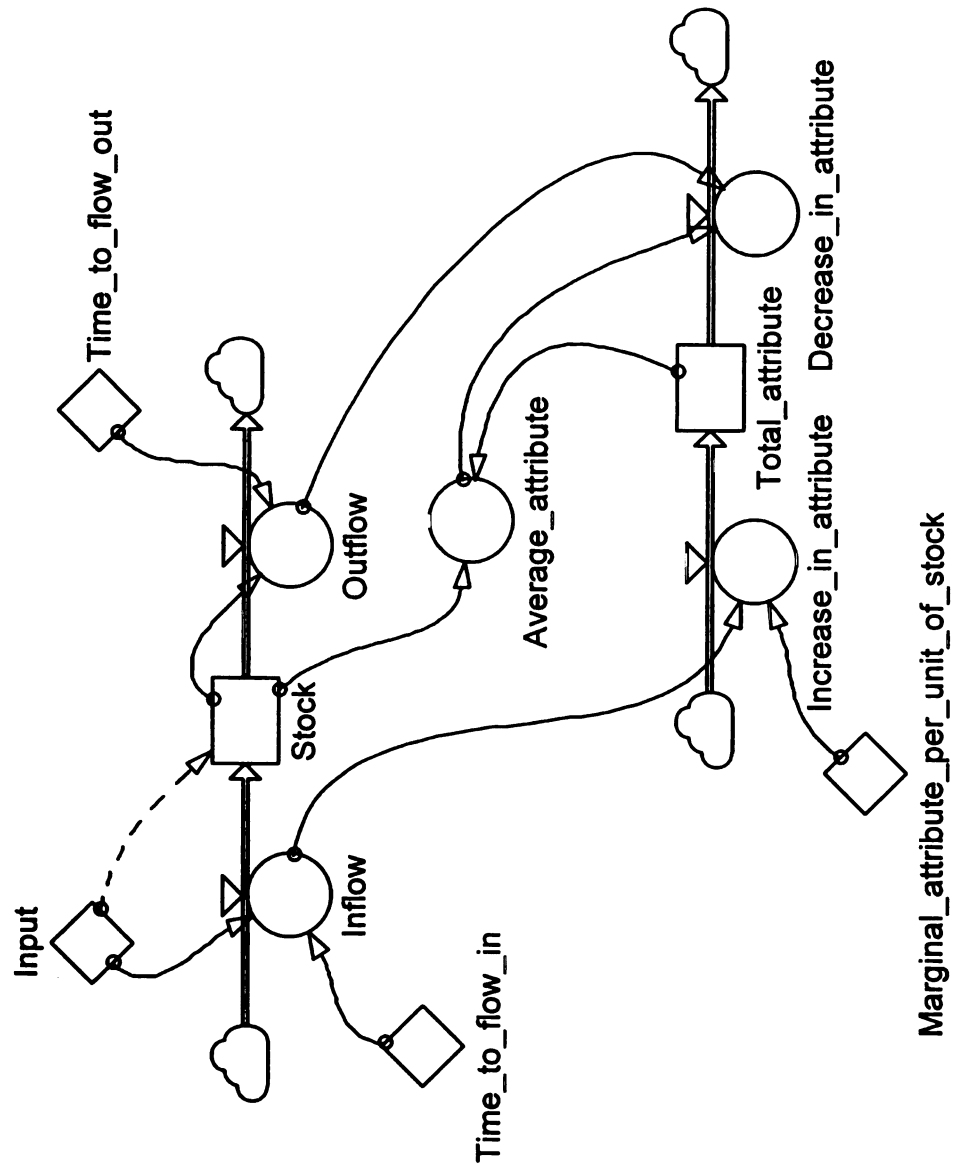


Figure C.2 - Generic classical co-flow structure

APPENDIX C (continued)

Generic Mathematical Structures Used in the Model
Classical Co-flow

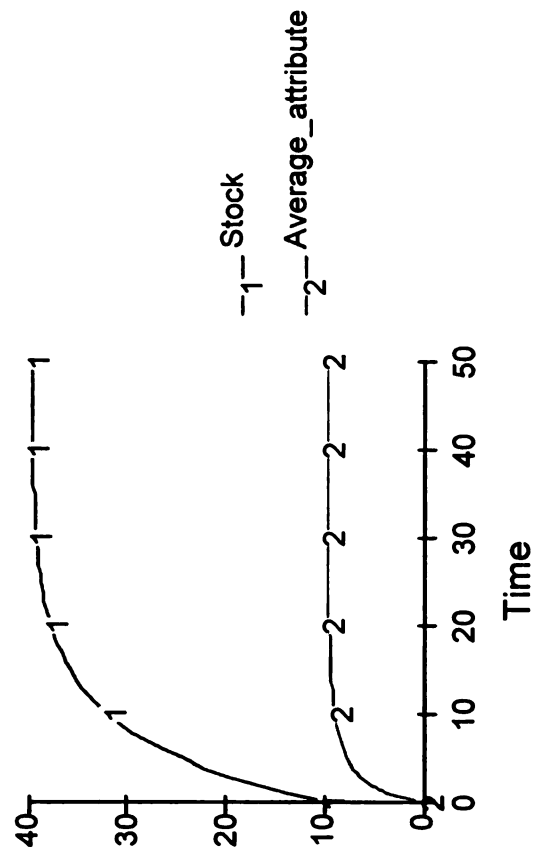


Figure C.3 - Generic classical co-flow output

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APPENDIX C (continued)

Generic Mathematical Structures Used in the Model Self-limiting Compounding Process

Compounding processes generate exponential growth curves, either increasing or decreasing. Self-limiting compounding processes first show exponential growth but then, due to some other factor, flatten out as they approach a particular limit to growth. The expected shape of the resultant curve is like an 'S.' It is generally accepted that no real quantity can grow (or decline) indefinitely. In the current study, both care system quality and prevention system quality were modeled as self-limiting compounding processes.

Figure C.4 shows the generic structure of the self-limiting compounding process with an example of its output. In this example, the stock reaches a steady state, or 'levels out' at approximately 40 units. Using the structure shown here, the level at which the system reaches a steady state can be predetermined. This is useful when one wishes to simulate an S-shaped curve that is conceptually bounded by a particular upper limit. To control when the model will achieve equilibrium, the reciprocal of the base compound fraction must be calculated. The base compound fraction is used to compute the moment, or point of time, at which additional growth of a stock variable, given a particular relationship, or effect, of available resources (e.g., funding), will reach a limit. Its reciprocal gives the minimum time constant that would lead to a steady state of the stock. The minimum time constant is then represented as the y coordinate associated with a particular x coordinate in a table function (time to decrease Stock, in this example). In this example, the base compound fraction is .08 (i.e., 8% of the current stock per year). The reciprocal of .08 is $1/.08$, or 12.5. Since the y values used in this table function drop below 12.5 where the x value is close to 40, the curve levels out at 40 units.

APPENDIX C (continued)

Generic Mathematical Structures Used in the Model Self-limiting Compounding Process

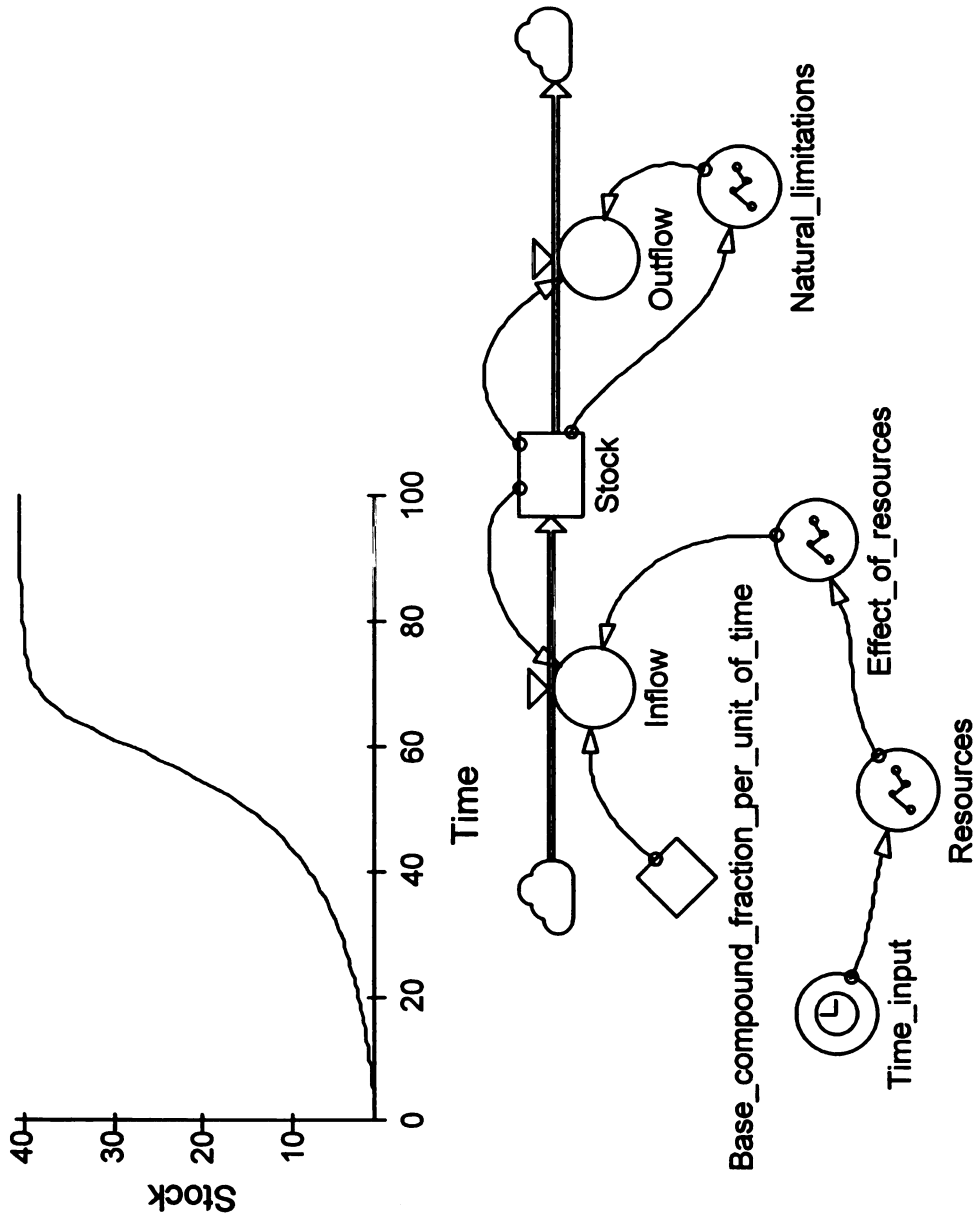


Figure C.4 - Generic self-limiting compounding process structure with output

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APPENDIX C (continued)

Generic Mathematical Structures Used in the Model External Resource Production Process

External resource production processes are used to generate a flow of production using one or more different resources. In the current study, available care resources and prevention resources are determined by a flow of care and prevention funding, respectively. As long as the external resource and the productivity term remain constant, the flow of production generated by the process will be linear. Considering the reference modes for both care and prevention, this happens to be the case in the current study.

Figure C.5 shows the generic structure of the external resource production process with its accompanying output. In this example, productivity is set to .5 and the external resource level is set to 1. The inflow provides a steady flow of half of a stock unit per unit of time, which generates the line shown in the behavior-over-time graph.

Generic Mathematical Structures Used in the Model
External Resource Production Process

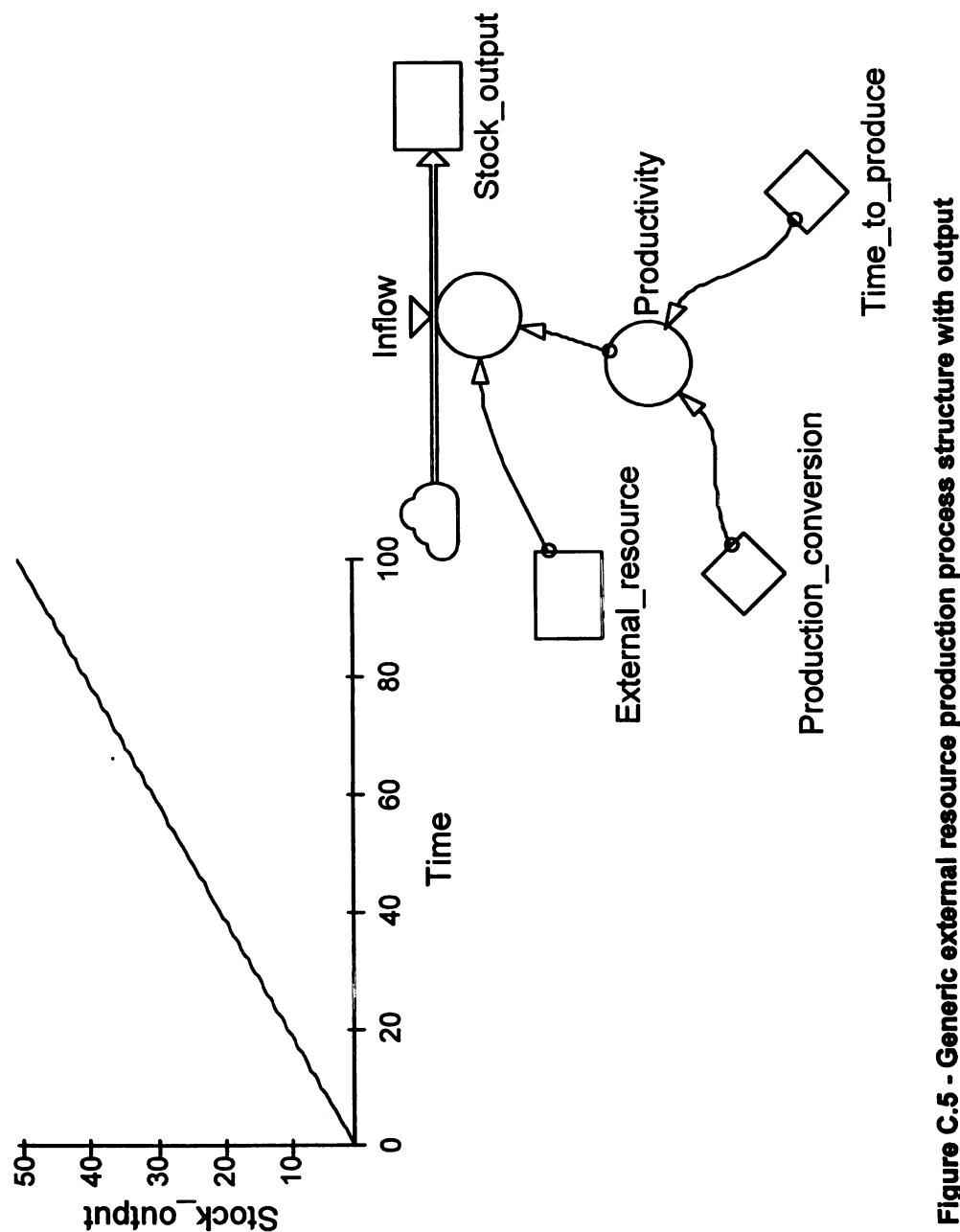


Figure C.5 - Generic external resource production process structure with output

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APPENDIX C (continued)

Generic Mathematical Structures Used in the Model Hines Co-flow

The Hines co-flow, named after the system dynamacist Jim Hines who created it, is the most commonly used generic structure in the base case model (see Figure C.6). It was used to represent all the constructs in both the psychosocial vulnerability domain. Hines co-flow is comprised of two parts: (1) a supply chain structure (see Figure C.1) and (2) a corresponding series of linked 'smooths' (see Figure C.2). A smooth is the dynamic average value of a stock over a specified time interval (e.g., the average level of satisfaction with care system quality computed over a changing or 'shifting' 6 month period of time). The behavior of a Hines co-flow structure is a function of both the initial value of the construct as well as the 'goal,' or expected ending value of the construct, given a particular period of time (i.e., the model's time horizon). Note that the time delay used in the Hines co-flow structure is derived from its corresponding supply chain structure.

Note also that the Hines co-flow structure incorporates a 'goal' as opposed to a 'marginal attribute' parameter. As seen in this structure's output in Figure C.7, average attributes for the corresponding stocks approach the set goal as time passes. In the sample output provided here, the average attribute for all three stock stages reach there intended goal within 60 time points. In addition, note that by setting the goal and the initial value of the average attribute, the modeler is able to view patterns of change within a controlled range. For example, in the current study values for constructs using the Hines co-flow structure will not go above 100 or below 0. Given that the specified range is arbitrary, it takes on the properties of an interval scale of quantification, like the commonly used Likert-type scale, only dynamic in nature.

APPENDIX C (continued)

Generic Mathematical Structures Used in the Model Hines Co-flow

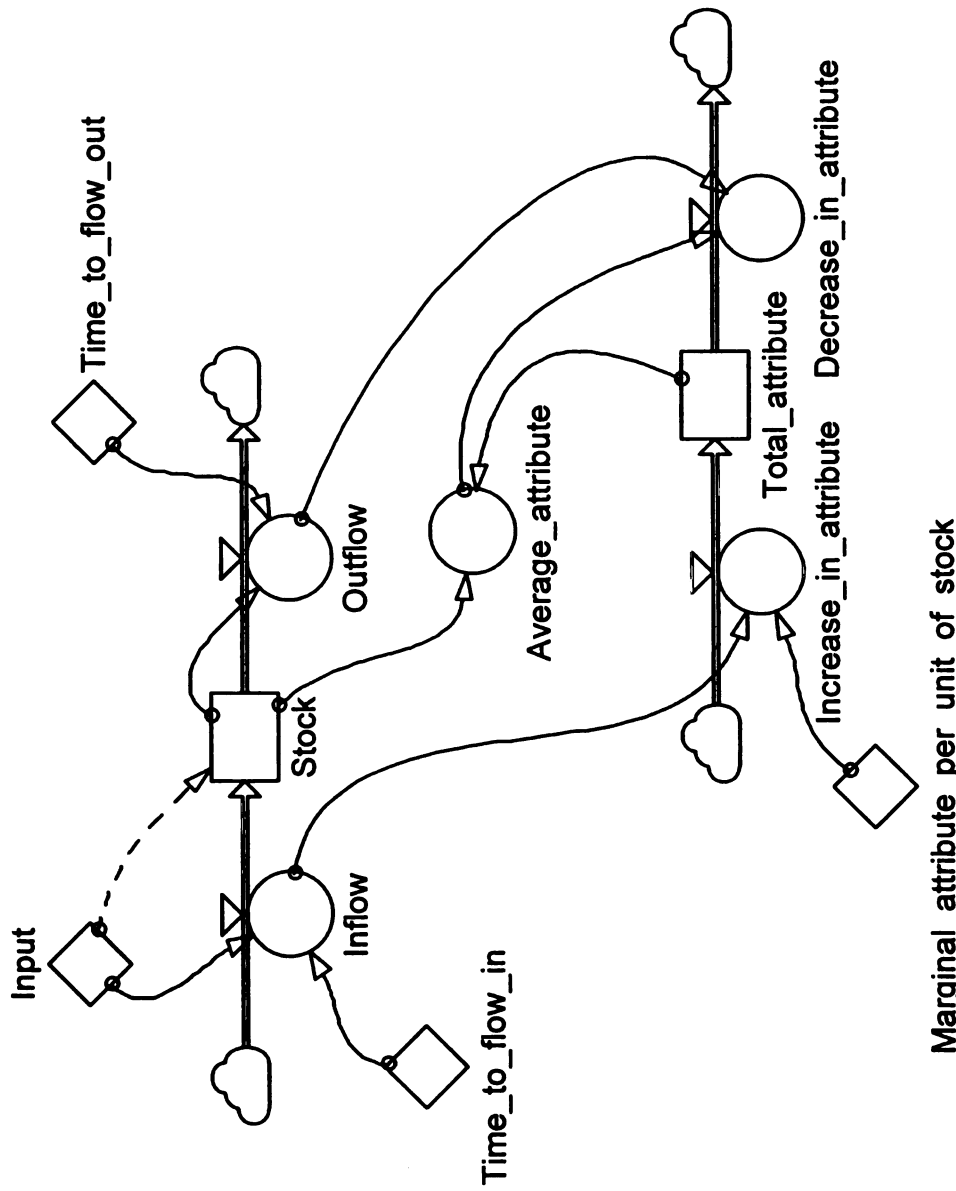


Figure C.6 - Generic Hines co-flow structure

Goal = 10

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APPENDIX C (continued)

Generic Mathematical Structures Used in the Model
Hines Co-flow

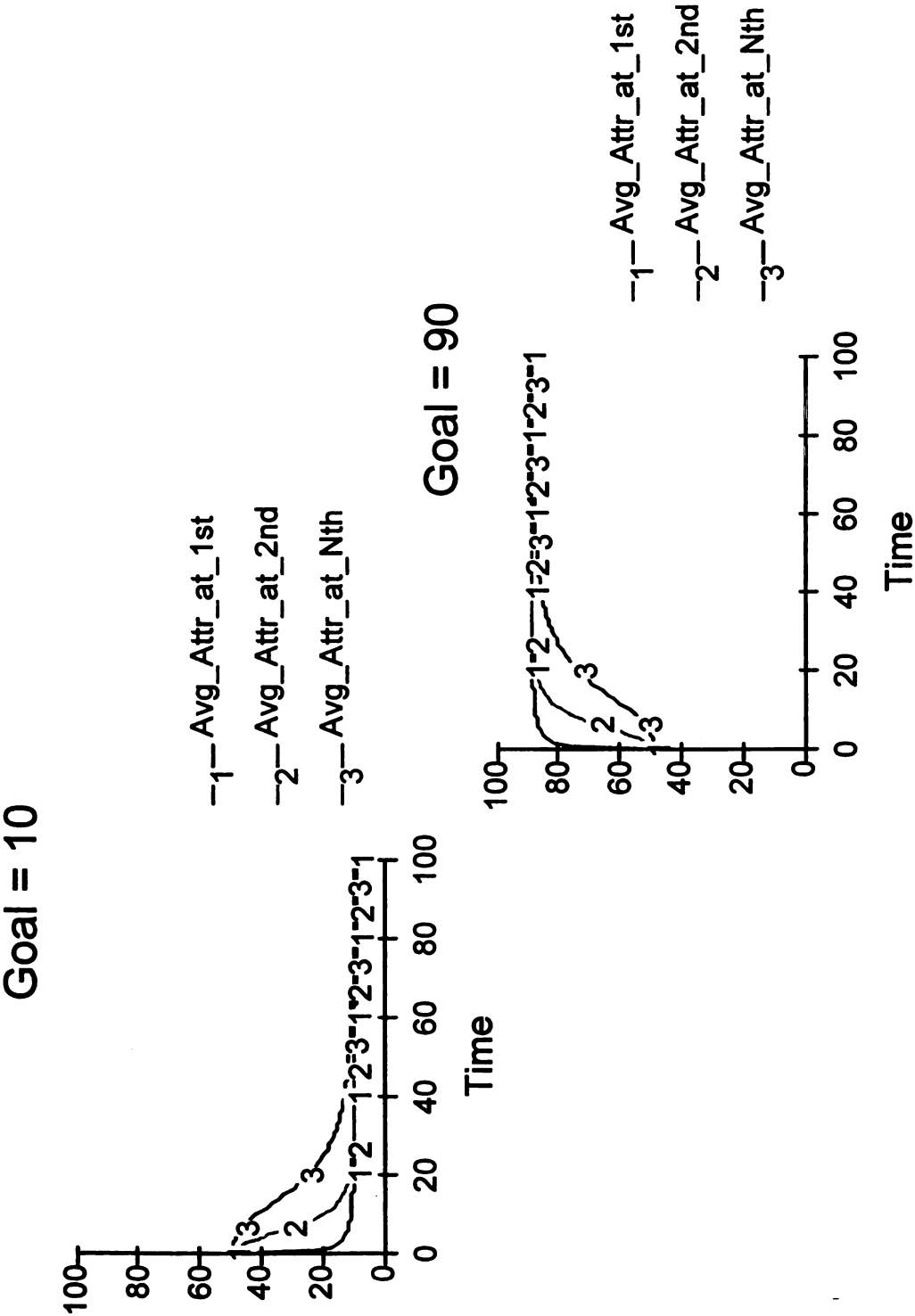


Figure C.7 - Hines co-flow output for two goals

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APPENDIX D

Example Antecedent Effect Functions

In order to program a given causal relationship, information or material from the antecedent construct needs to be converted into terms, or dimensions, of the construct it affects. In system dynamics models, these conversions must adhere to certain mathematical rules. Although all variables that comprise a construct are necessary, stocks and rates are the fundamental elements used to make the mathematical conversion. With this statement in mind, table functions were used to program causal links between two key constructs of different dimensions (i.e., units).

A table function is a continuous mathematical relationship, linear or non-linear, between two variables. Powersim and most other system dynamics modeling software allow the table function relationship to be defined graphically. Figures D.1 and D.2 present two sets of examples of table functions. In Figure D.1, table function graph (a) shows the non-linear, decreasing curve used to determine the multiplier value (y) for all possible values of satisfaction with prevention system quality (SPSQ) that will affect, in this case, system change action (SCA). Note that possible values for the system change action (SCA) multiplier range from 0.0 to 2.0. Algebraically, any value below 1.0 will diminish the current level of system change action (SCA) at an accelerating rate as zero is approached, a value of 1.0 will have no effect on the current level of system change action (SCA), and a value greater than 1.0 will reinforce the current level of SCA at an accelerating rate as 2.0 is approached. Similarly, table function graph (b) shows the non-linear, increasing curve used to determine a conversion relationship from care system quality (CSQ) units into satisfaction with care system quality (SCSQ) units. For example, 10 units of care system quality (CSQ) would be converted, or translated, into 20 units of satisfaction with care system quality SCSQ.

Other examples of table functions used in the model are shown in table function graphs (c) and (d). Table function graph (c) specifies the probability that a particular sex or drug risk encounter would generate a new case of HIV infection. Table function graph (d) specifies the linear, decreasing multiplicative relationship that impacts the prevention complacency (PC) given the current level of perceived HIV stigma.

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Figure D.2 presents two less typical applications of table functions. Table function graph (a) is used to control the proportion of the all system resources allocated to care (CR) as a function of the proportion of persons who have been diagnosed with HIV who are actively receiving HIV/AIDS-related treatments and support services. Note that both axes represent 'dimensionless' values. Using a proportion in this way solves the problem of working with theoretically indefinite variable levels, such as the number of persons who might ultimately be 'on care' (i.e., receiving care) in Michigan over the model time horizon.

The last example in Figure D.2, table function (b), uses a table function to specify the point of time at which a compounding process will begin to flatten out and move into 'steady state' or equilibrium. The dynamic problem is to limit the quality of care services (CSQ) to at a value the fell between 0 and 100. The base compound fraction in this example was 0.16, the reciprocal of which is $1/0.16$ or 6.25. Note that the non-linear, decreasing curve includes this value. Furthermore, note that was 'placed' near to 100, the scale limit set for care system quality CSQ. The resulting behavior is an S-shaped curve that cannot go higher than this upper limit.

As is evidenced by these examples, table function can be defined in an infinite number of ways. What is most important is that the assumptions that were used to inform their specification were grounded by empirically supported data (quantitative and/or qualitative). Finally, as with all steps within the process of modeling for understanding, final selection of a table function curve typically requires a series of practice runs, or iterations, of construct programming and simulation.

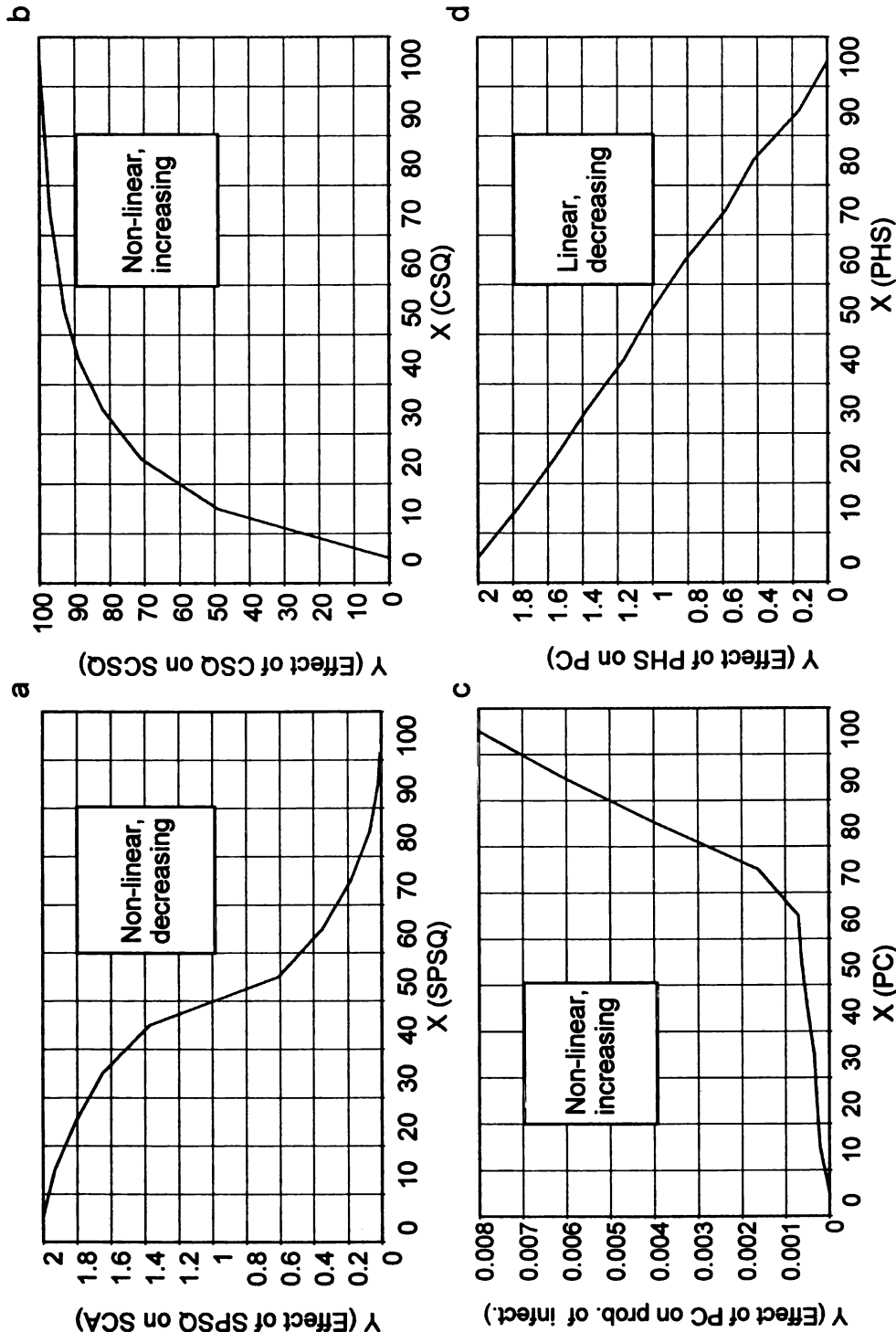


Figure D.1 - Use of table functions to program antecedent effects (example set 1)

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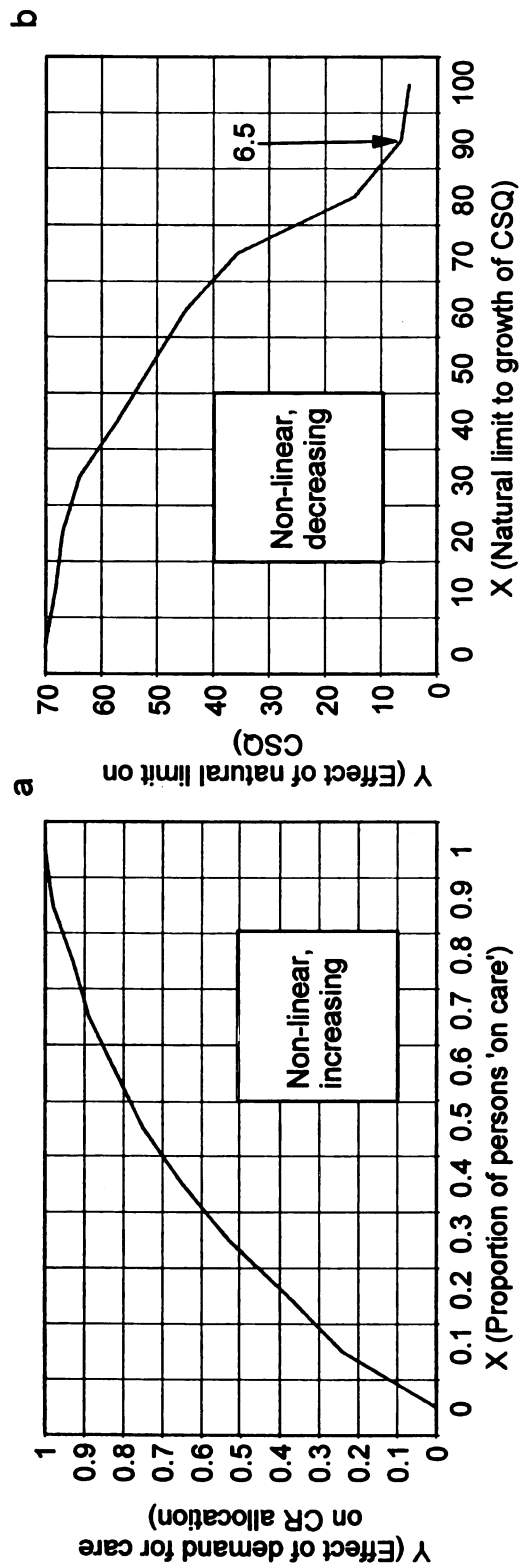


Figure D.2 - Use of table functions to program antecedent effects (example set 2)

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Epi_LHU

Epidemiological Burden Domain Stock-and-Flow Diagrams

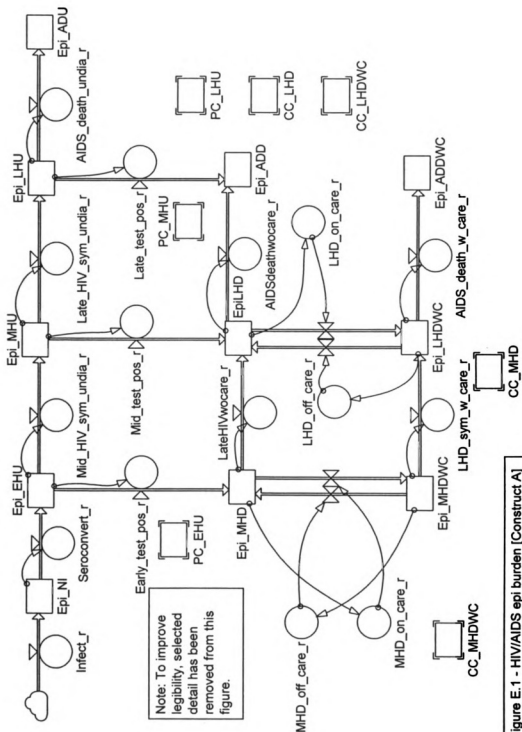


Figure E.1 - HIV/AIDS epi burden [Construct A]

APPENDIX E (continued)

HIV/AIDS Epi Burden [Construct A]

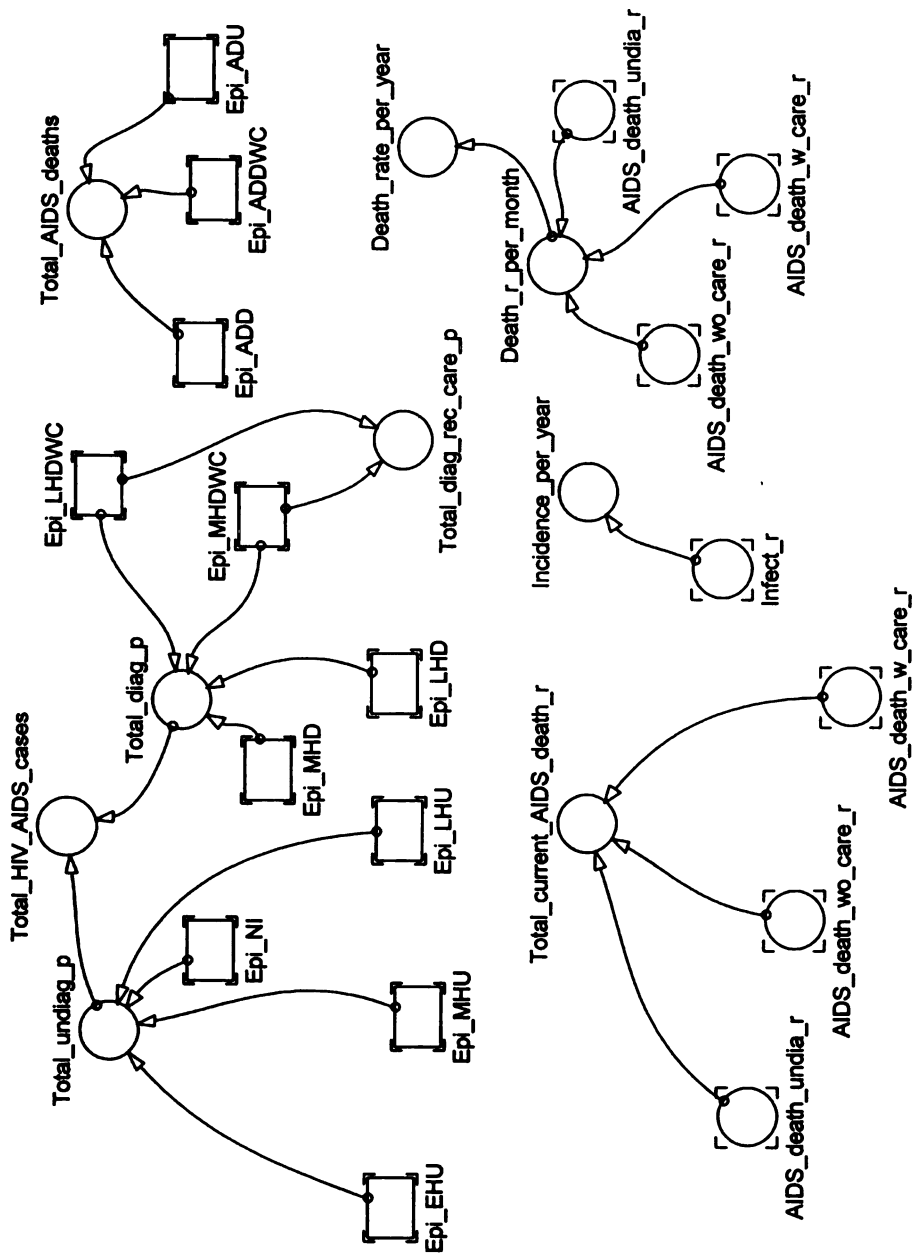


Figure E.2 - HIV/AIDS epi burden auxiliary computations [Construct A]

APPENDIX E (continued)

HIV Symptoms [Construct B]

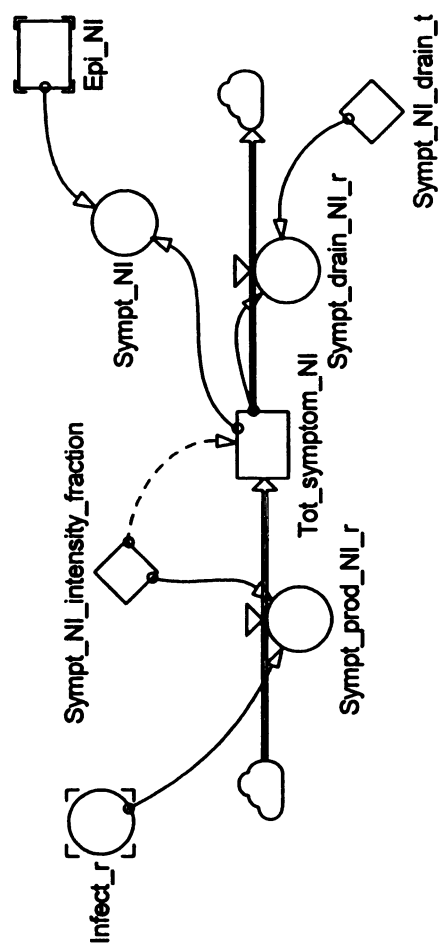


Figure E.3 - HIV symptoms among newly infected persons [Construct B]

HIV Symptoms [Construct B]

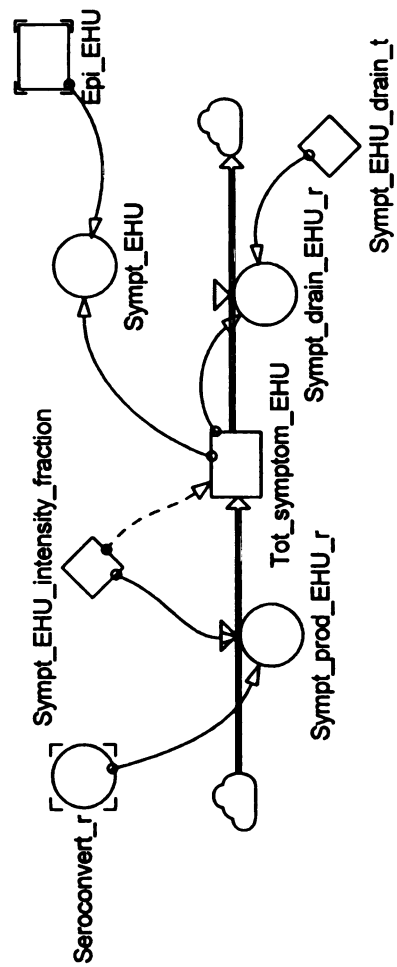


Figure E.4 - HIV symptoms among early stage undiagnosed persons [Construct B]

HIV Symptoms [Construct B]

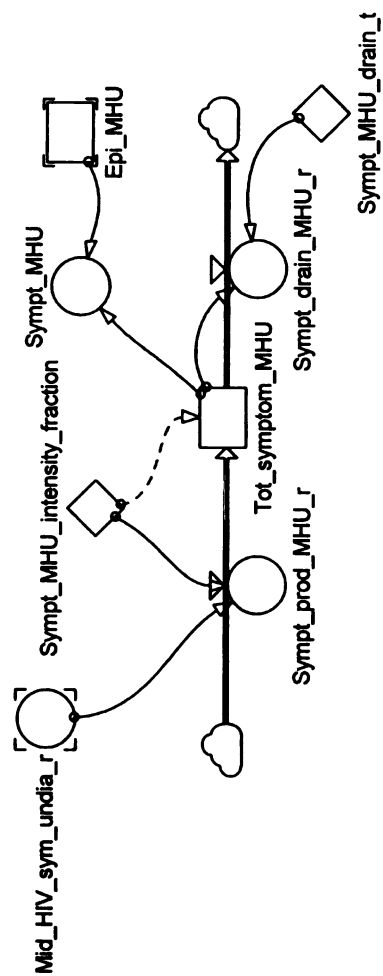


Figure E.5 - HIV symptoms among mid-stage undiagnosed persons [Construct B]

HIV Symptoms [Construct B]

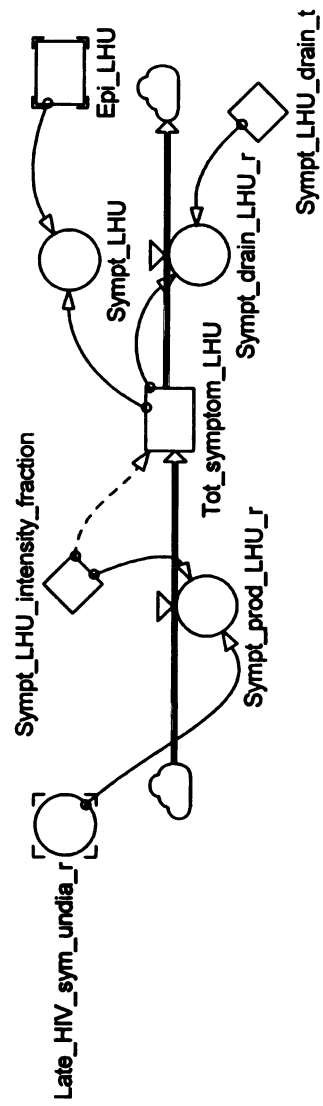


Figure E.6 - HIV symptoms among late stage undiagnosed persons [Construct B]

APPENDIX E (continued)

HIV Symptoms [Construct B]

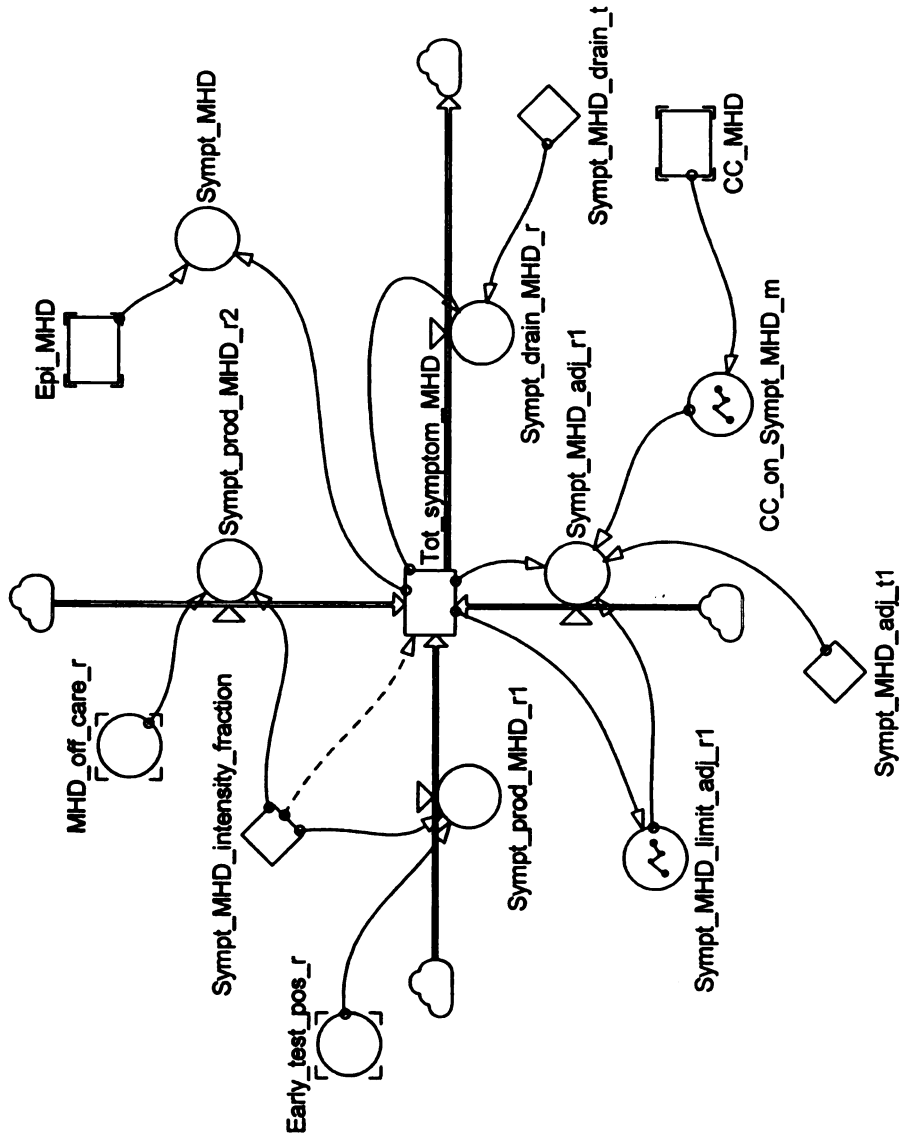


Figure E.7 - HIV symptoms among mid-stage diagnosed persons [Construct B]

APPENDIX E (continued)
HIV Symptoms [Construct B]

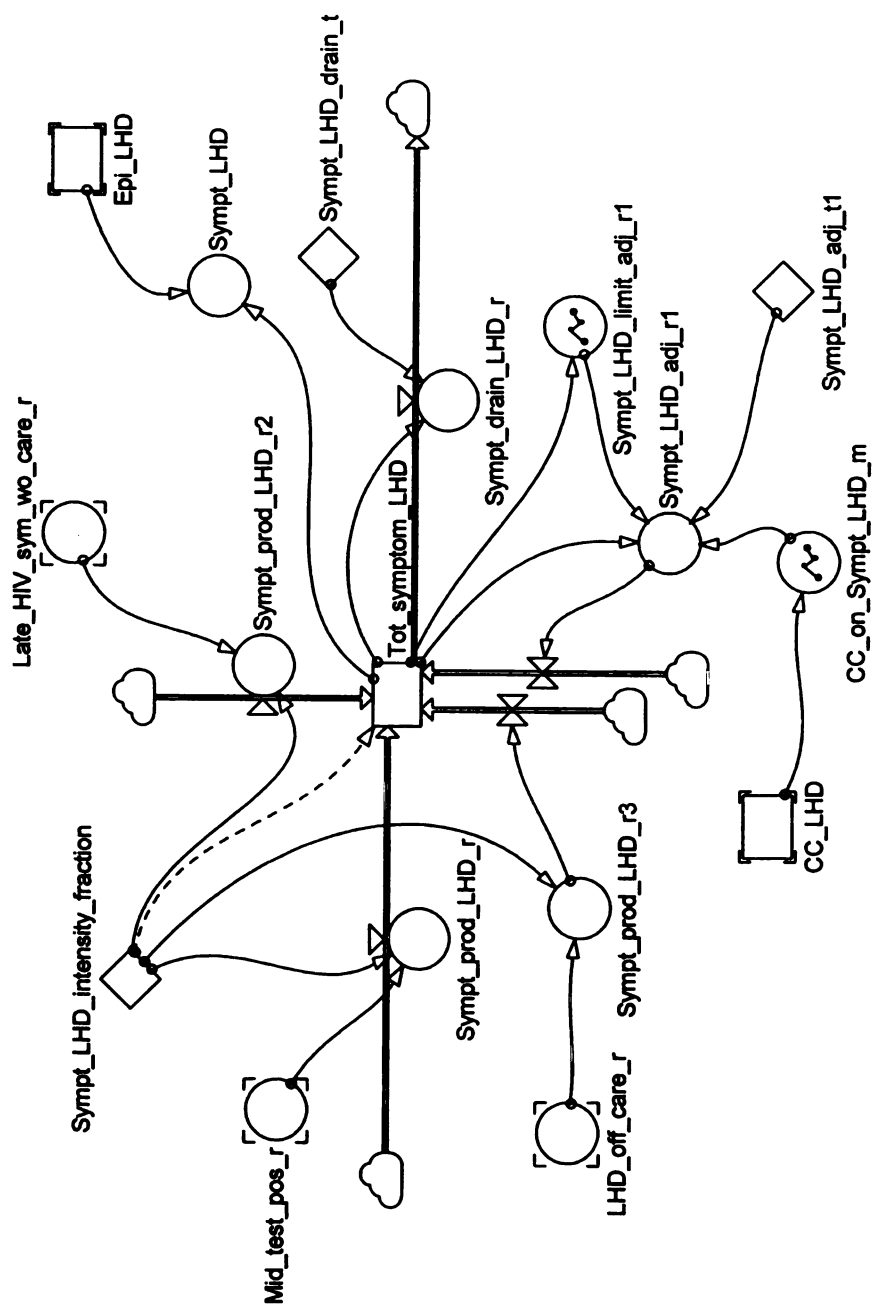


Figure E.8 - HIV symptoms among late stage diagnosed persons [Construct B]

HIV Symptoms [Construct B]

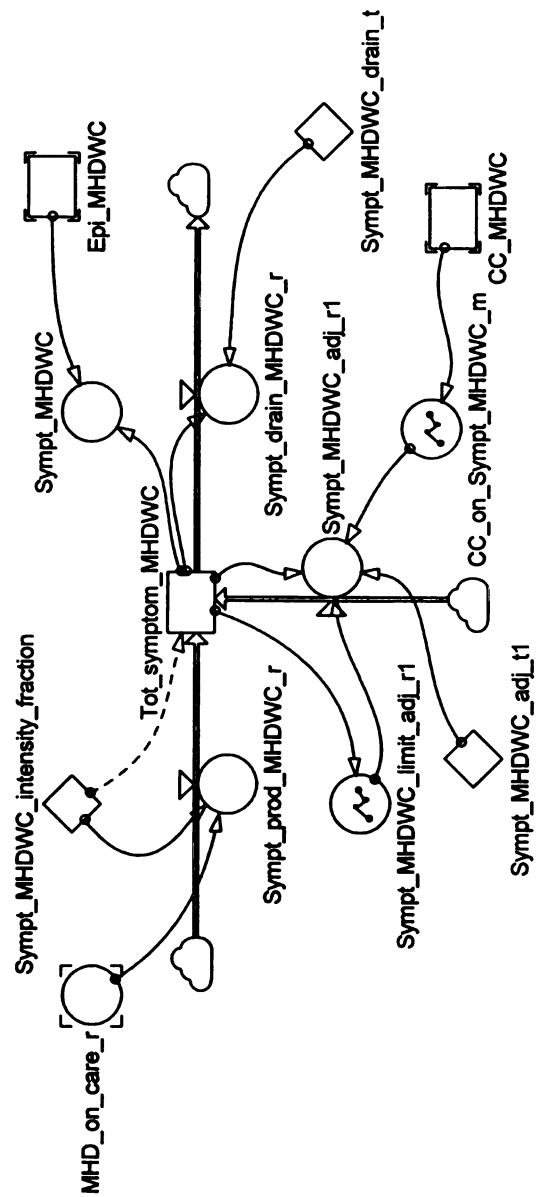


Figure E.9 - HIV symptoms among mid-stage persons with care [Construct B]

APPENDIX E (continued)

HIV Symptoms [Construct B]

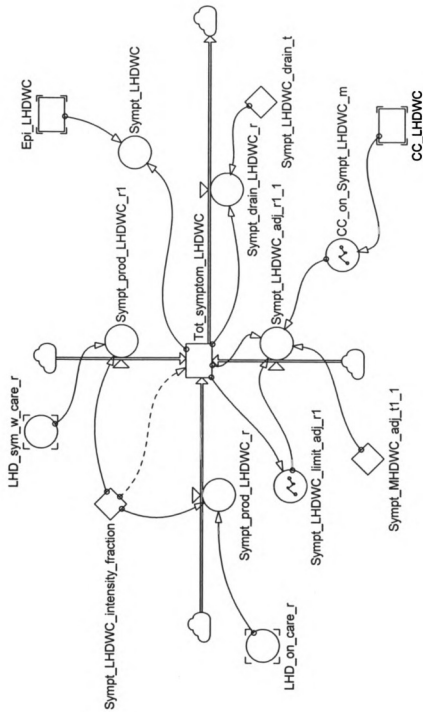


Figure E.10 - HIV symptoms among late state persons with care [Construct B]

APPENDIX E (continued)

HIV Symptoms [Construct B]

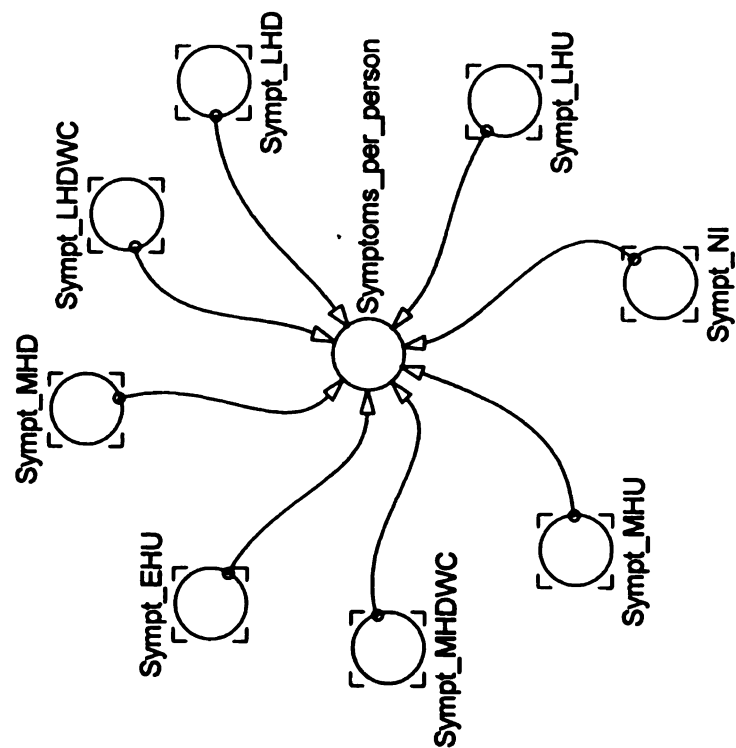


Figure E.11 - Aggregate HIV symptoms [Construct B]

APPENDIX F

HIV/AIDS Intervention Domain Stock-and-Flow Diagrams Care System Quality [Construct C]

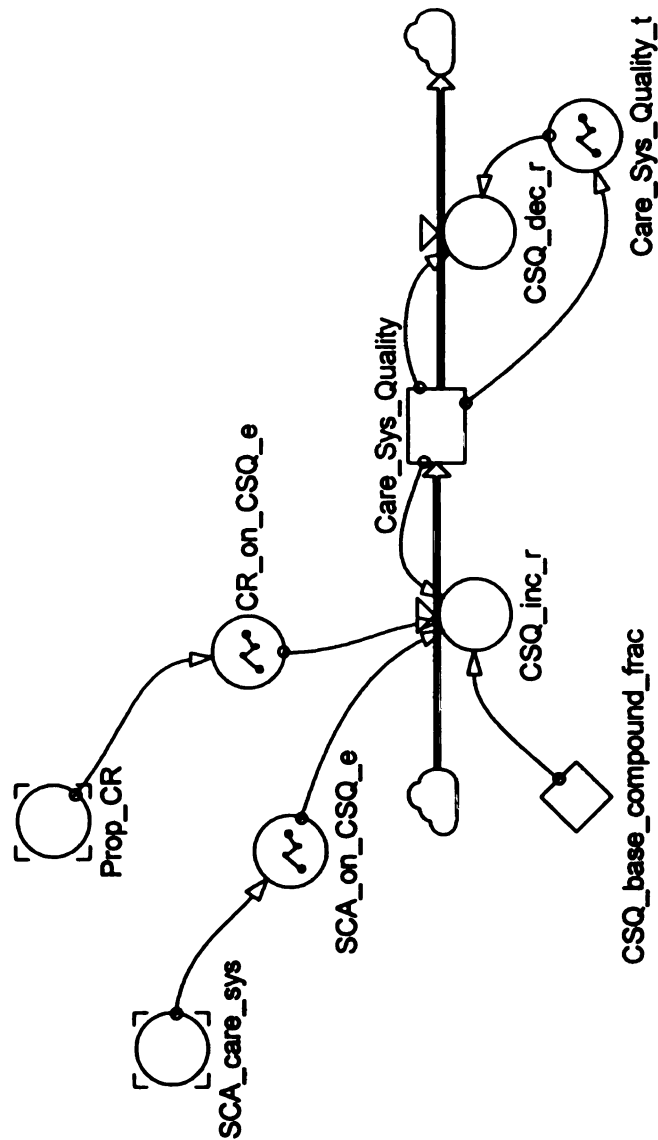


Figure F.1 - Care system quality [Construct C]

APPENDIX F (continued)

Prevention System Quality [Construct D]

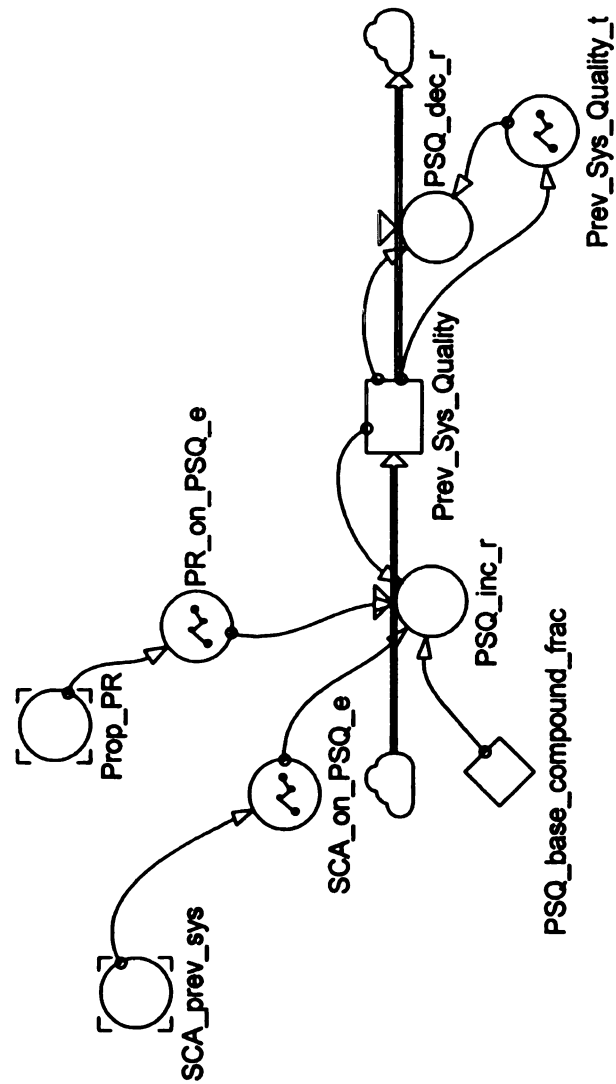


Figure F.2 - Prevention system quality [Construct D]

APPENDIX F (continued)

Care Resources [Construct E]

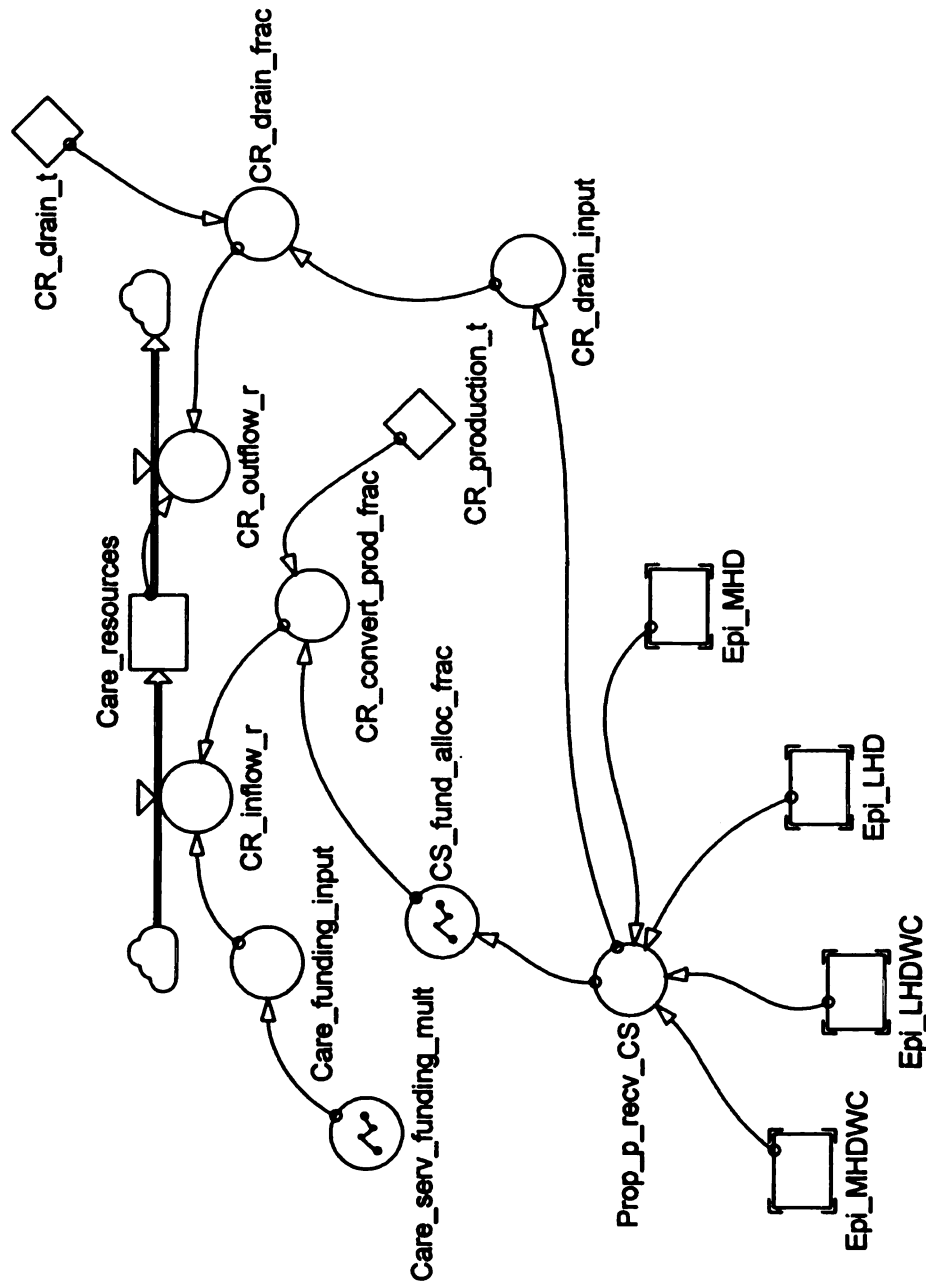


Figure F.3 - Care resources [Construct E]

APPENDIX F (continued)

Prevention Resources [Construct F]

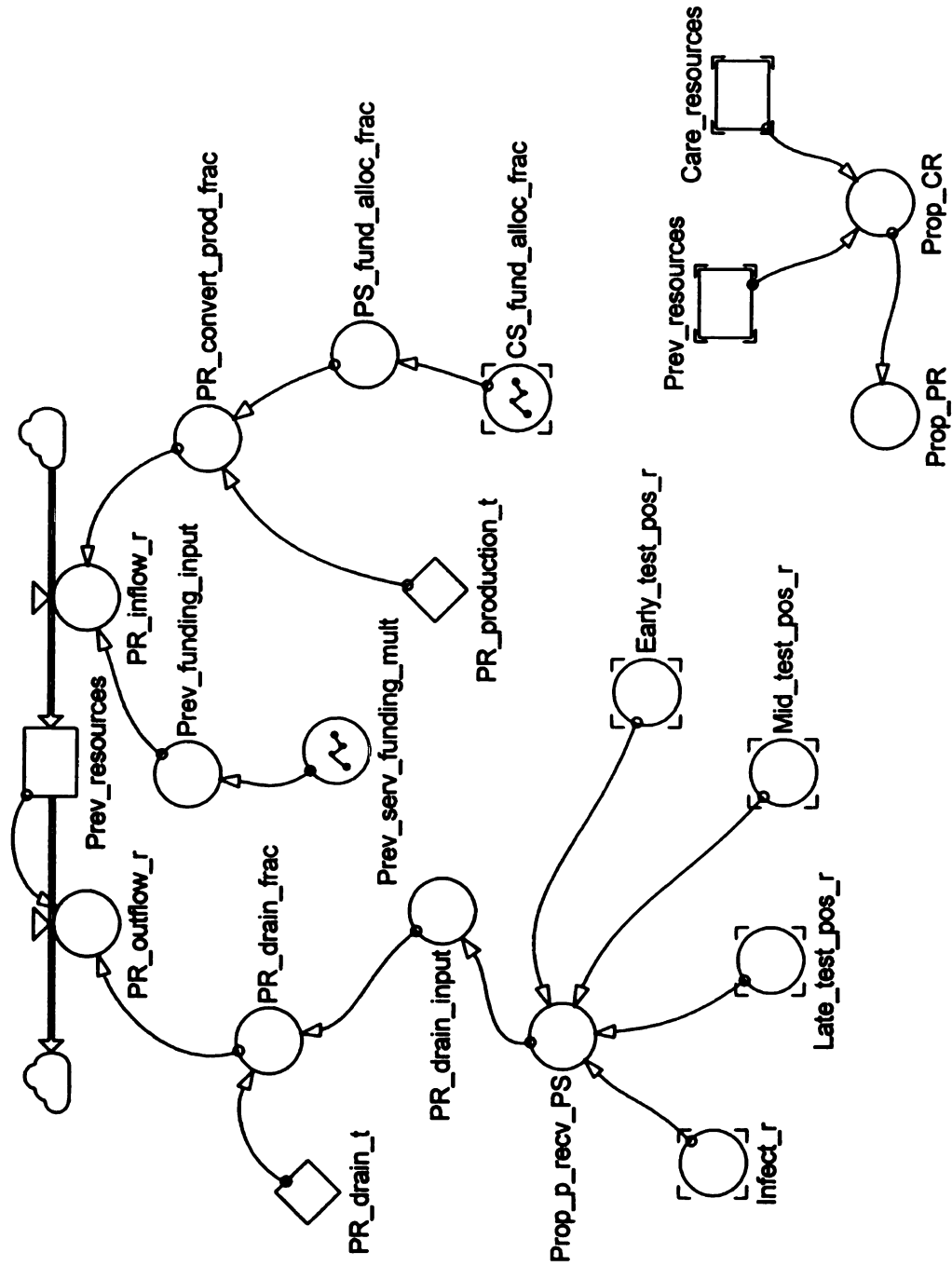


Figure F.4 - Prevention resources [Construct F]

APPENDIX G

Psychosocial Vulnerability Domain Stock-and-Flow Diagrams Satisfaction with Care System Quality [Construct G]

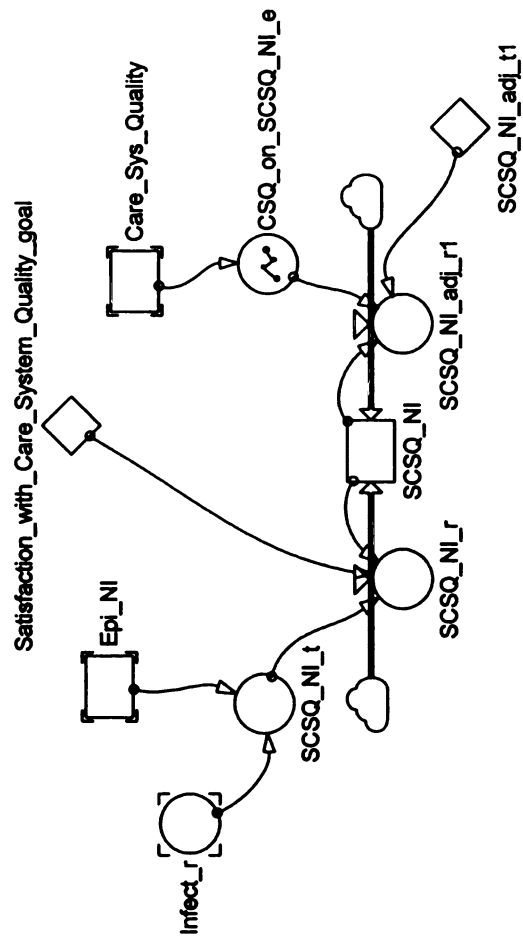


Figure G.1 - Satisfaction with care system quality among newly infected persons [Construct G]

APPENDIX G (continued)

Satisfaction with Care System Quality [Construct G]

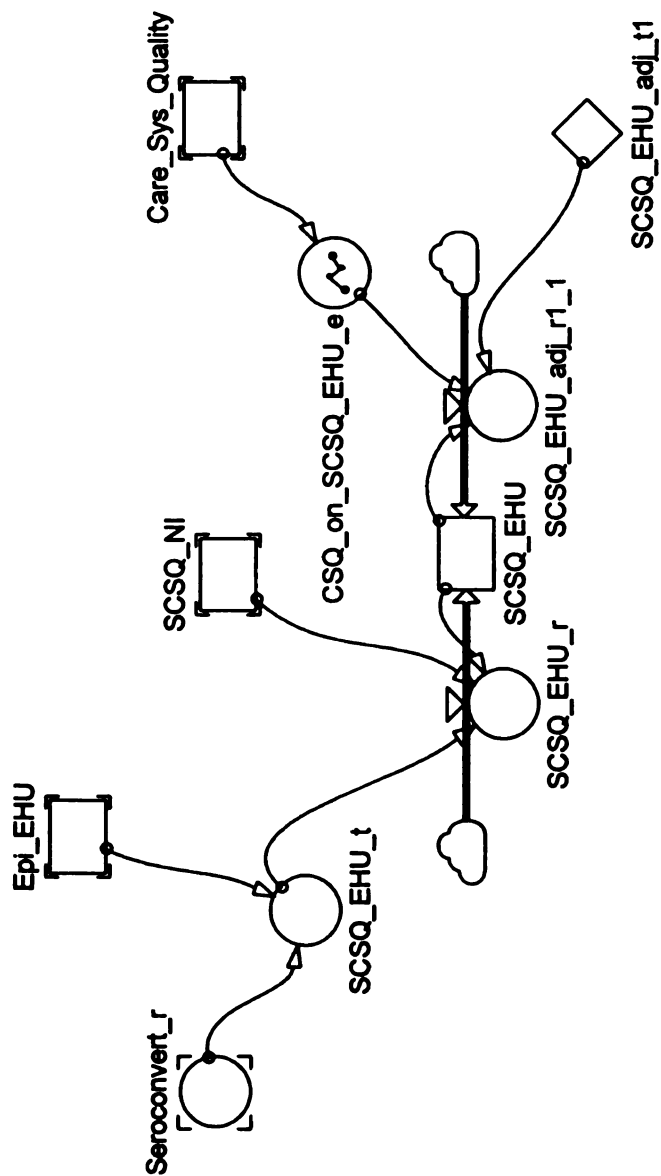


Figure G.2 - Satisfaction with care system quality among early stage undiagnosed persons [Construct G]

APPENDIX G (continued)

Satisfaction with Care System Quality [Construct G]

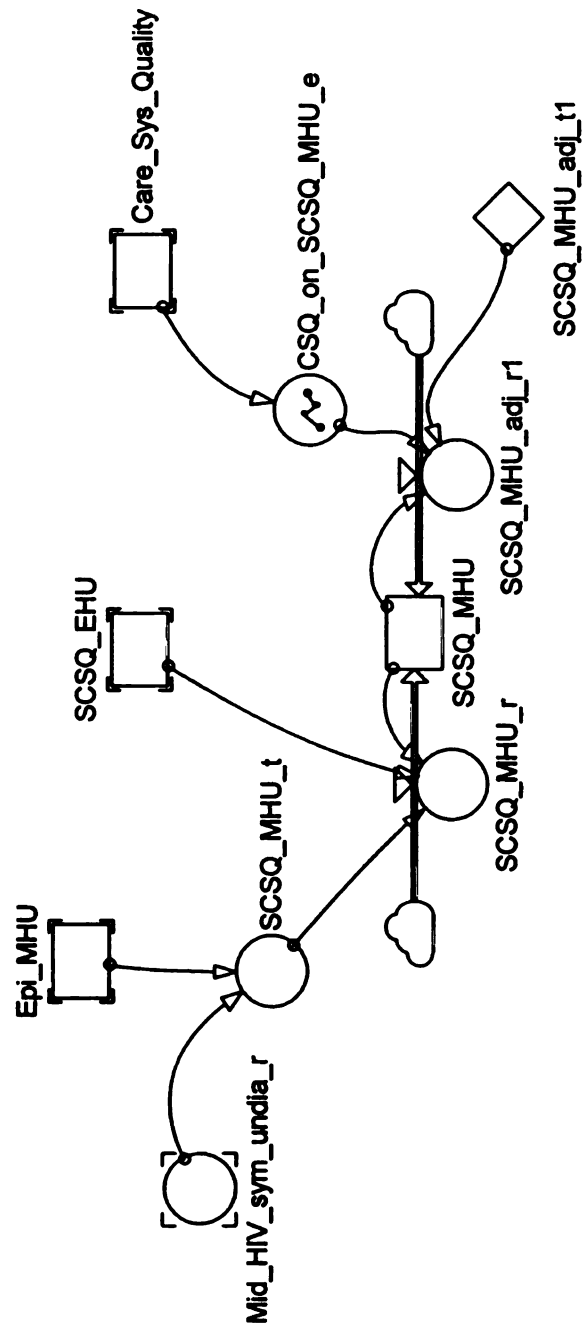


Figure G.3 - Satisfaction with care system quality among mid-stage undiagnosed persons [Construct G]

APPENDIX G (continued)

Satisfaction with Care System Quality [Construct G]

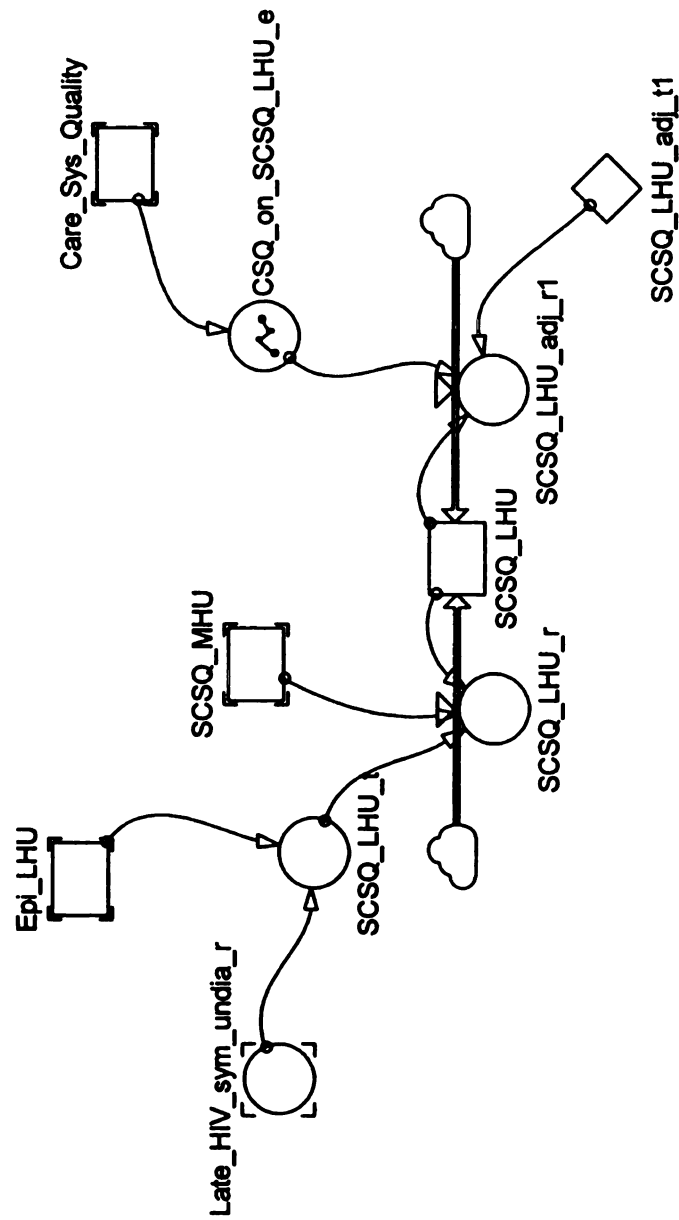


Figure G.4 - Satisfaction with care system quality among late stage undiagnosed persons [Construct G]

APPENDIX G (continued)

Satisfaction with Care System Quality [Construct G]

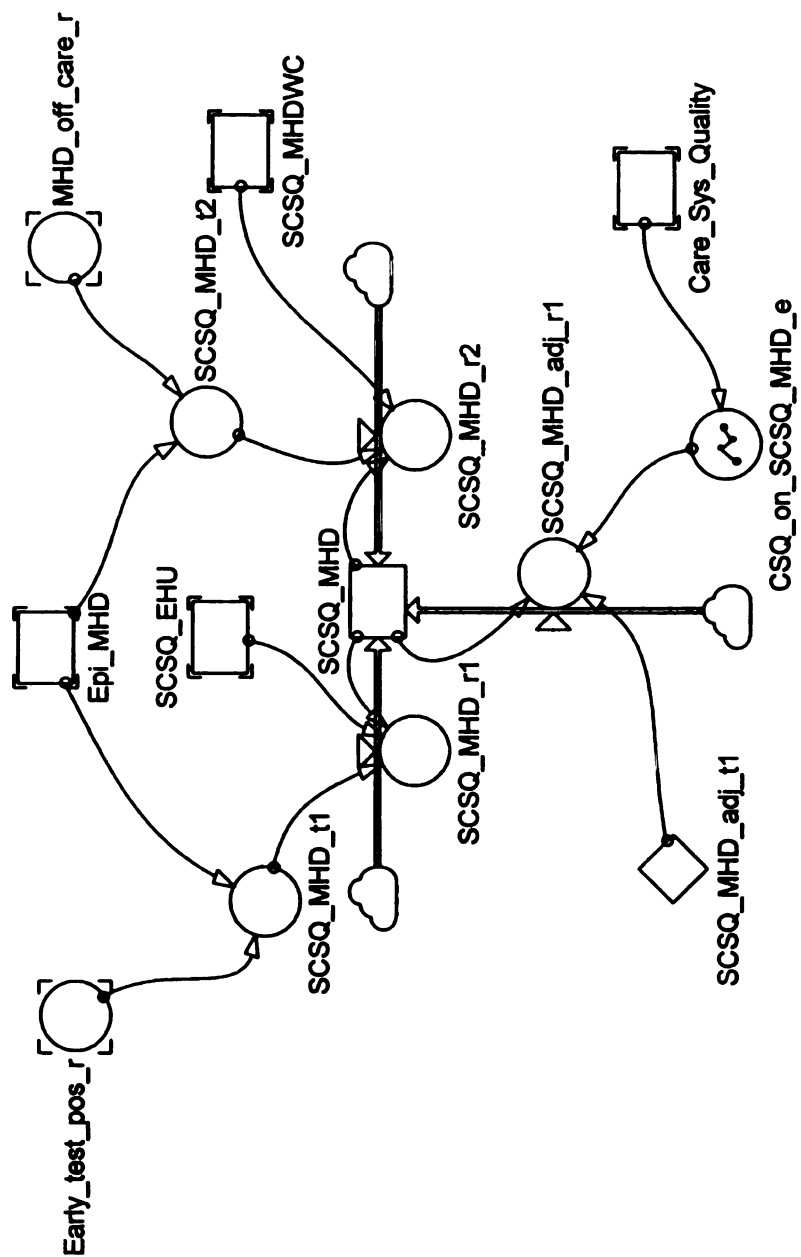


Figure G.5 - Satisfaction with care system quality among mid-stage diagnosed persons [Construct G]

Satisfaction with Care System Quality [Construct G]

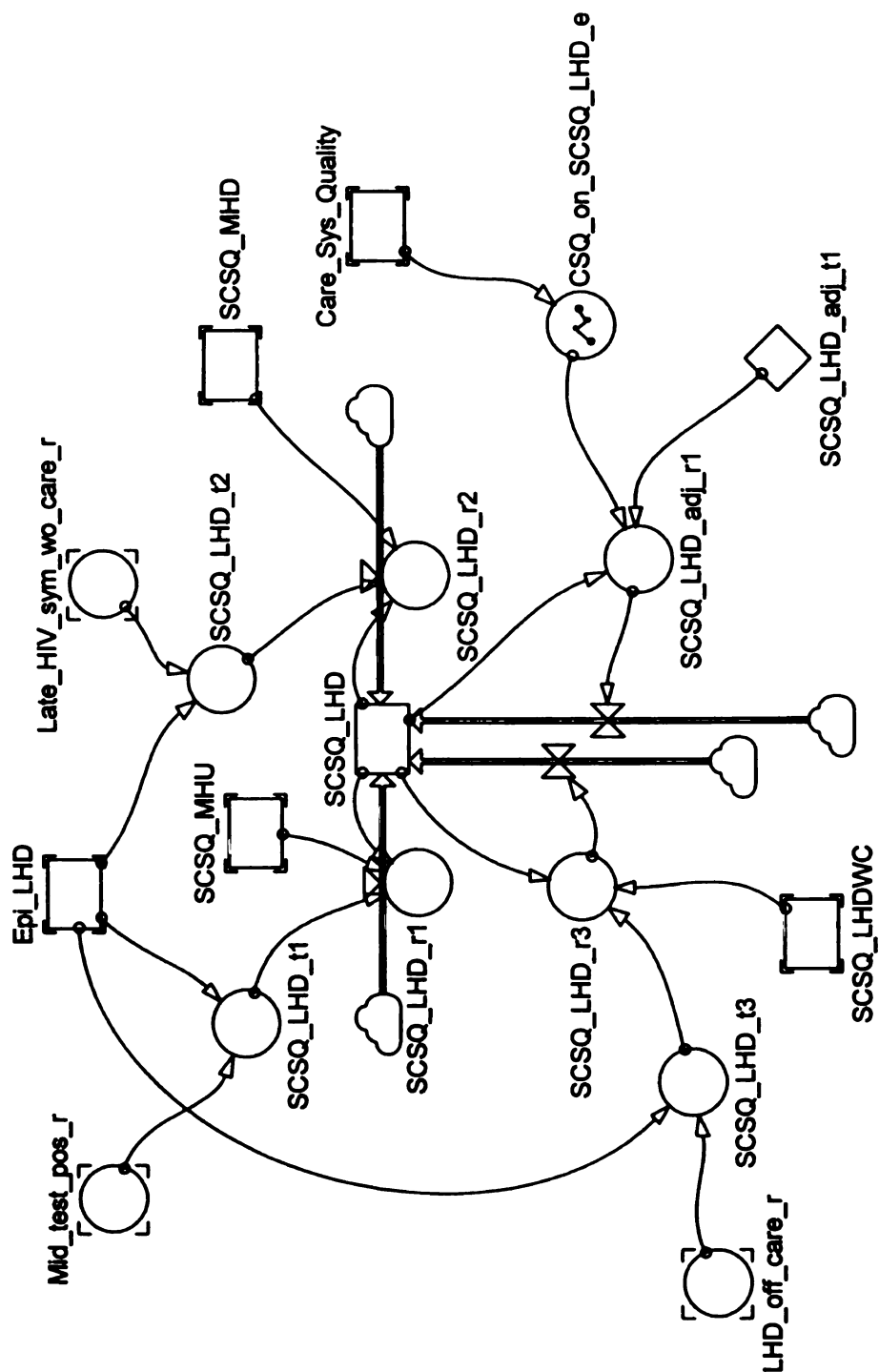


Figure G.6 - Satisfaction with care system quality among late stage diagnosed persons [Construct G]

APPENDIX G (continued)

Satisfaction with Care System Quality [Construct G]

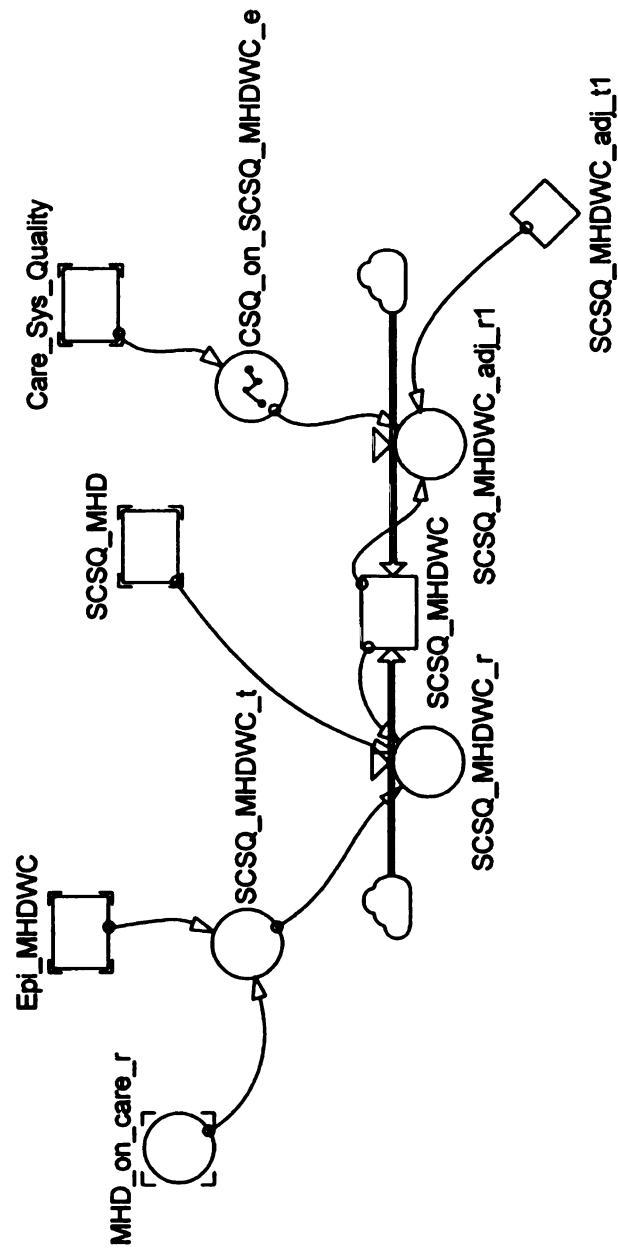


Figure G.7 - Satisfaction with care system quality among mid-stage persons with care [Construct G]

APPENDIX G (continued)

Satisfaction with Care System Quality [Construct G]

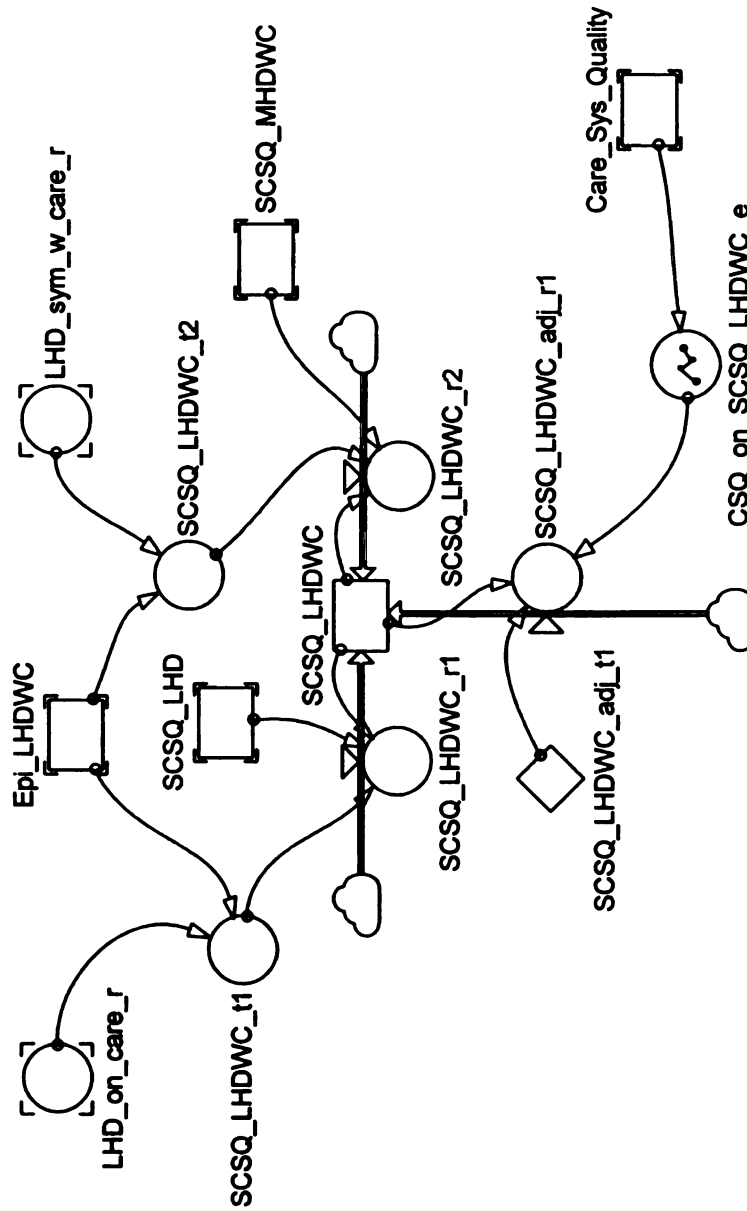


Figure G.8 - Satisfaction with care system quality among late state persons with care [Construct G]

APPENDIX G (continued)

Satisfaction with Care System Quality [Construct G]

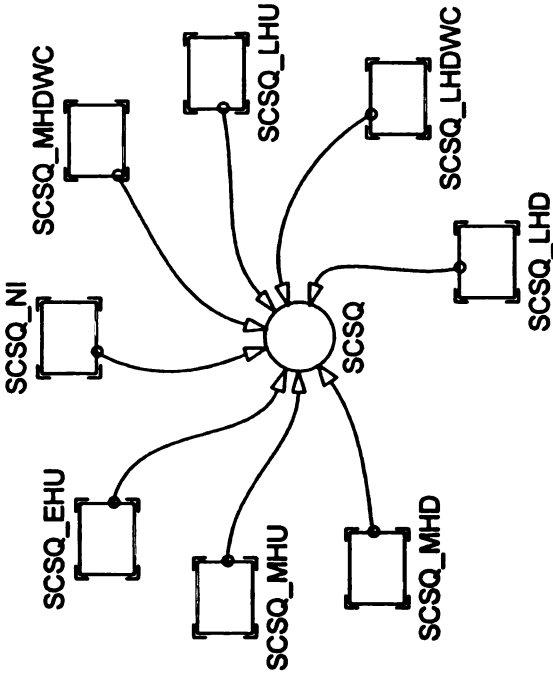


Figure G.9 - Aggregate satisfaction with care system quality [Construct G]

APPENDIX G (continued)

Satisfaction with Prevention System Quality [Construct H]

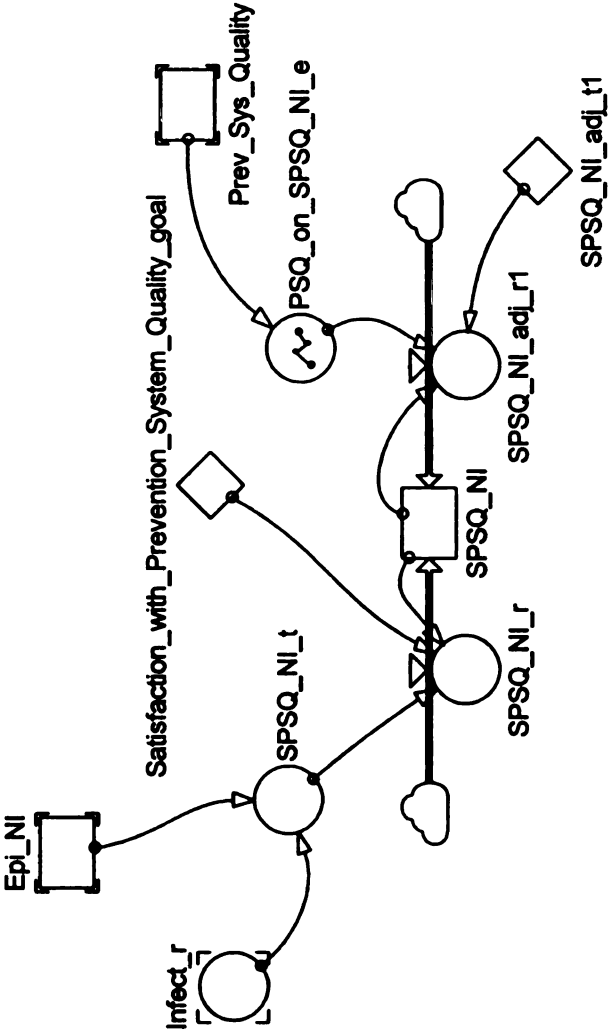


Figure G.10 - Satisfaction with prevention system quality among newly infected persons [Construct H]

APPENDIX G (continued)

Satisfaction with Prevention System Quality [Construct H]

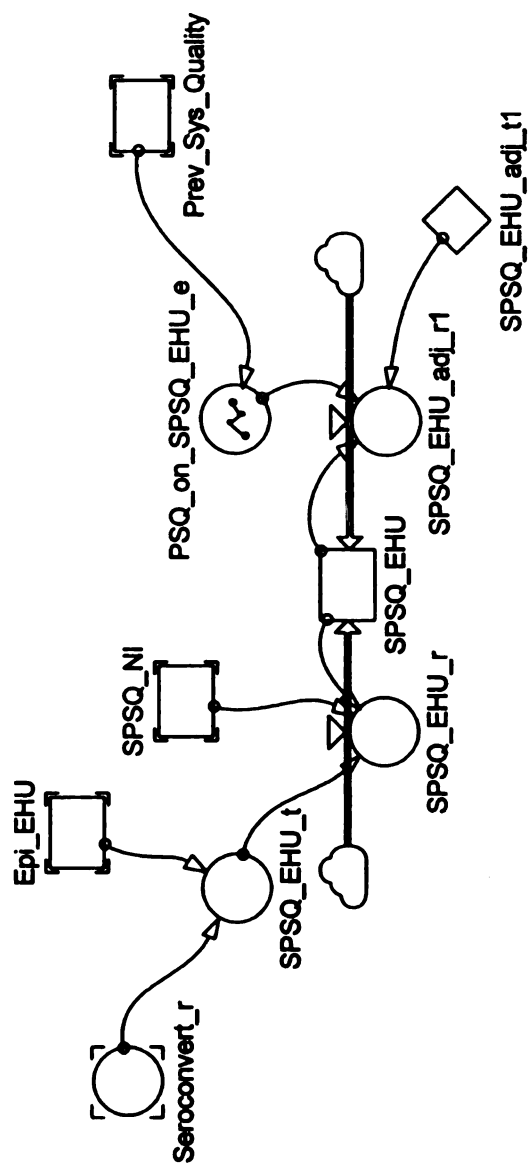


Figure G.11 - Satisfaction with prevention system quality among early stage undiagnosed persons [Construct H]

APPENDIX G (continued)

Satisfaction with Prevention System Quality [Construct H]

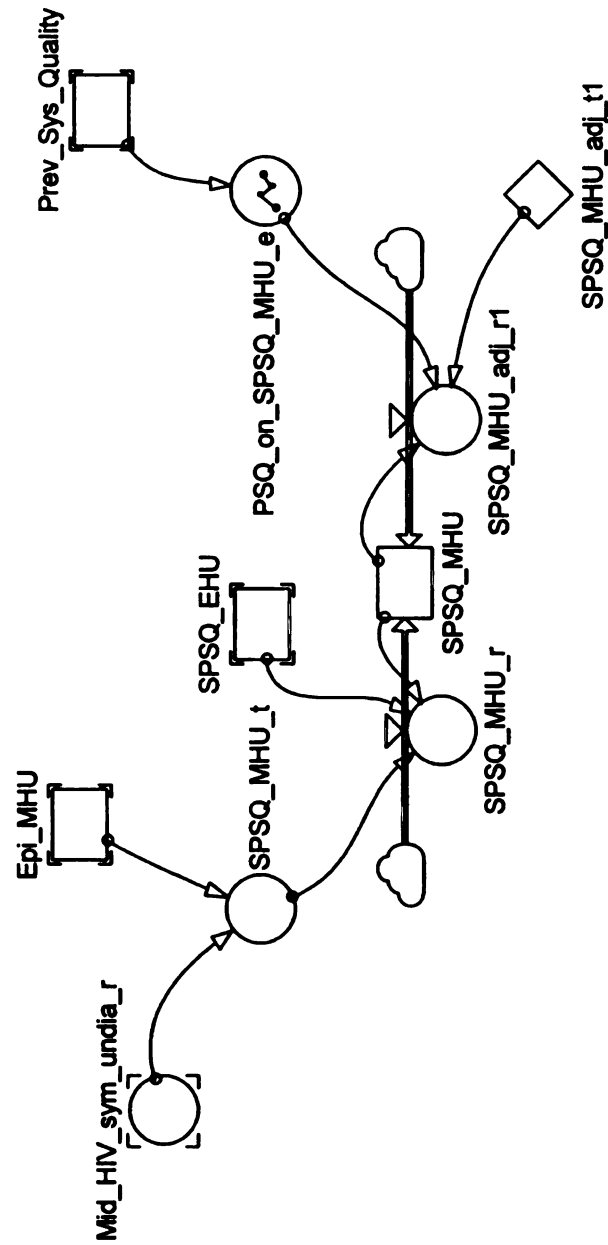


Figure G.12 - Satisfaction with prevention system quality among mid-stage undiagnosed persons [Construct H]

APPENDIX G (continued)

Satisfaction with Prevention System Quality [Construct H]

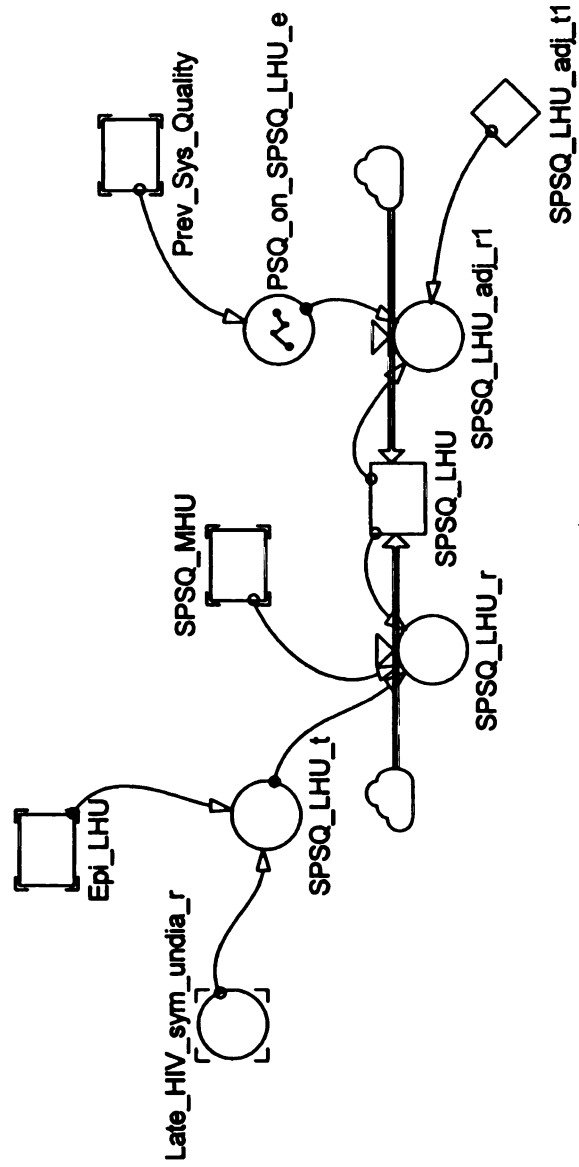


Figure G.13 - Satisfaction with prevention system quality among late stage undiagnosed persons [Construct H]

APPENDIX G (continued)

Satisfaction with Prevention System Quality [Construct H]

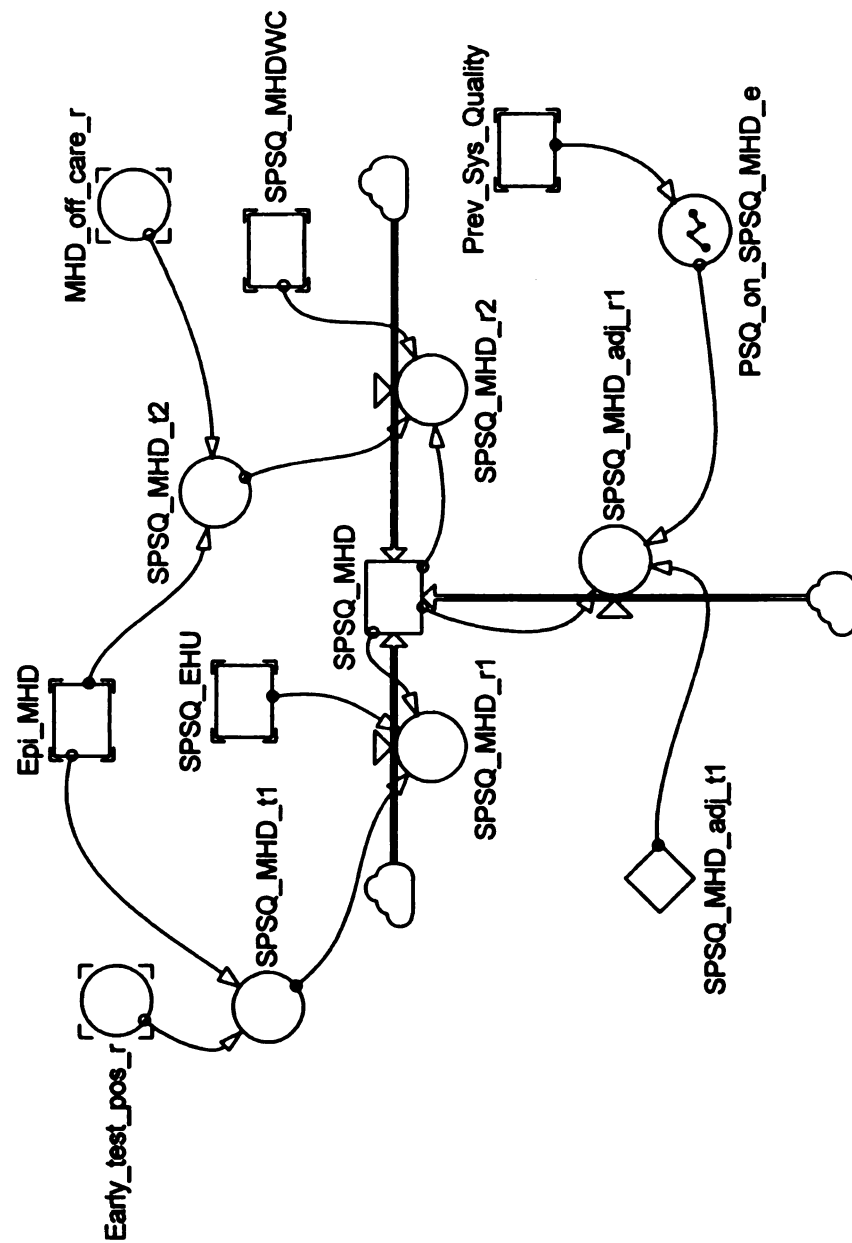


Figure G.14 - Satisfaction with prevention system quality among mid-stage diagnosed persons [Construct H]

APPENDIX G (continued)

Satisfaction with Prevention System Quality [Construct H]

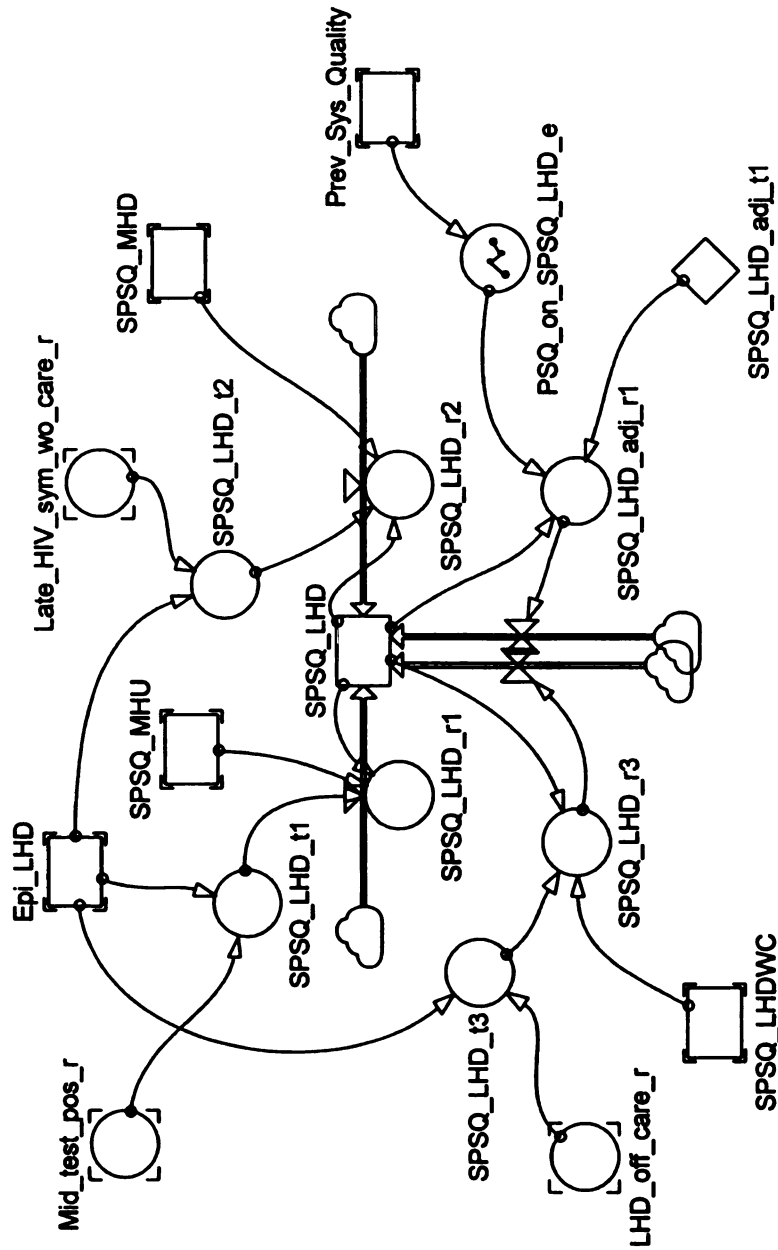


Figure G.15 - Satisfaction with prevention system quality among late stage diagnosed persons [Construct H]

Satisfaction with Prevention System Quality [Construct H]

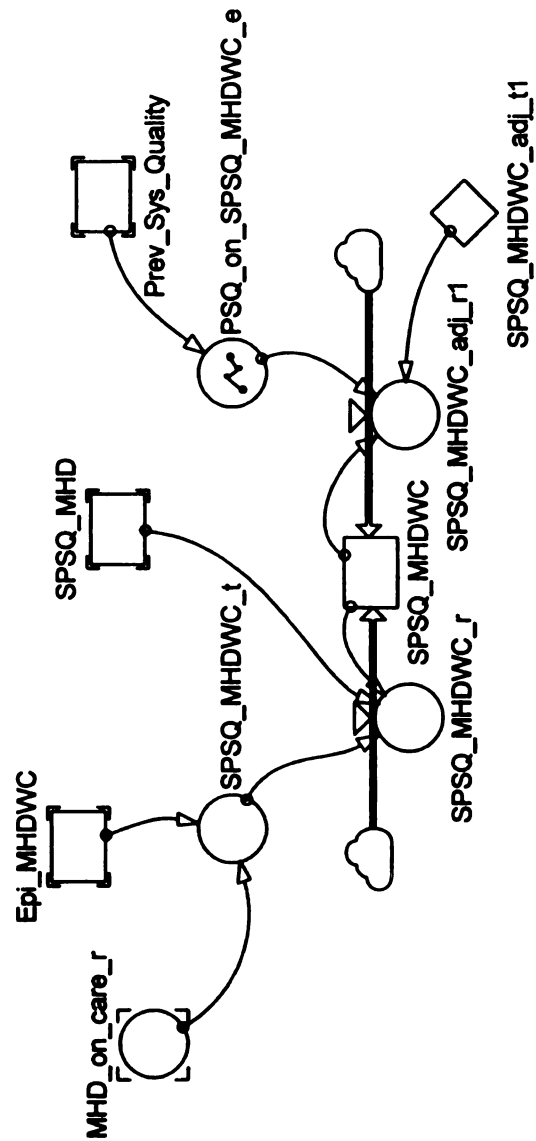


Figure G.16 - Satisfaction with prevention system quality among mid-stage persons with care [Construct H]

APPENDIX G (continued)

Satisfaction with Prevention System Quality [Construct H]

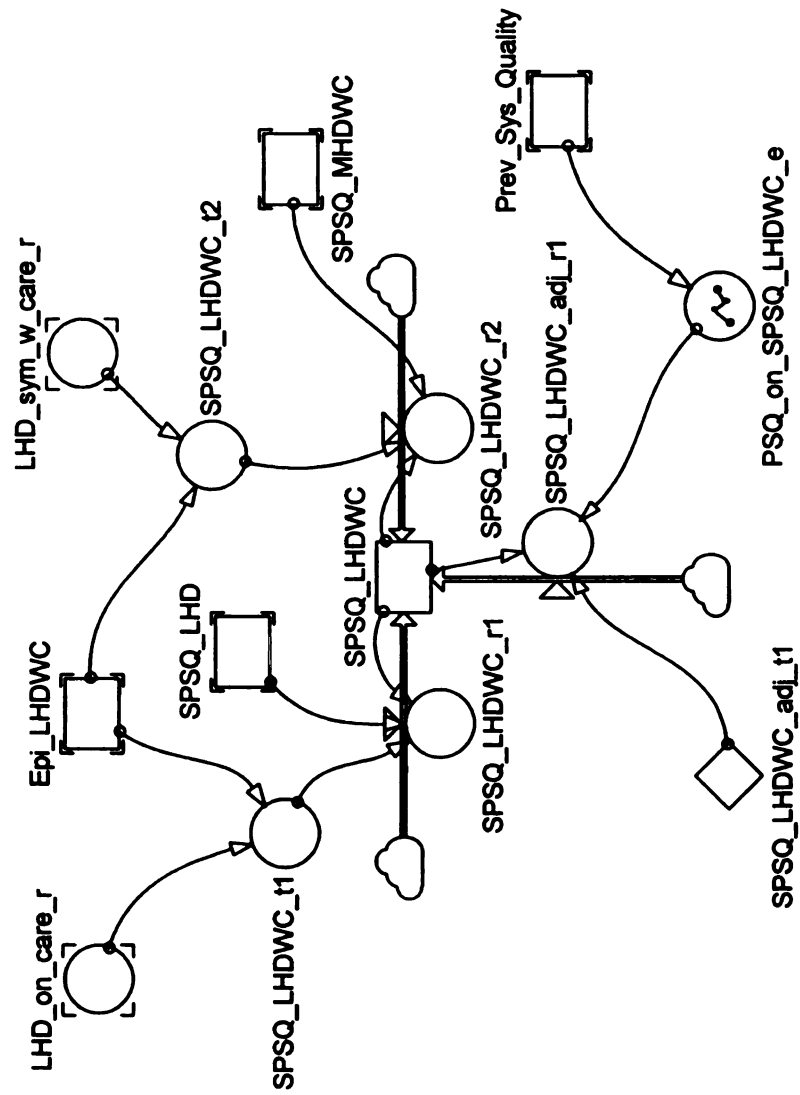


Figure G.17 - Satisfaction with prevention system quality among late state persons with care [Construct H]

APPENDIX G (continued)

Satisfaction with Prevention System Quality [Construct H]

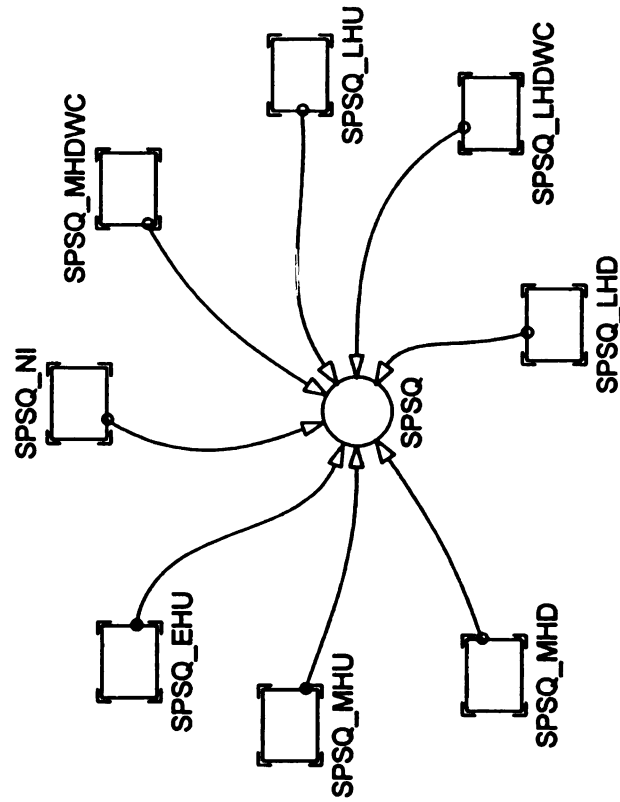


Figure G.18 - Aggregate satisfaction with prevention system quality [Construct H]

Perceived Treatment Efficacy [Construct I]

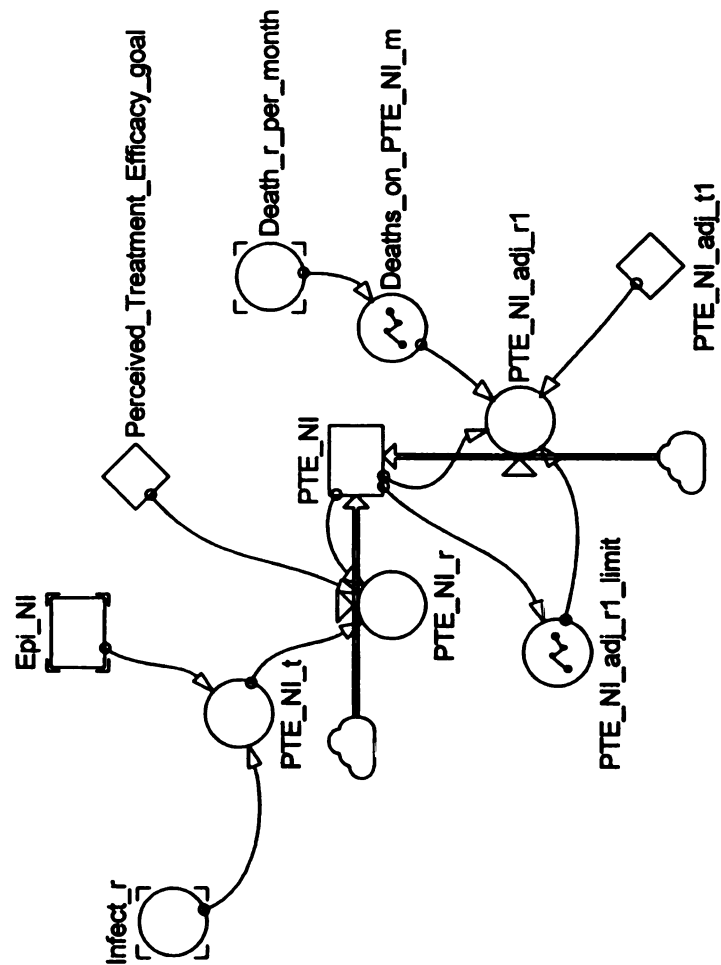


Figure G.19 - Perceived treatment efficacy among newly infected persons [Construct I]

APPENDIX G (continued)

Perceived Treatment Efficacy [Construct I]

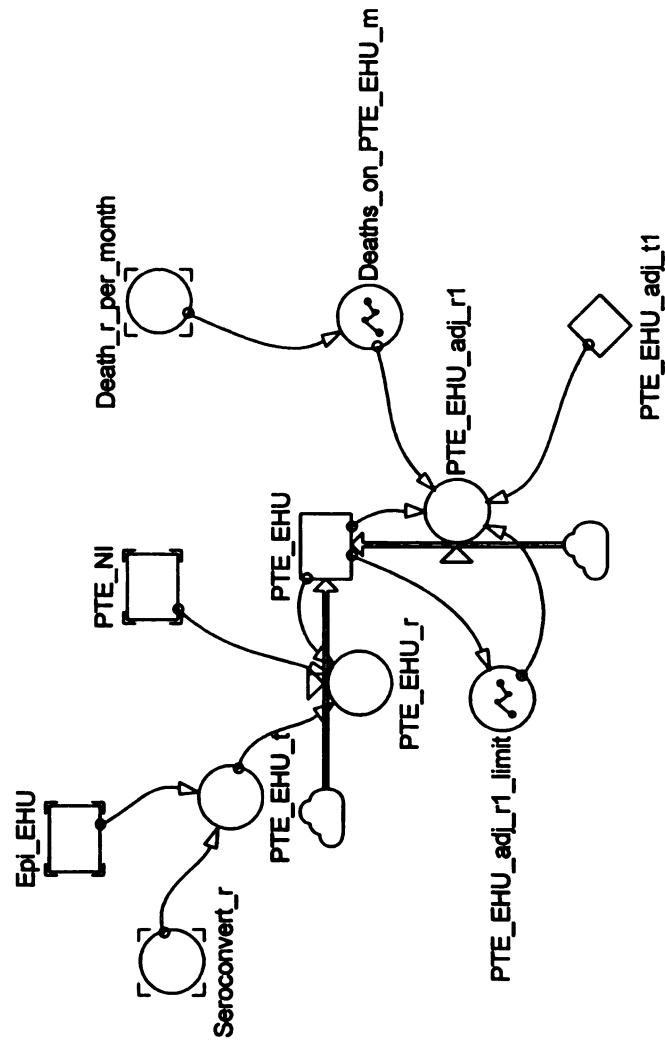


Figure G.20 - Perceived treatment efficacy among early stage undiagnosed persons [Construct I]

Perceived Treatment Efficacy [Construct I]

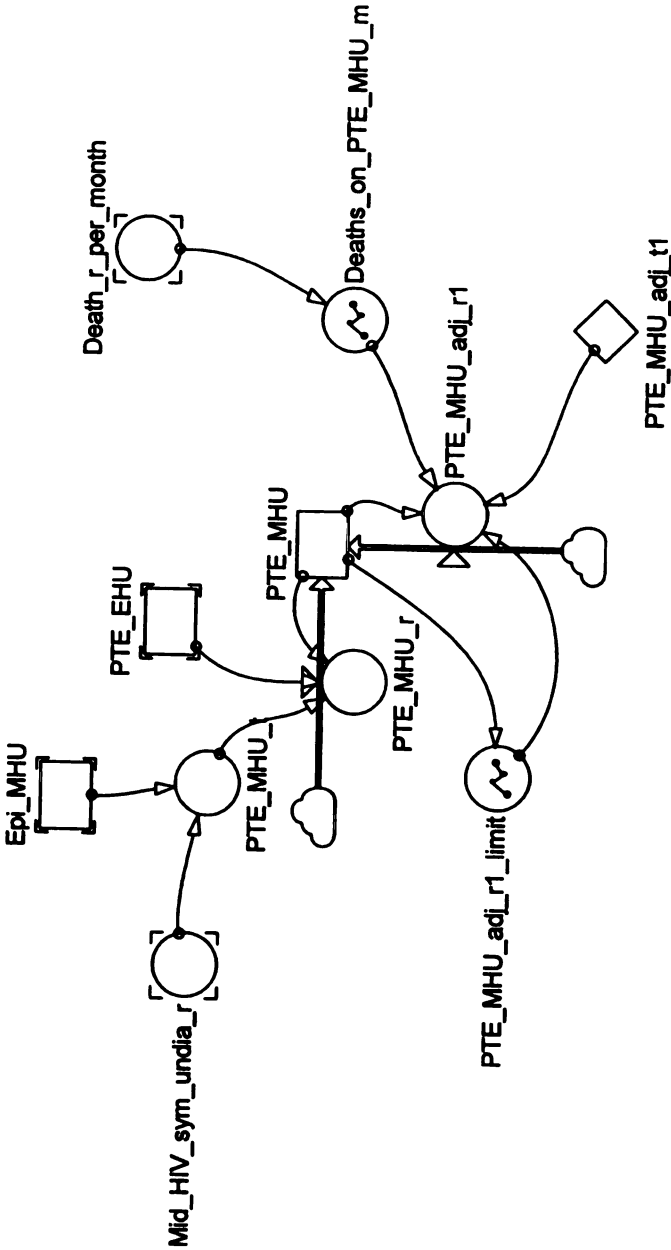


Figure G.21 - Perceived treatment efficacy among mid-stage undiagnosed persons [Construct 1]

APPENDIX G (continued)

Perceived Treatment Efficacy [Construct I]

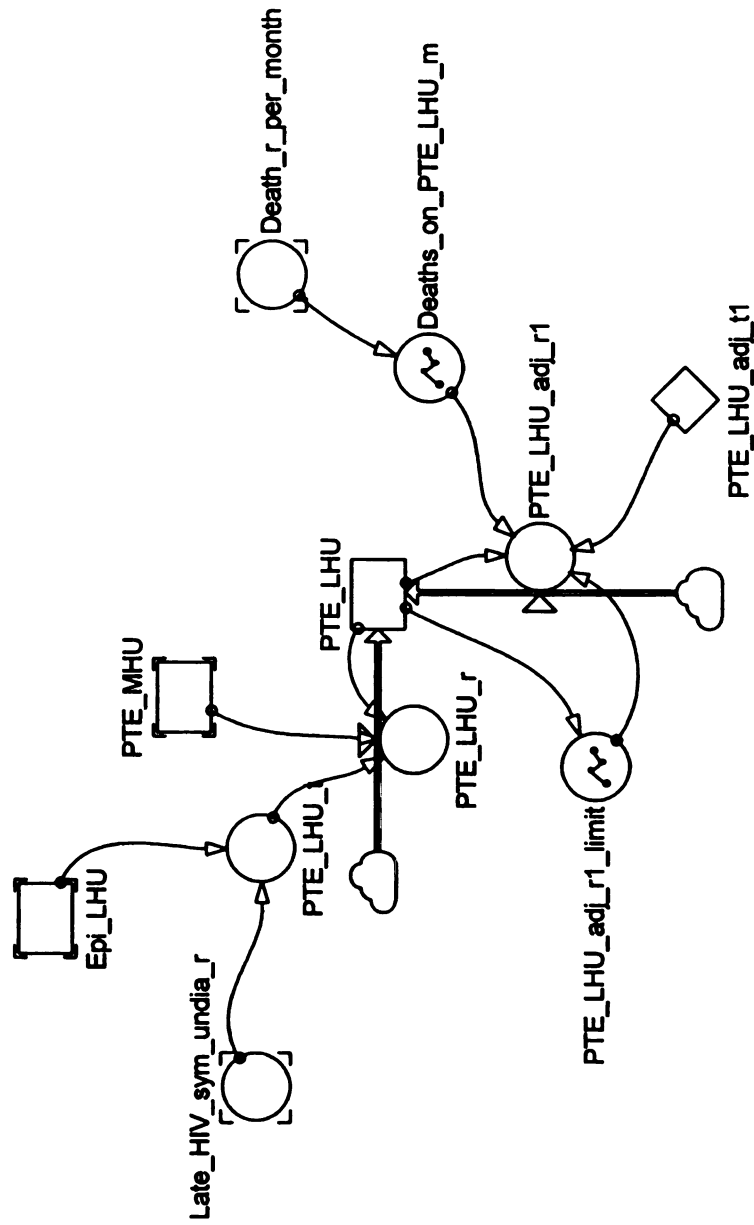


Figure G.22 - Perceived treatment efficacy among late stage undiagnosed persons [Construct I]

APPENDIX G (continued)

Perceived Treatment Efficacy [Construct I]

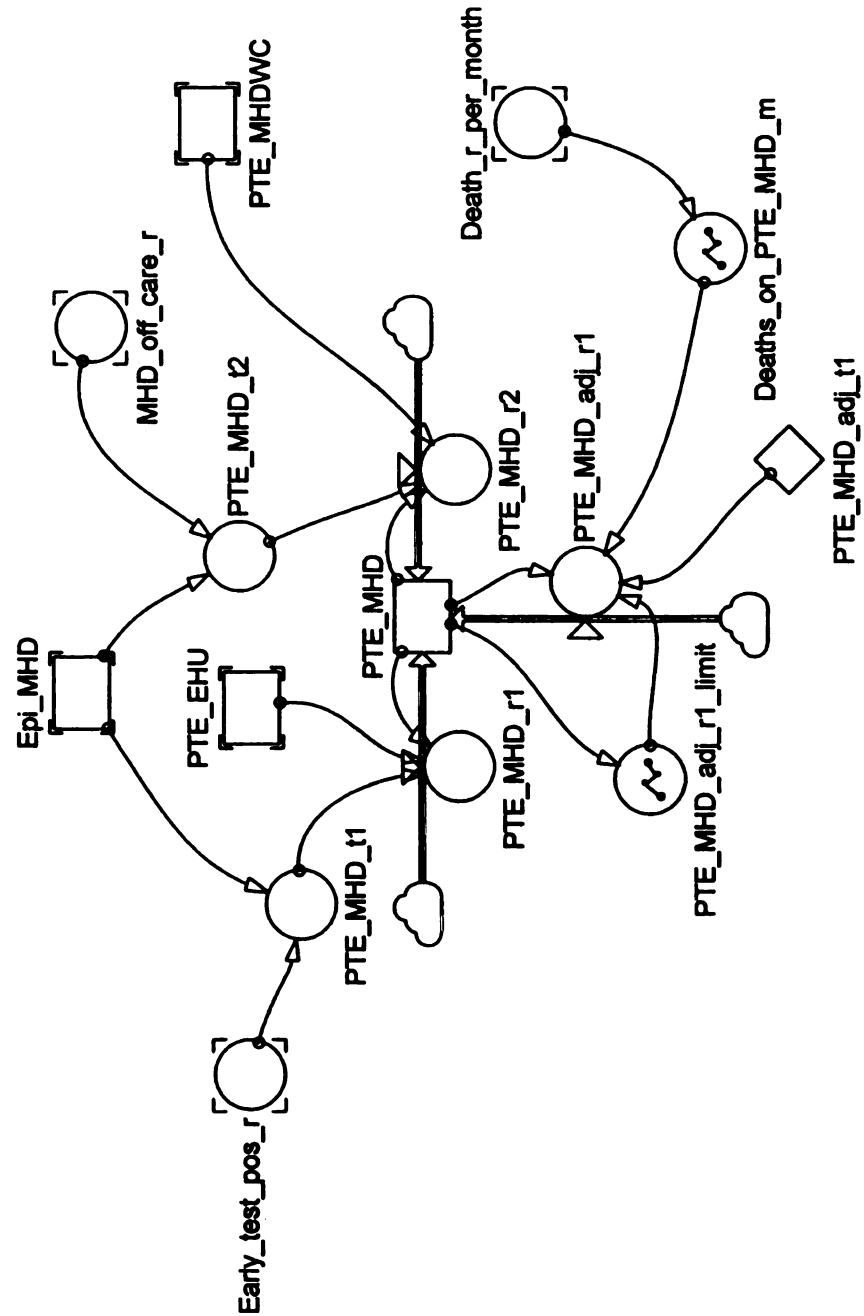


Figure G.23 - Perceived treatment efficacy among mid-stage diagnosed persons [Construct I]

APPENDIX G (continued)

Perceived Treatment Efficacy [Construct I]

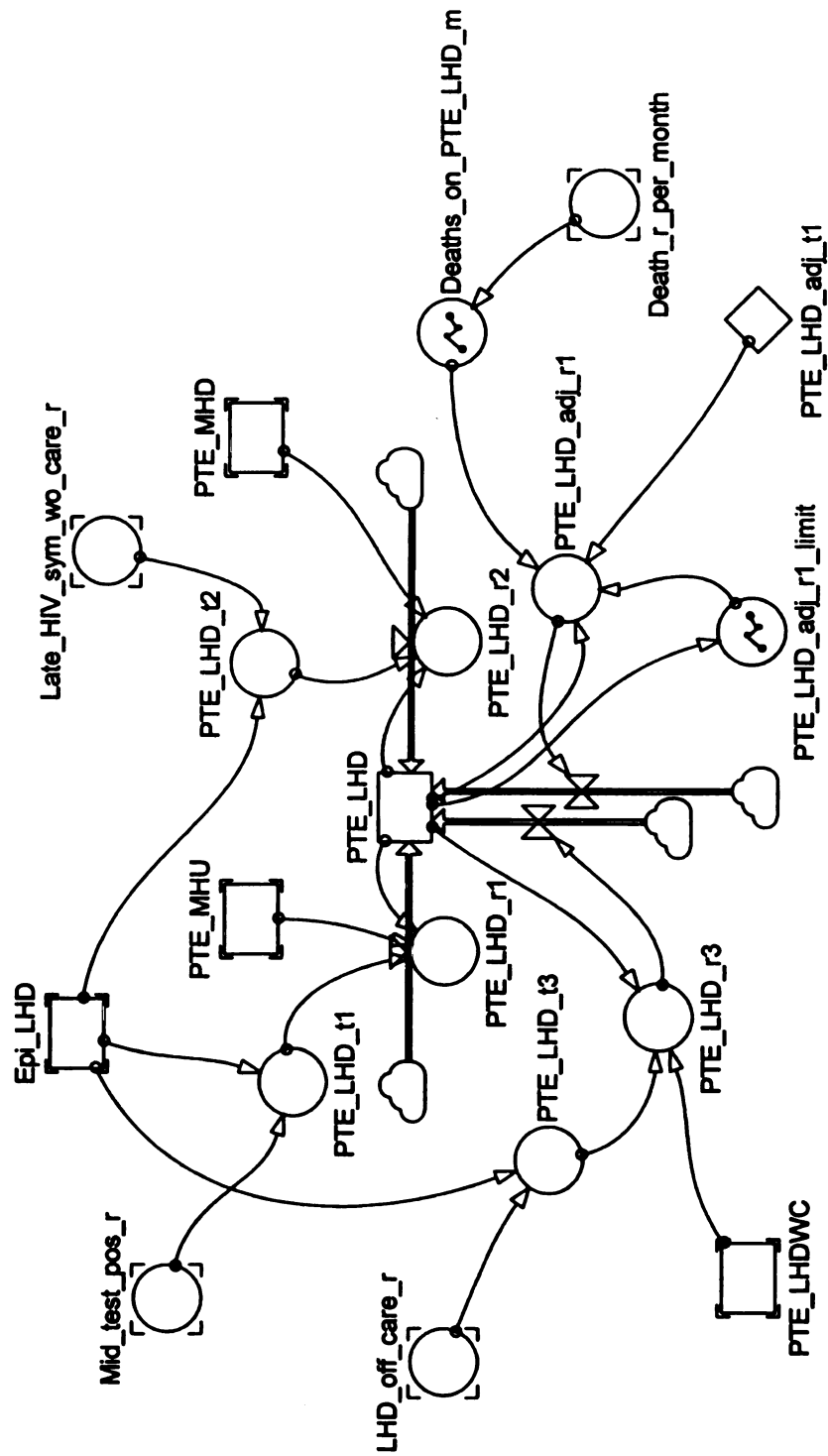


Figure G.24 - Perceived treatment efficacy among late stage diagnosed persons [Construct I]

APPENDIX G (continued)

Perceived Treatment Efficacy [Construct I]

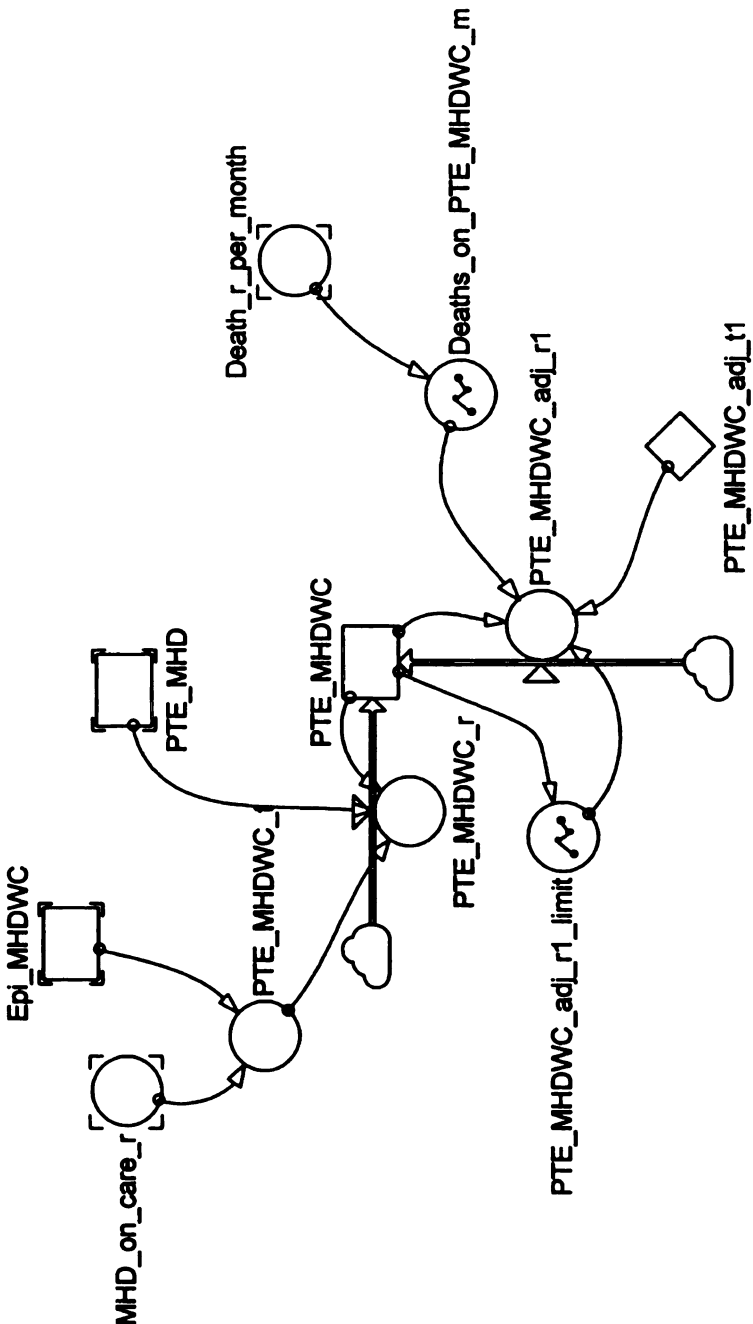


Figure G.25 - Perceived treatment efficacy among mid-stage persons with care [Construct 1]

APPENDIX G (continued)

Perceived Treatment Efficacy [Construct I]

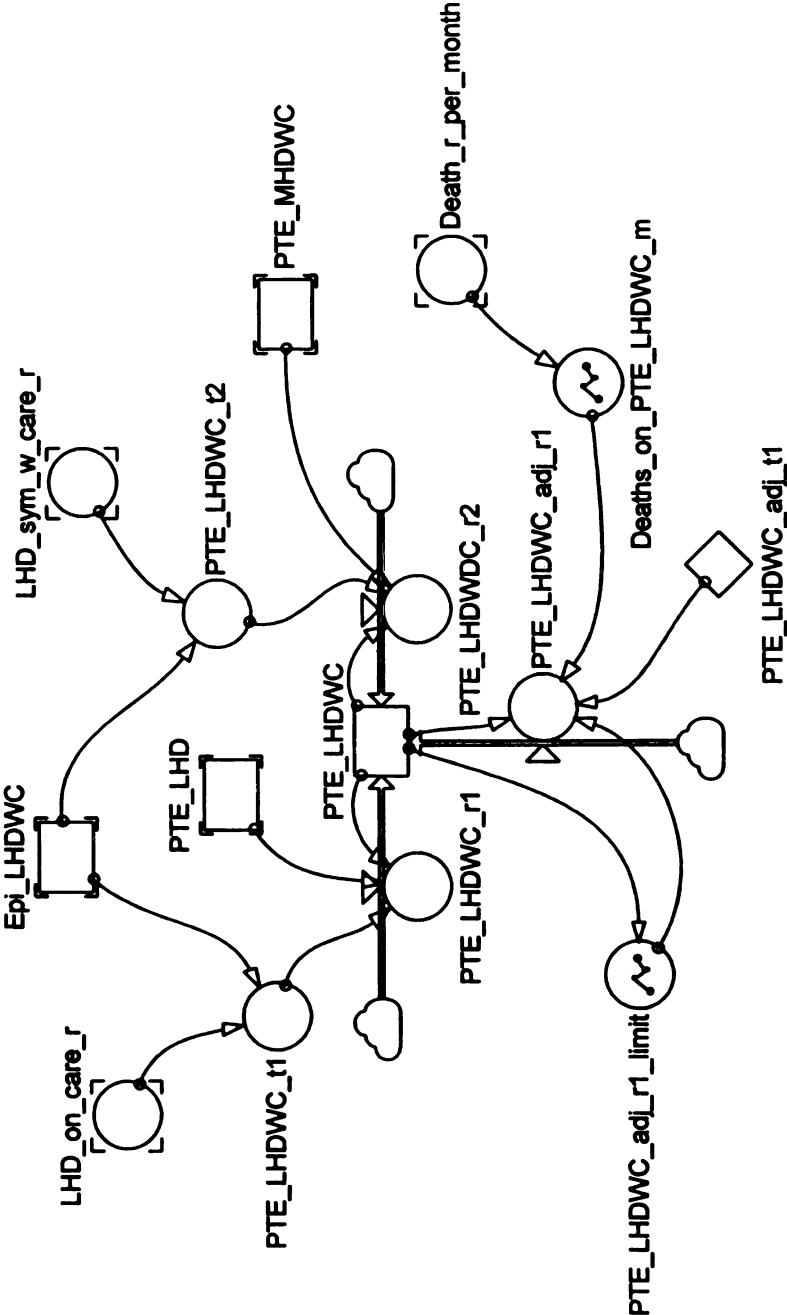


Figure G.26 - Perceived treatment efficacy among late state persons with care [Construct I]

APPENDIX G (continued)

Perceived Treatment Efficacy [Construct I]

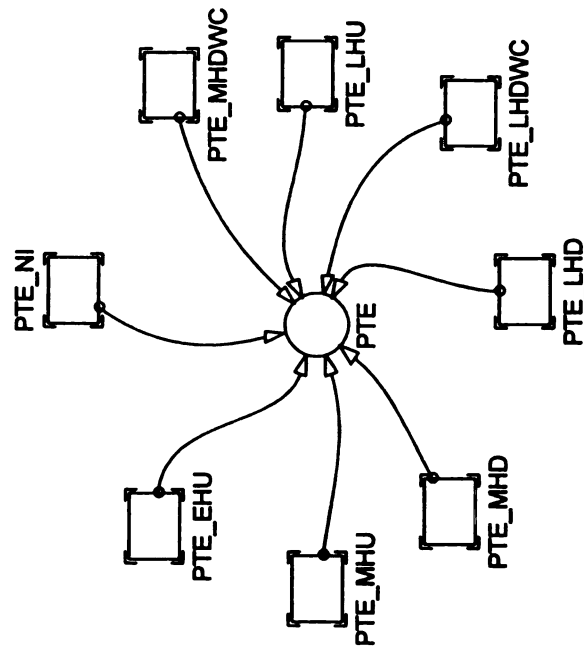


Figure G.27 - Aggregate perceived treatment efficacy [Construct I]

APPENDIX G (continued)

Perceived HIV Stigma [Construct J]

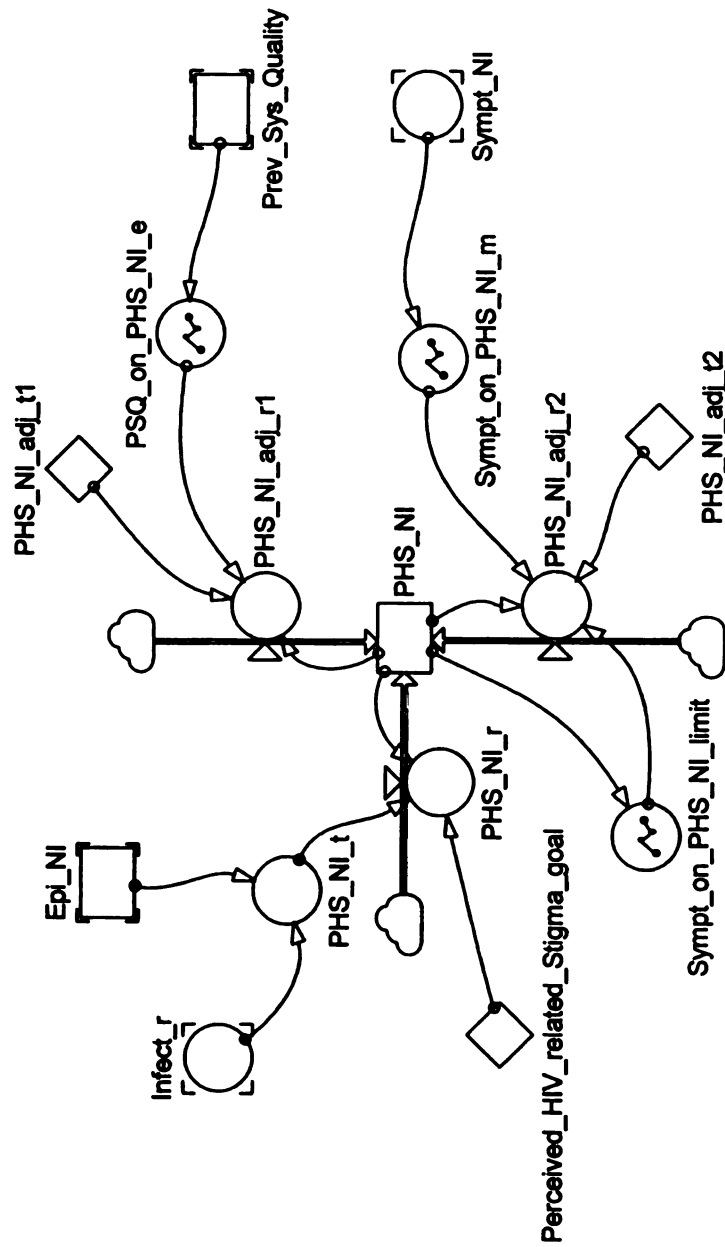


Figure G.28 - Perceived HIV stigma among newly infected persons [Construct J]

APPENDIX G (continued)

Perceived HIV Stigma [Construct J]

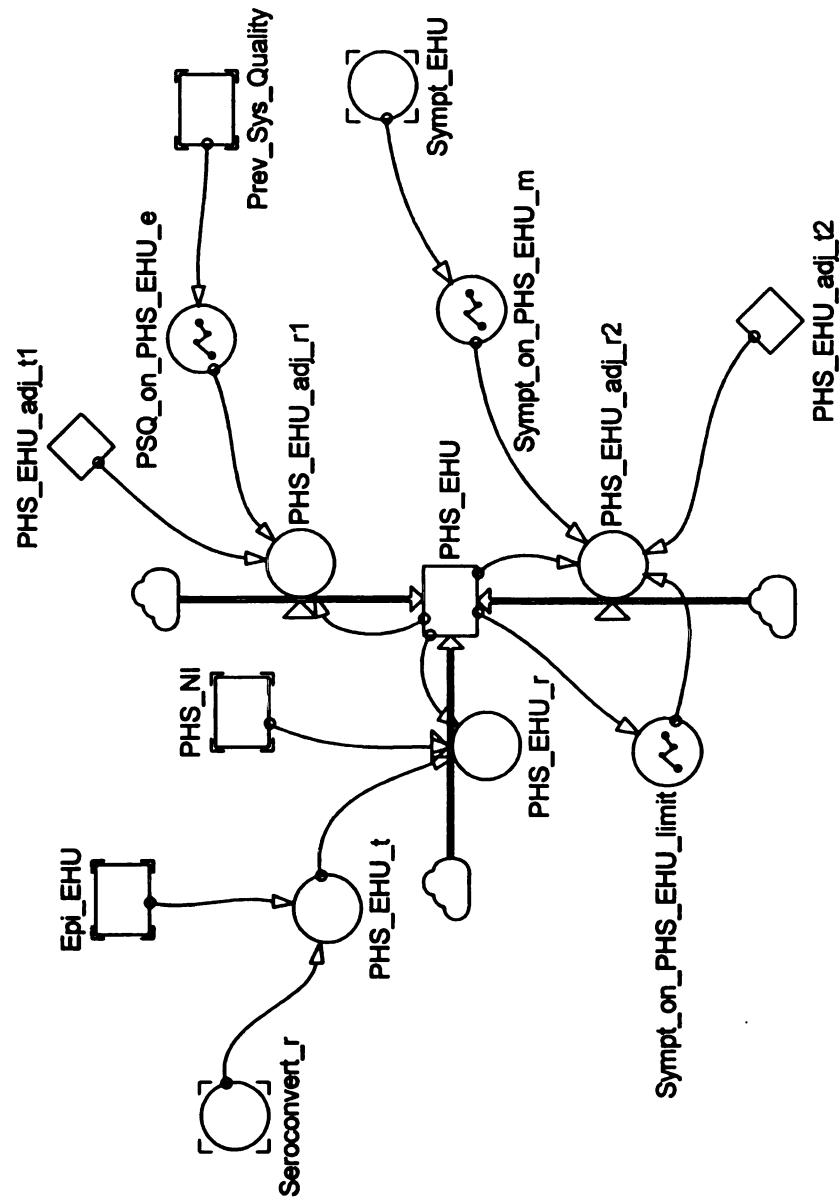


Figure G.29 - Perceived HIV stigma among early stage undiagnosed persons [Construct J]

APPENDIX G (continued)

Perceived HIV Stigma [Construct J]

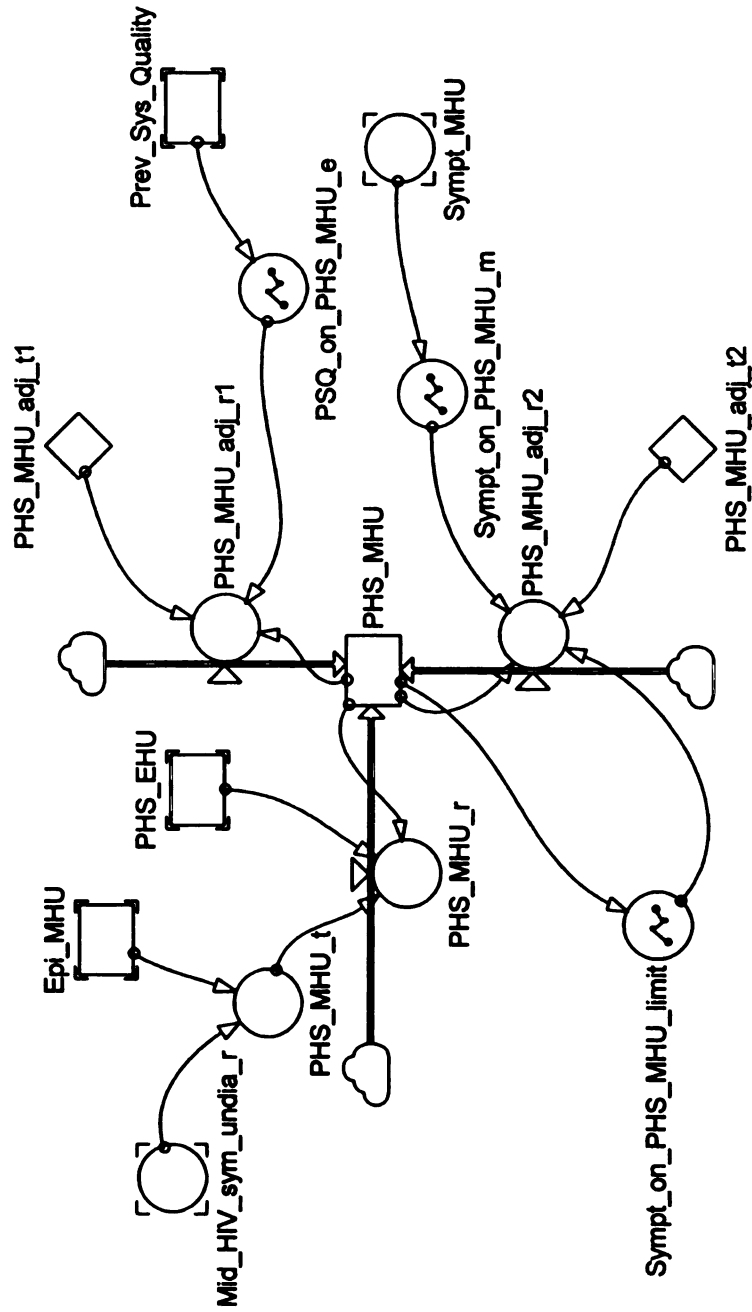


Figure G.30 - Perceived HIV stigma among mid-stage undiagnosed persons [Construct J]

APPENDIX G (continued)

Perceived HIV Stigma [Construct J]

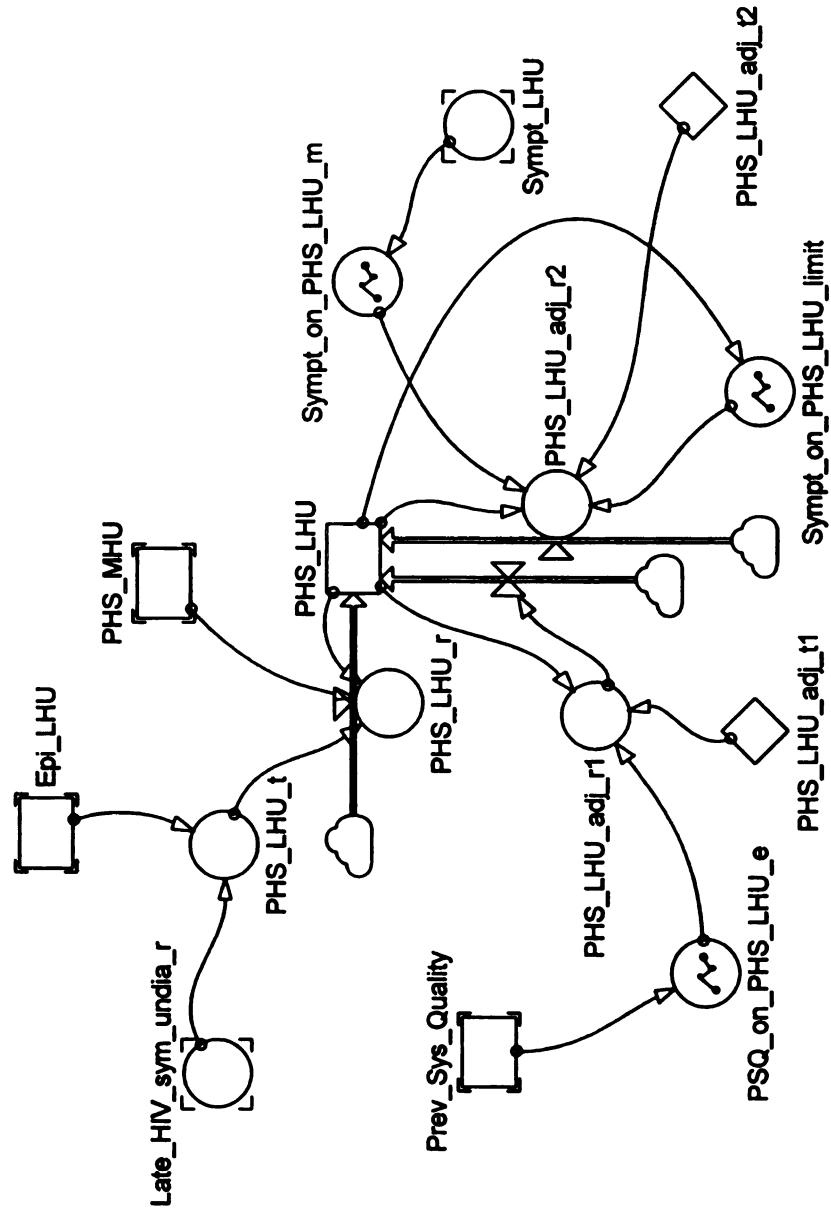


Figure G.31 - Perceived HIV stigma among late stage undiagnosed persons [Construct J]

Perceived HIV Stigma [Construct J]

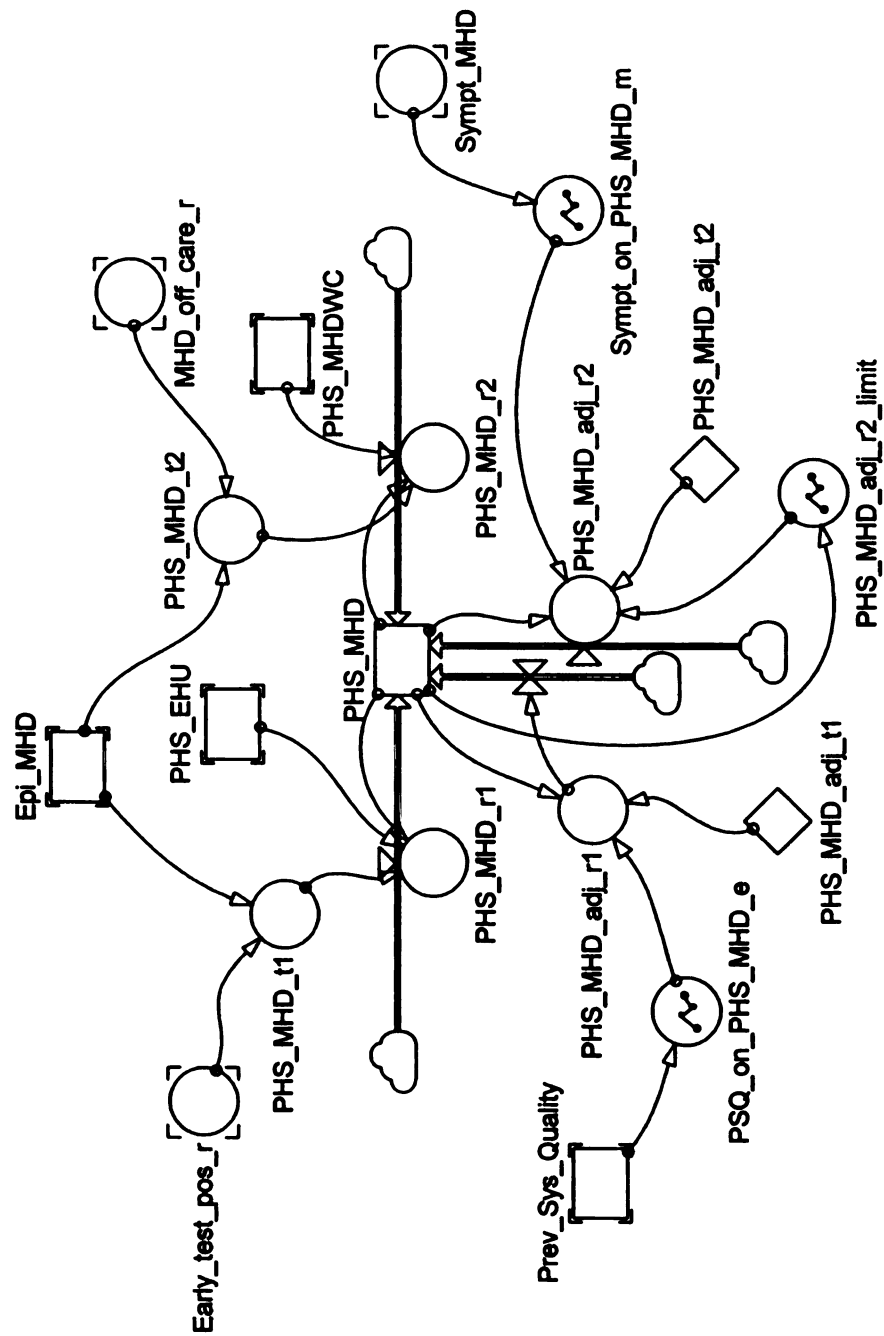


Figure G.32 - Perceived HIV stigma among mid-stage diagnosed persons [Construct J]

Perceived HIV Stigma [Construct J]

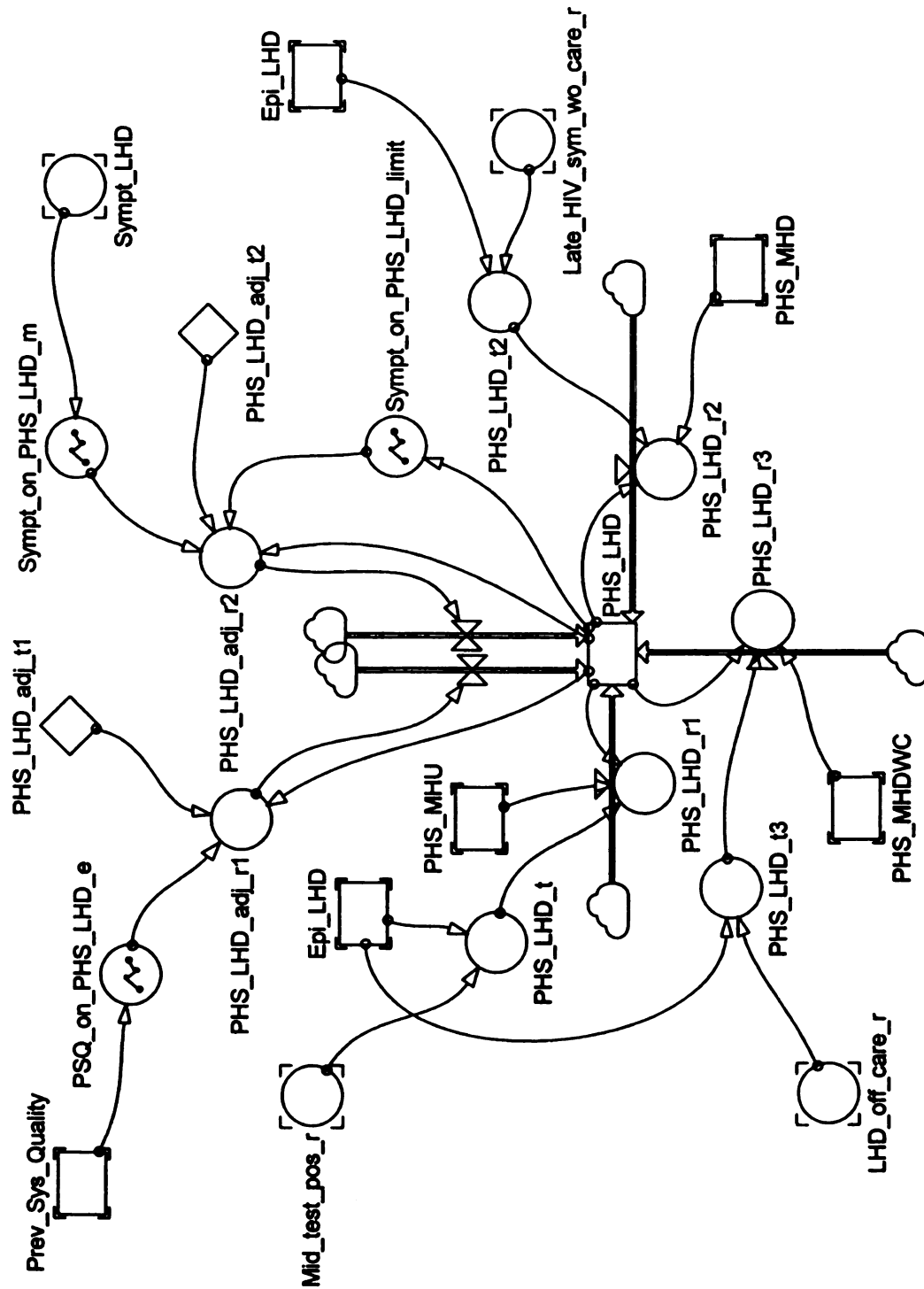


Figure G.33 - Perceived HIV stigma among late stage diagnosed persons [Construct J]

APPENDIX G (continued)

Perceived HIV Stigma [Construct J]

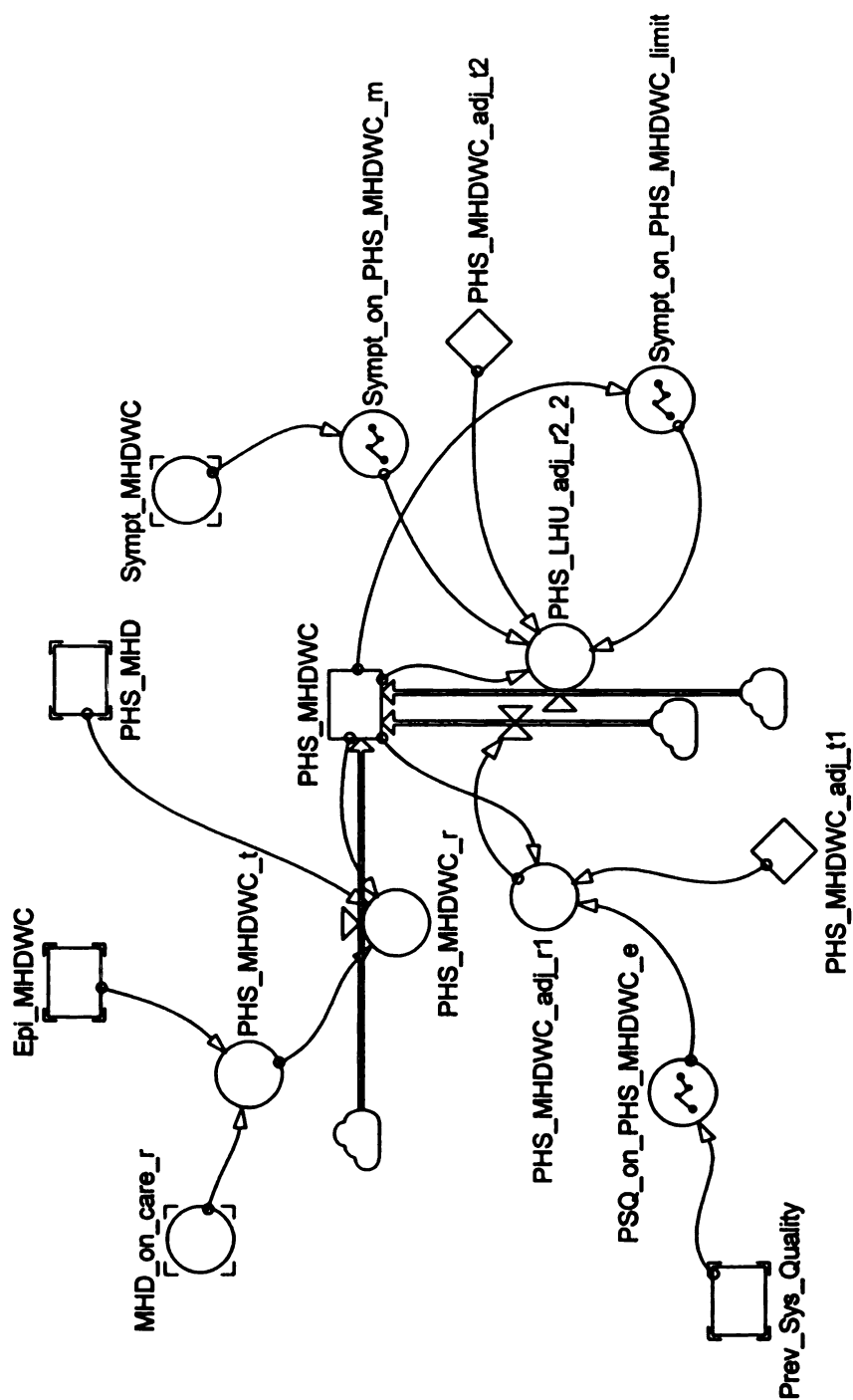


Figure G.34 - Perceived HIV stigma among mid-stage persons with care [Construct J]

APPENDIX G (continued)

Perceived HIV Stigma [Construct J]

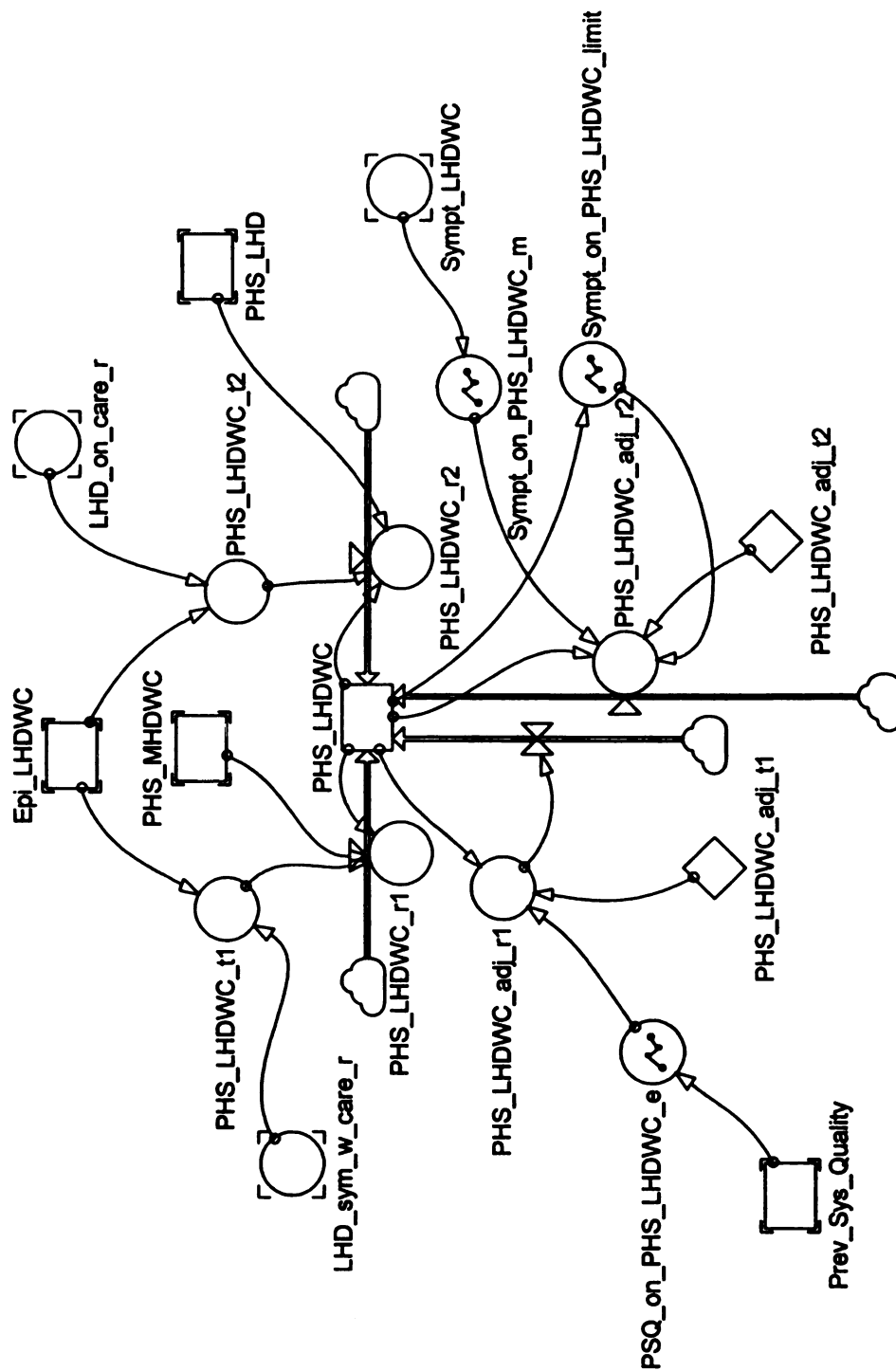


Figure G.35 - Perceived HIV stigma among late state persons with care [Construct J]

APPENDIX G (continued)

Perceived HIV Stigma [Construct J]

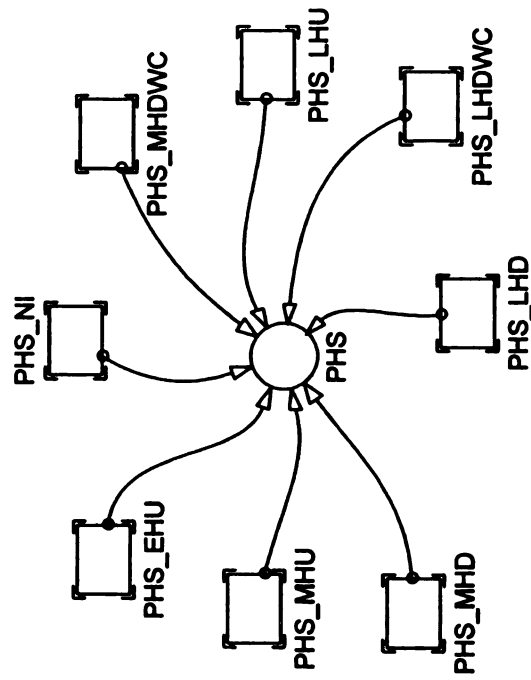


Figure G.36 - Aggregate perceived HIV stigma [Construct J]

APPENDIX G (continued)

Self-concept (Empowerment) [Construct K]

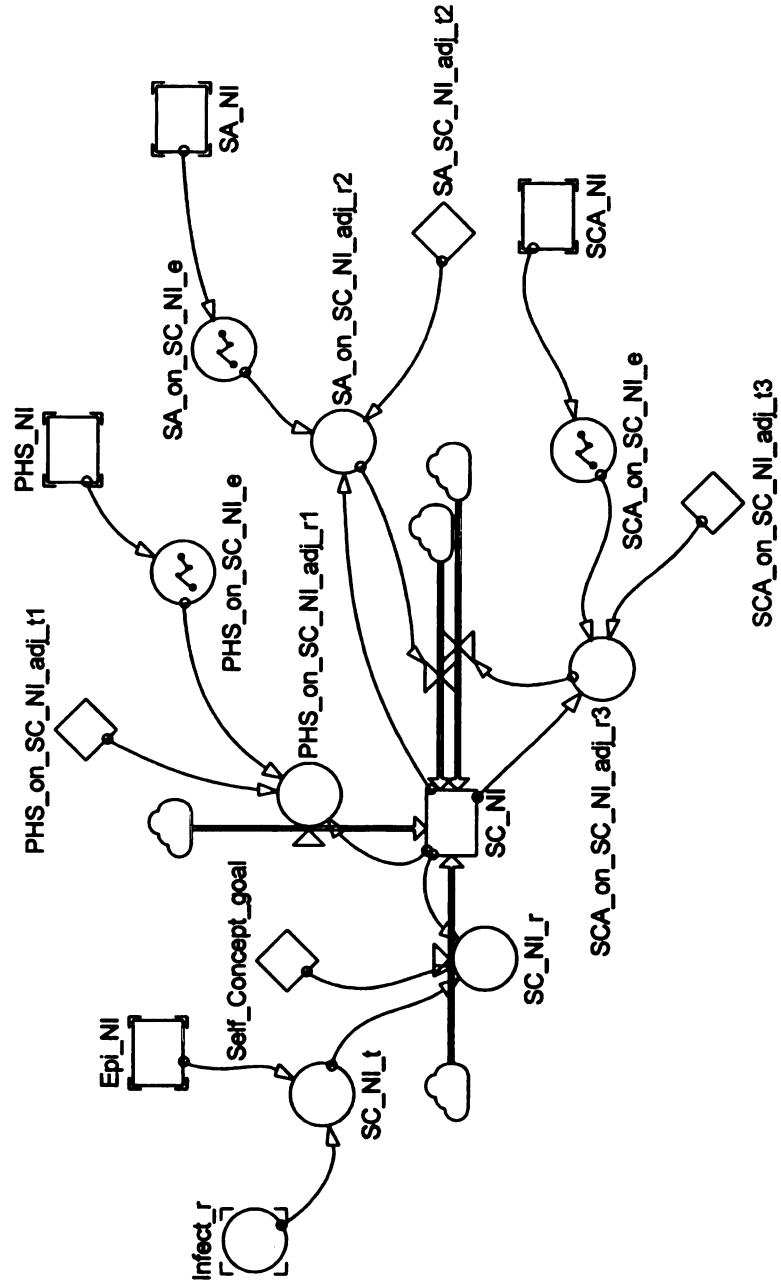


Figure G.37 - Self-concept among newly infected persons [Construct K]

APPENDIX G (continued)

Self-concept (Empowerment) [Construct K]

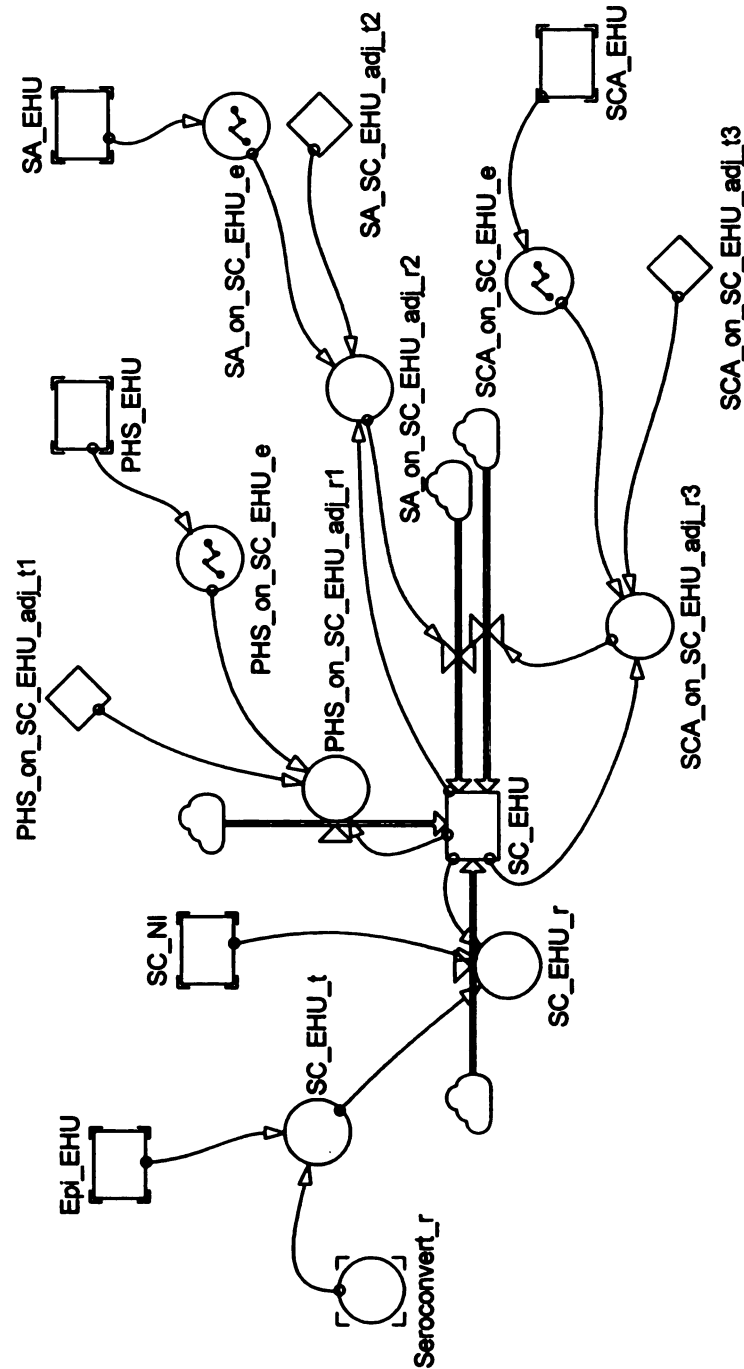
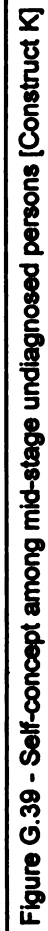


Figure G.38 - Self-concept among early stage undiagnosed persons [Construct K]

Self-concept (Empowerment) [Construct K]



Self-concept (Empowerment) [Construct K]

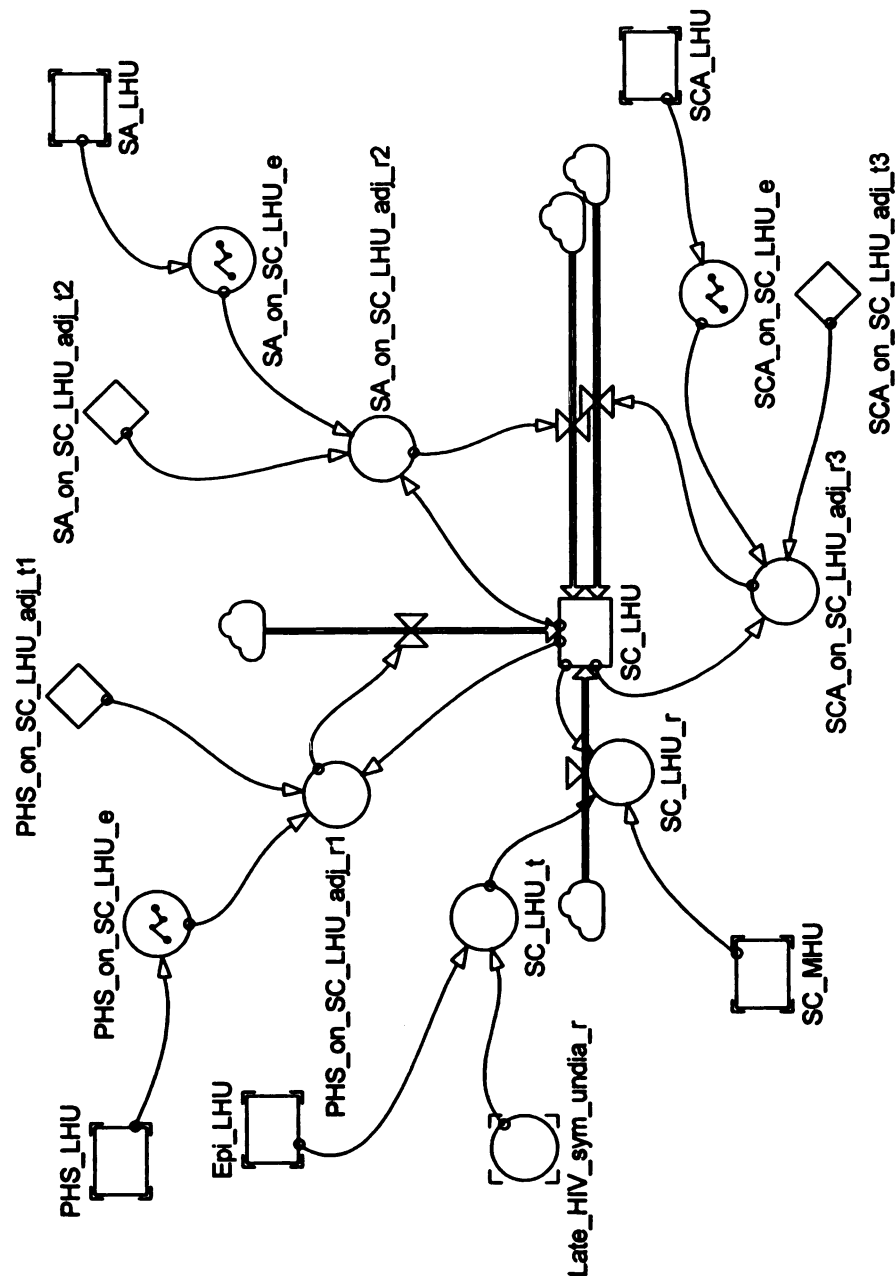


Figure G.40 - Self-concept among late stage undiagnosed persons [Construct K]

APPENDIX G (continued)

Self-concept (Empowerment) [Construct K]

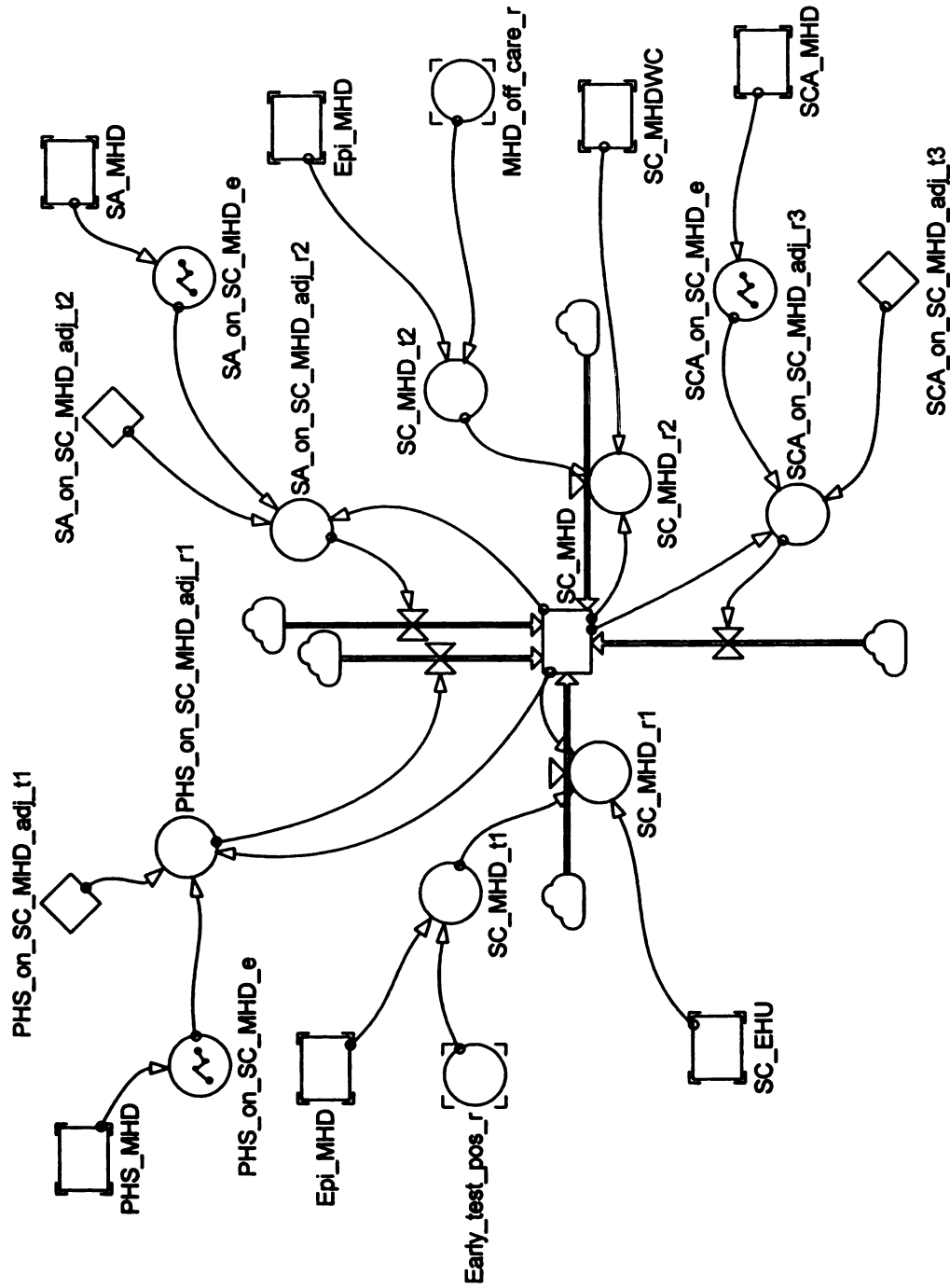


Figure G.41 - Self-concept among mid-stage diagnosed persons [Construct K]

APPENDIX G (continued)

Self-concept (Empowerment) [Construct K]

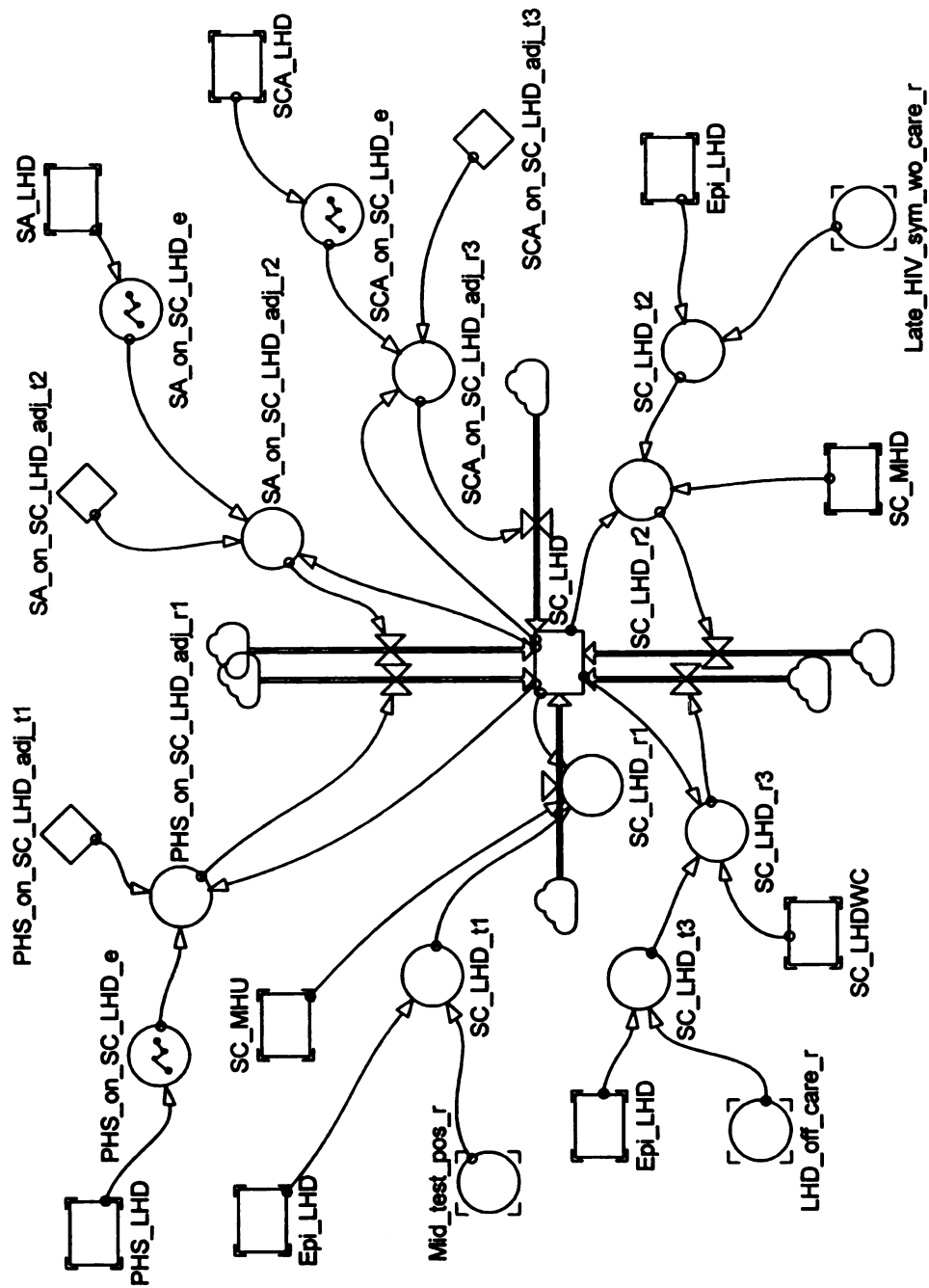


Figure G.42 - Self-concept among late stage diagnosed persons [Construct K]

APPENDIX G (continued)

Self-concept (Empowerment) [Construct K]

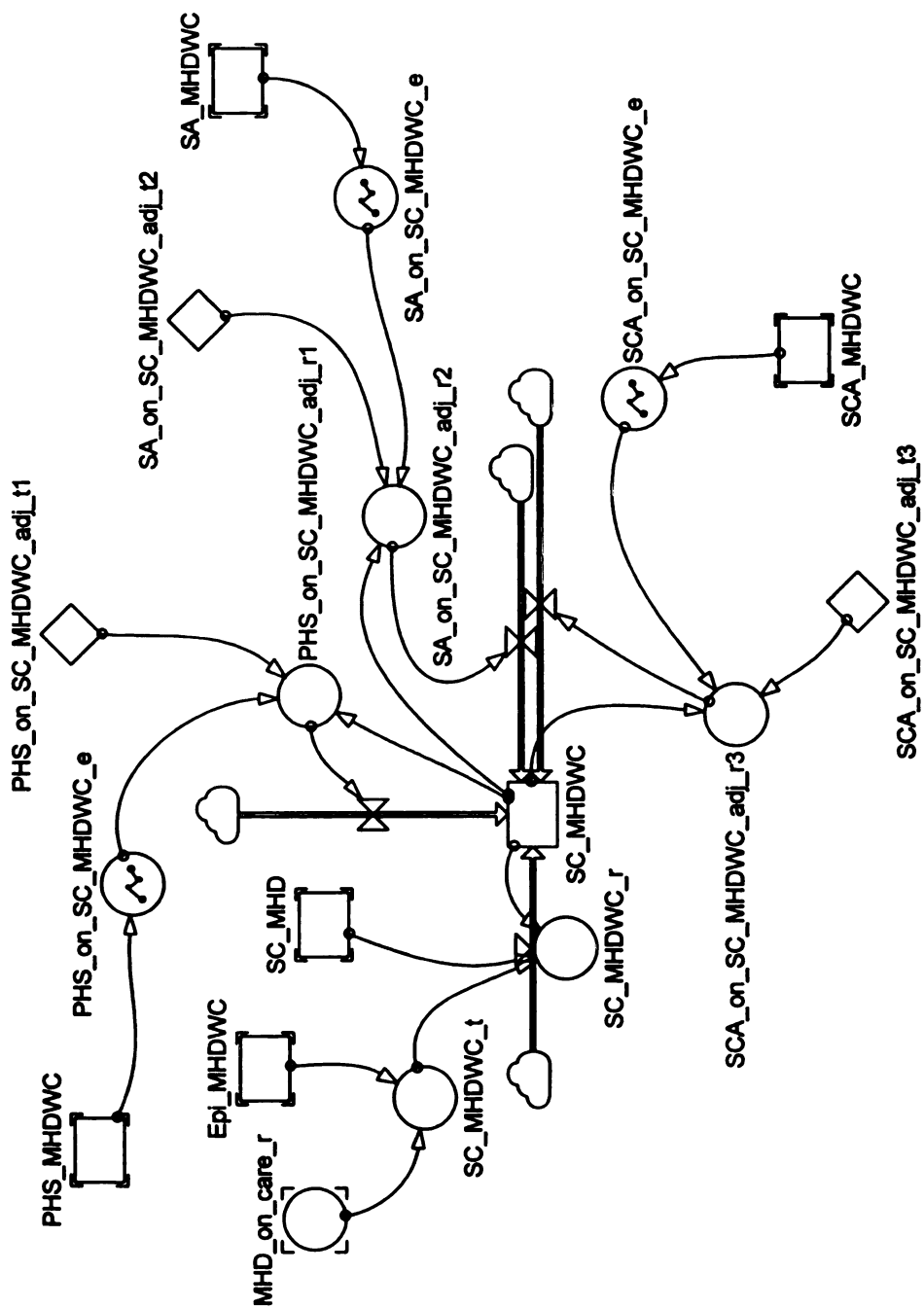


Figure G.43 - Self-concept among mid-stage persons with care [Construct K]

APPENDIX G (continued)

Self-concept (Empowerment) [Construct K]

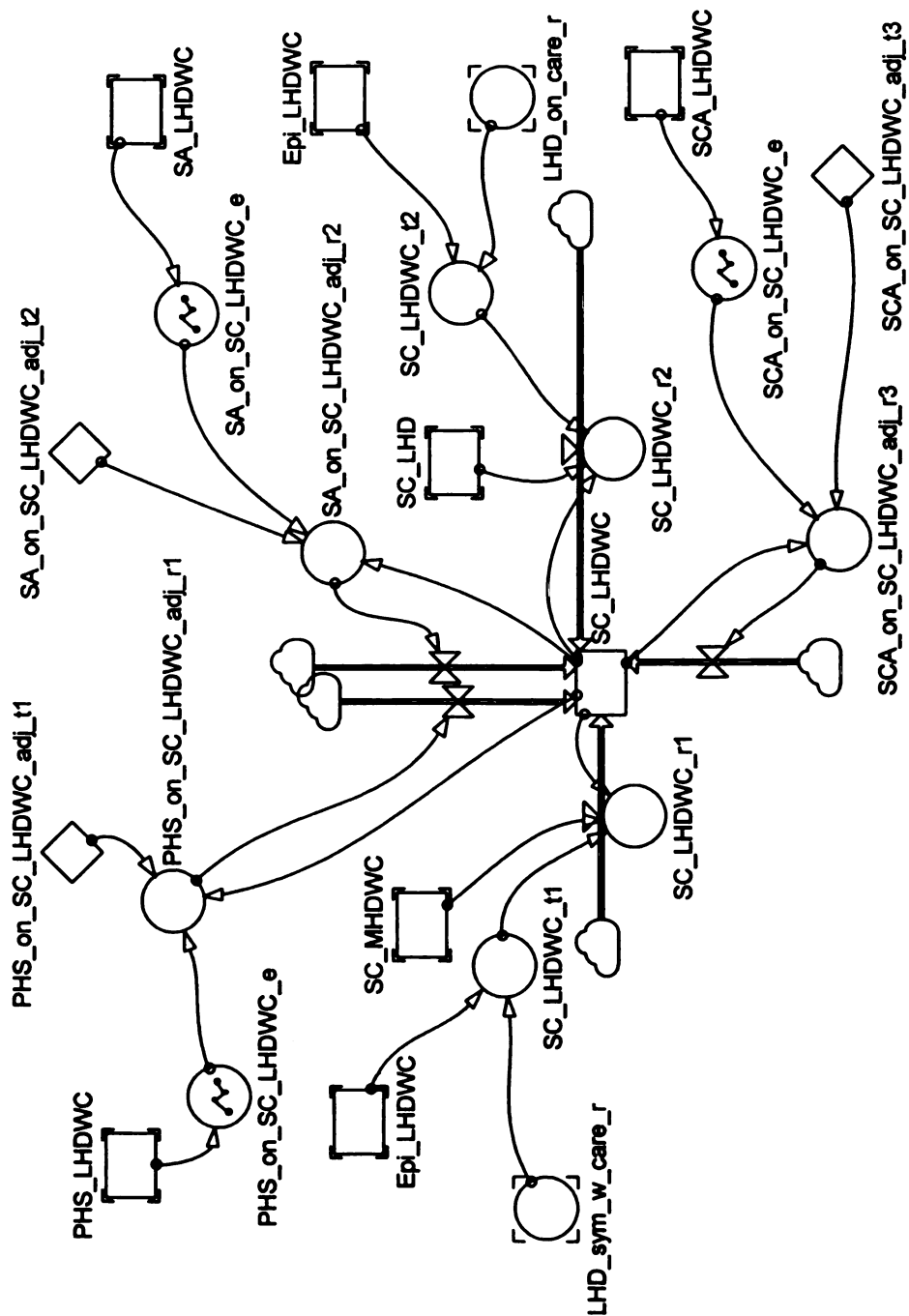


Figure G.44 - Self-concept among late state persons with care [Construct K]

APPENDIX G (continued)

Self-concept (Empowerment) [Construct K]

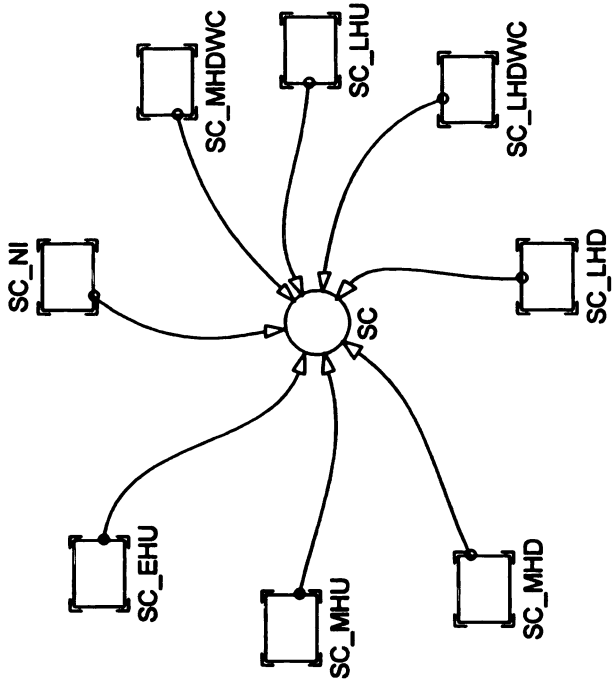


Figure G.45 - Aggregate self-concept [Construct K]

APPENDIX G (continued)

System Awareness (Empowerment) [Construct L]

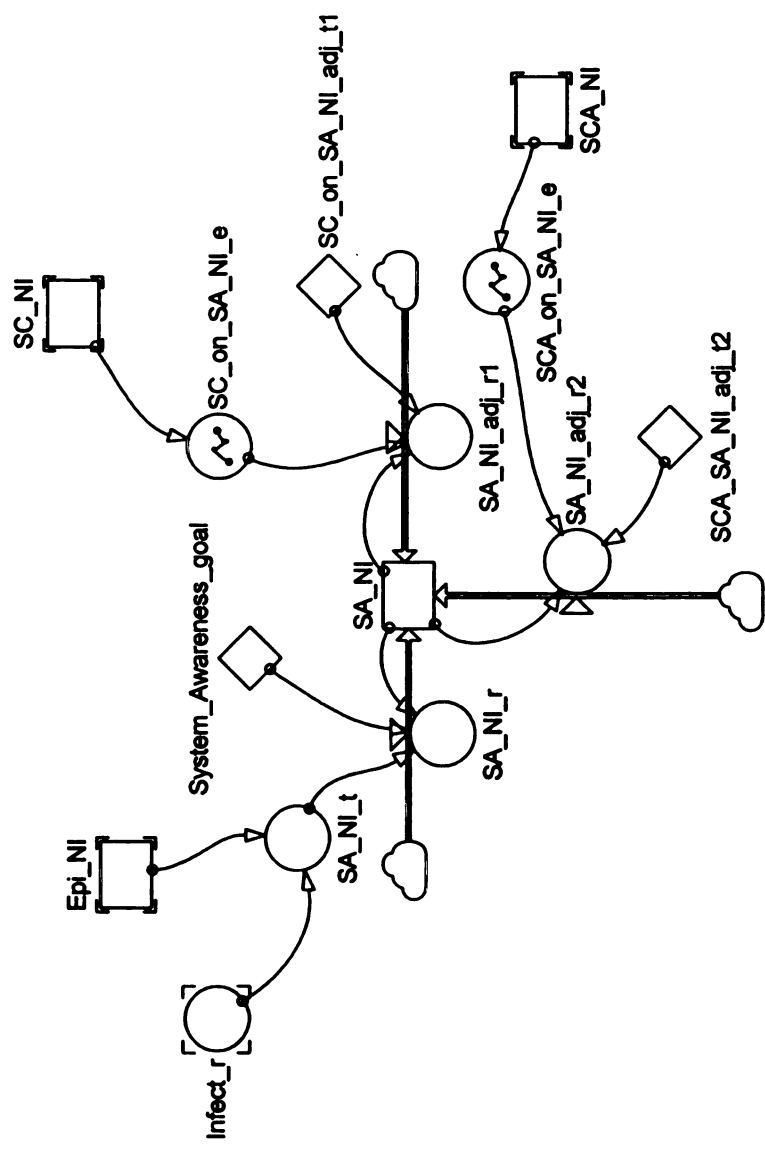


Figure G.46 - System awareness among newly infected persons [Construct L]

APPENDIX G (continued)

System Awareness (Empowerment) [Construct L]

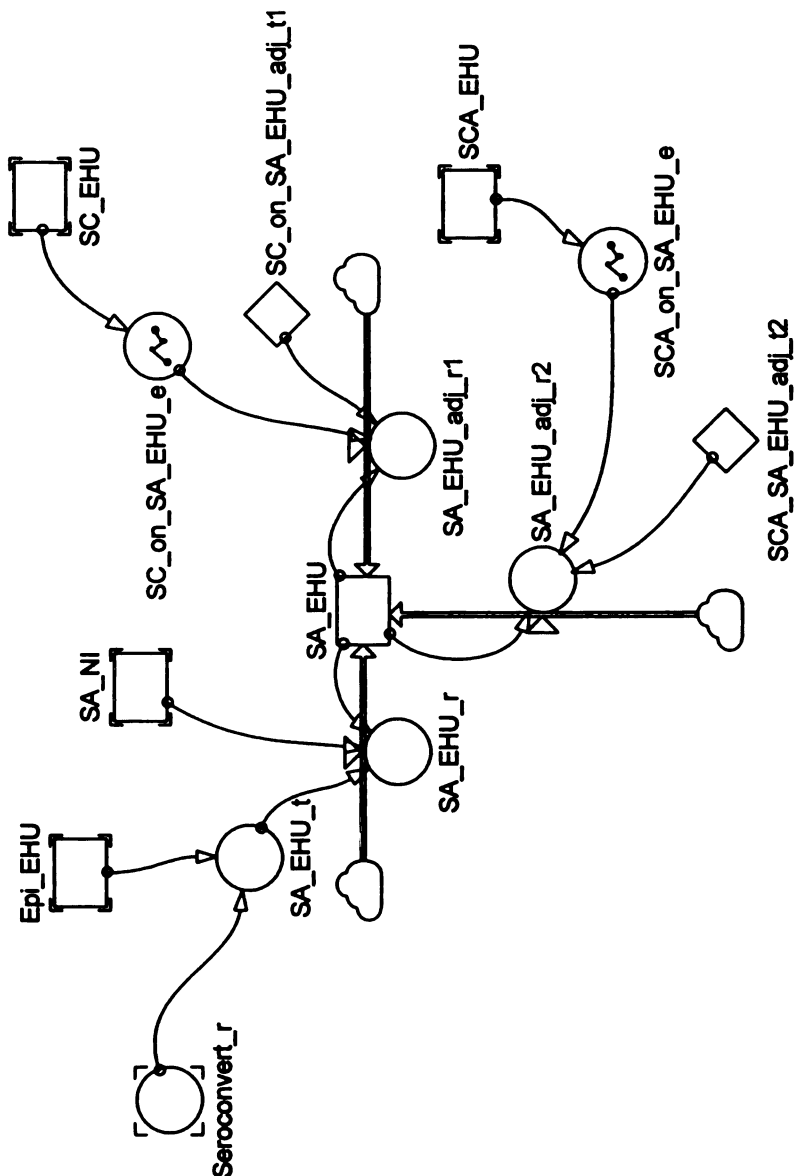


Figure G.47 - System awareness among early stage undiagnosed persons [Construct L]

APPENDIX G (continued)

System Awareness (Empowerment) [Construct L]

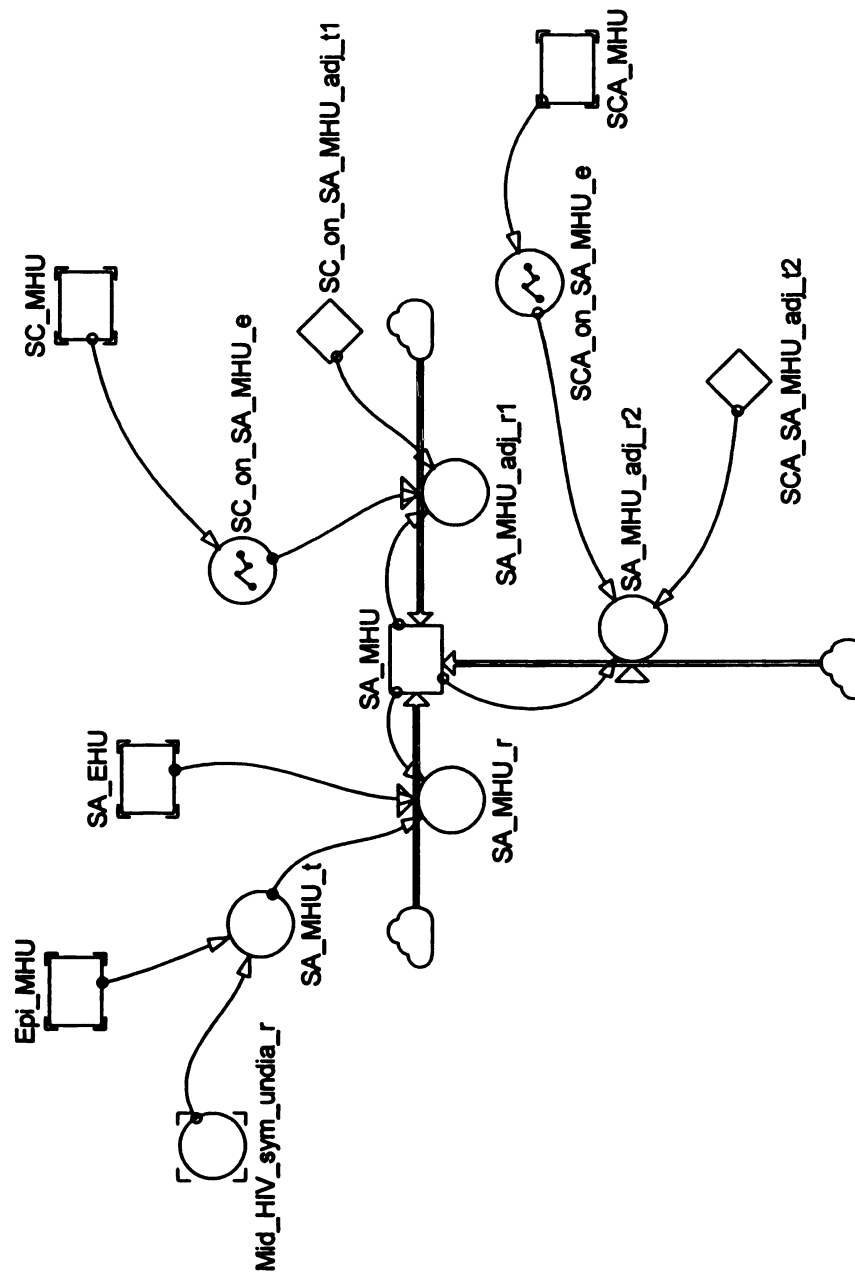


Figure G.48 - System awareness among mid-stage undiagnosed persons [Construct L]

APPENDIX G (continued)

System Awareness (Empowerment) [Construct L]

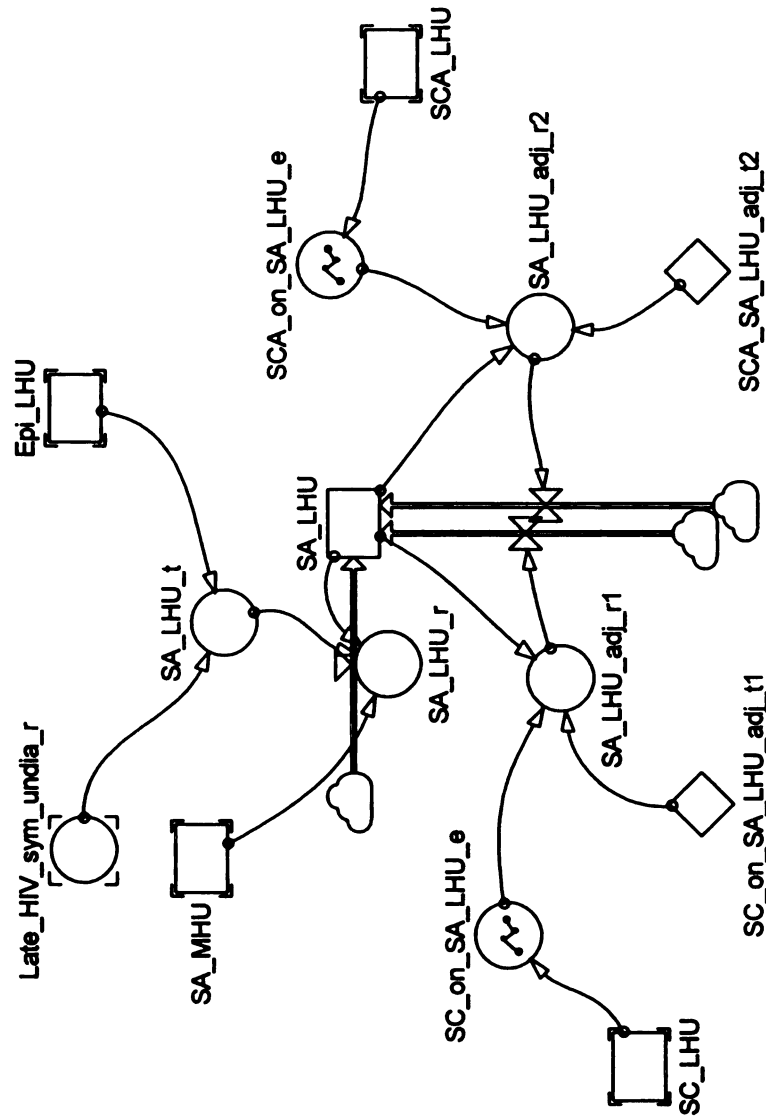


Figure G.49 - System awareness among late stage undiagnosed persons [Construct L]

APPENDIX G (continued)

System Awareness (Empowerment) [Construct L]

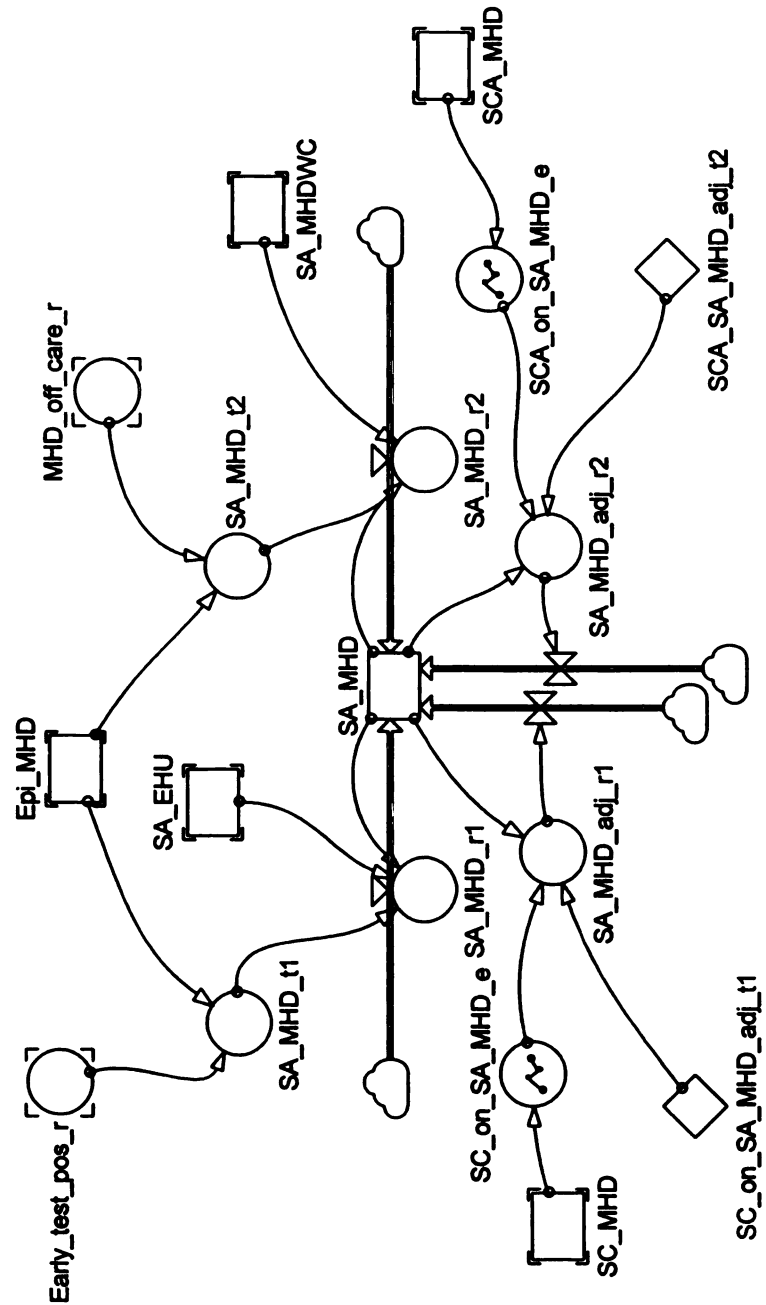


Figure G.50 - System awareness among mid-stage diagnosed persons [Construct L]

System Awareness (Empowerment) [Construct L]

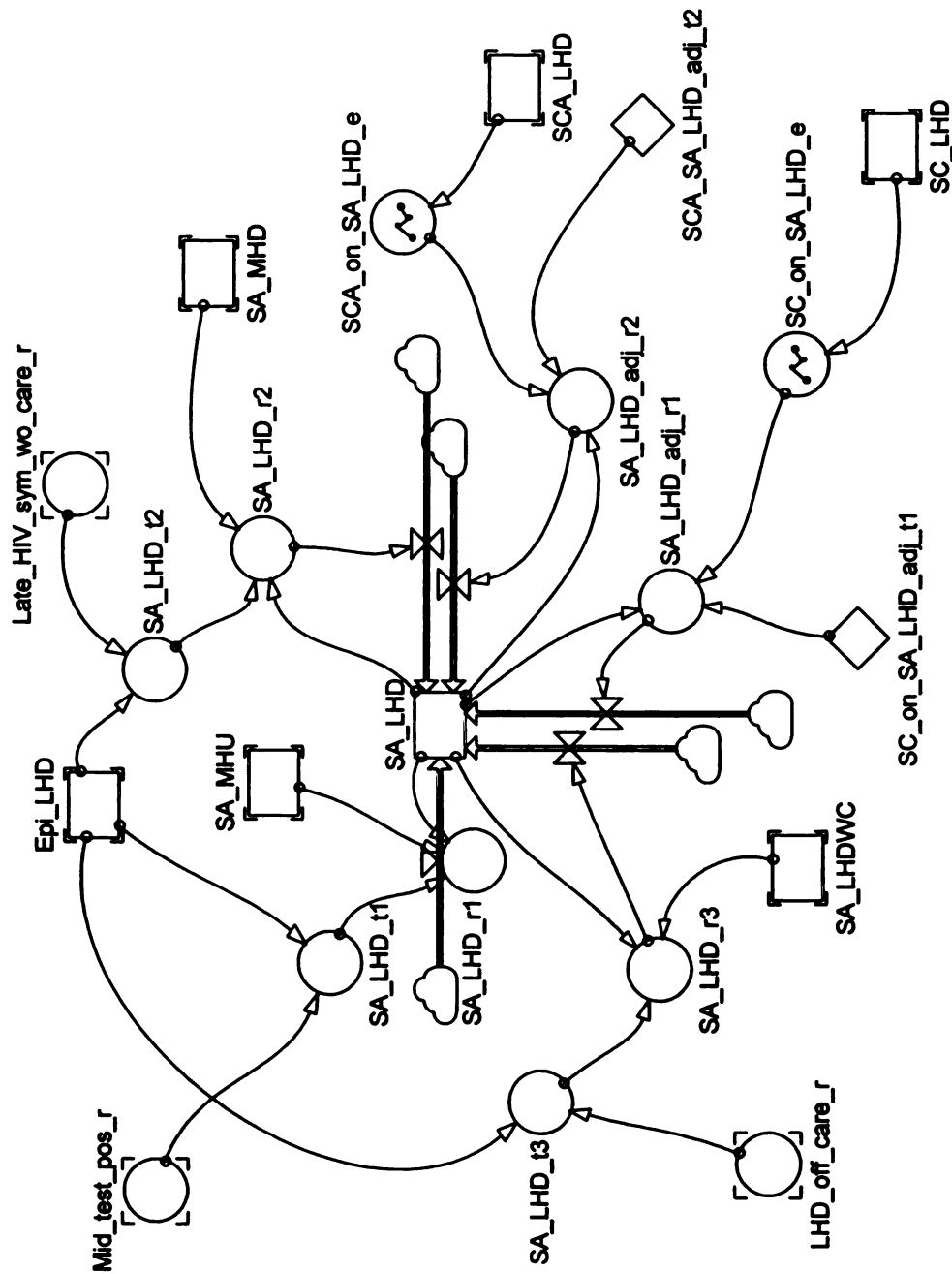


Figure G.51 - System awareness among late stage diagnosed persons [Construct L]

System Awareness (Empowerment) [Construct L]

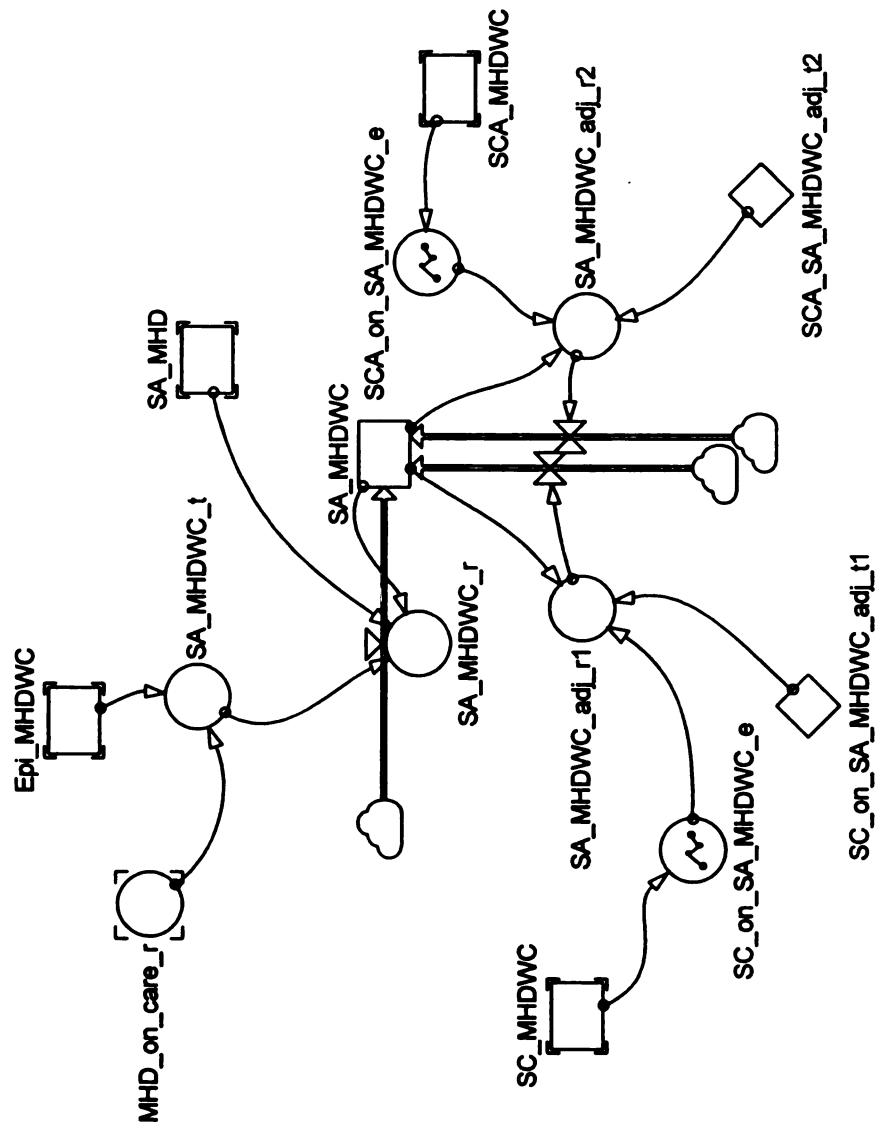


Figure G.52 - System awareness among mid-stage persons with care [Construct L]

System Awareness (Empowerment) [Construct L]

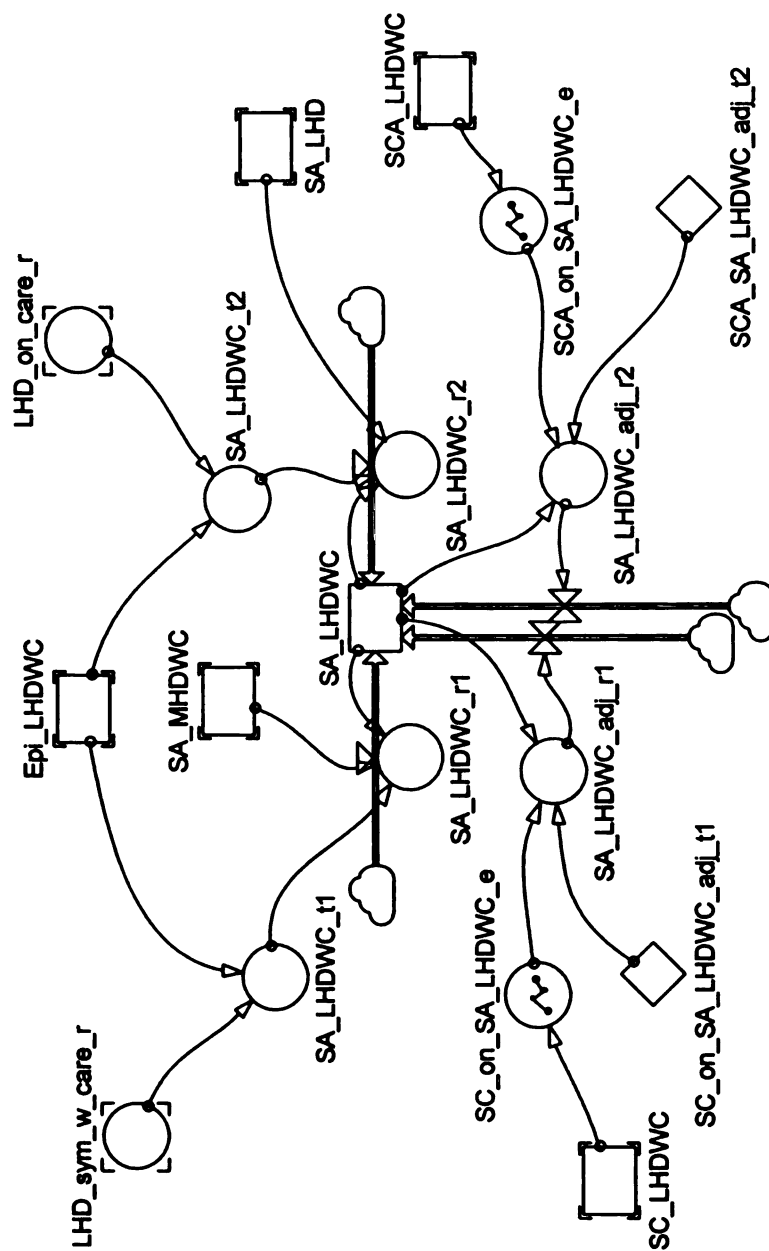


Figure G.53 - System awareness among late state persons with care [Construct L]

APPENDIX G (continued)

System Awareness (Empowerment) [Construct L]

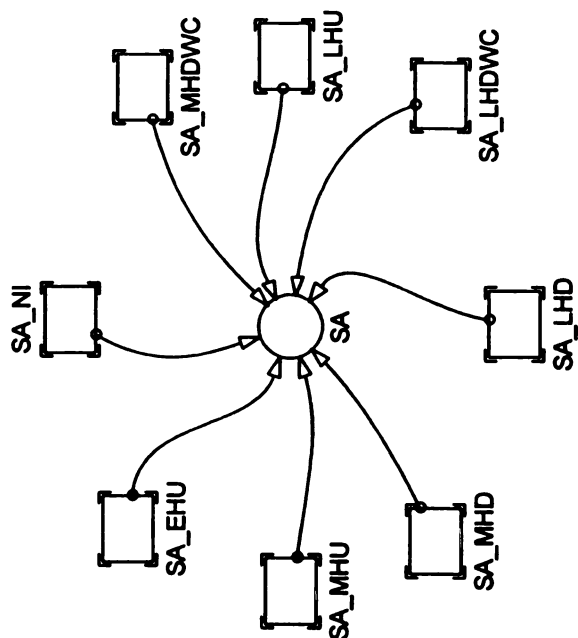


Figure G.54 - Aggregate system awareness [Construct L]

APPENDIX G (continued)

System Change Action (Empowerment) [Construct M]

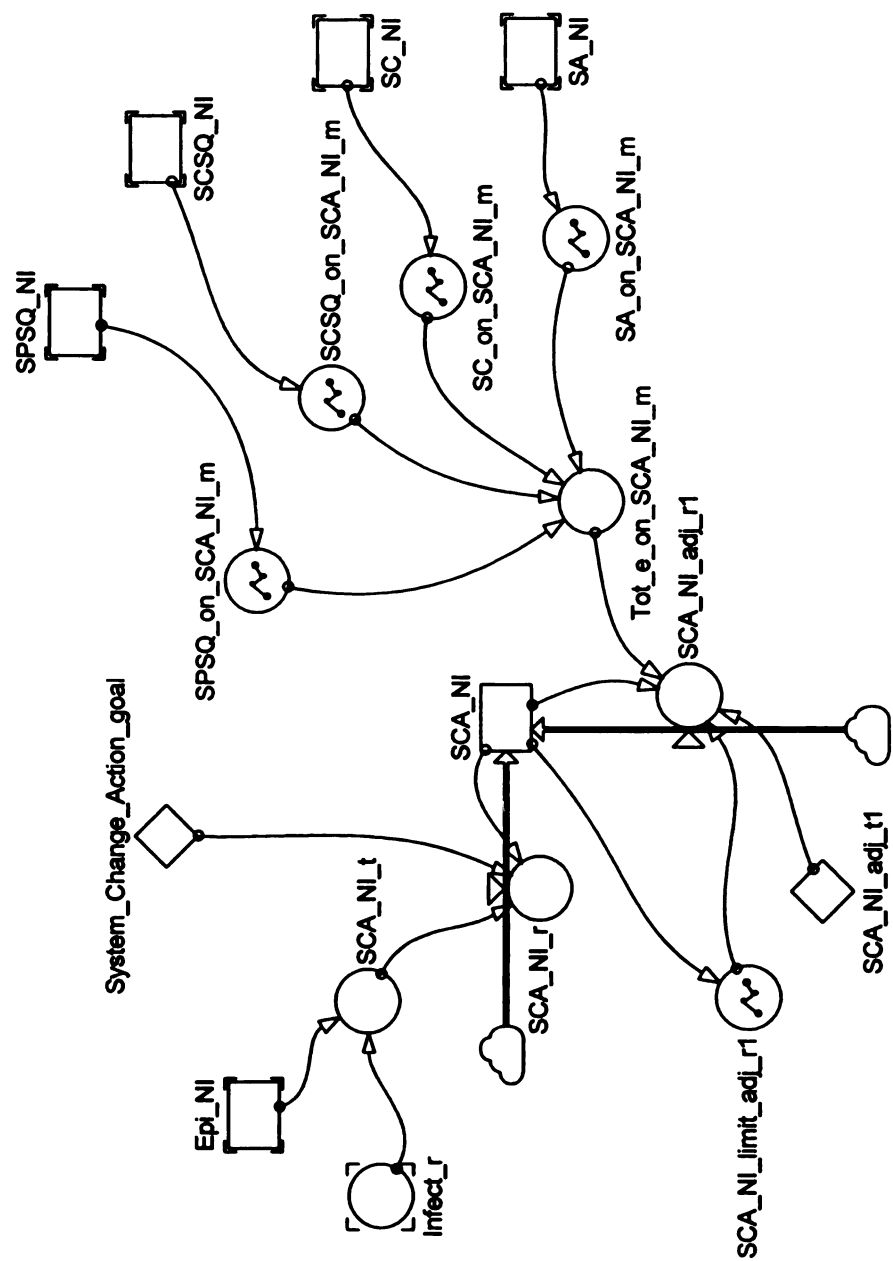


Figure G.55 - System change action among newly infected persons [Construct M]

System Change Action (Empowerment) [Construct M]



System Change Action (Empowerment) [Construct M]

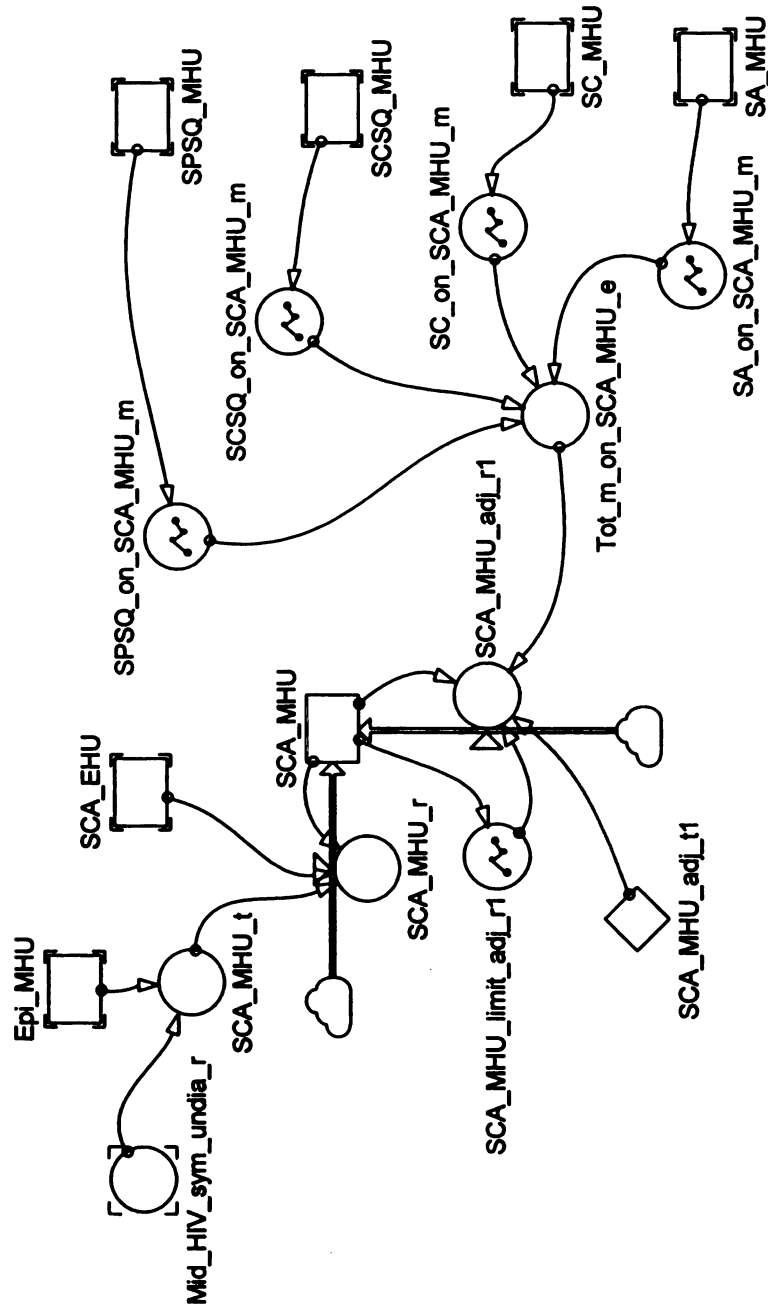


Figure G.57 - System change action among mid-stage undiagnosed persons [Construct M]

APPENDIX G (continued)

System Change Action (Empowerment) [Construct M]

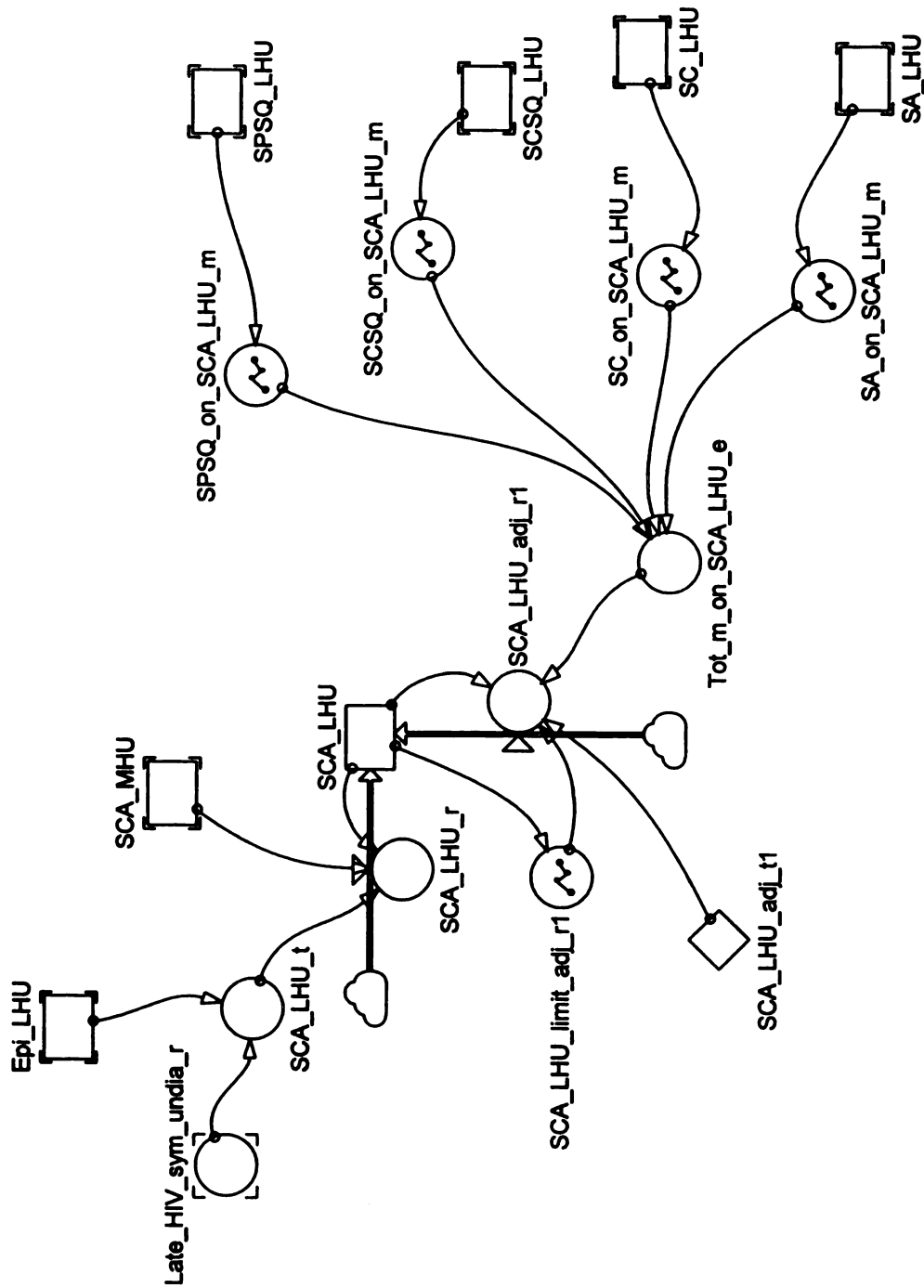


Figure G.58 - System change action among late stage undiagnosed persons [Construct M]

APPENDIX G (continued)

System Change Action (Empowerment) [Construct M]

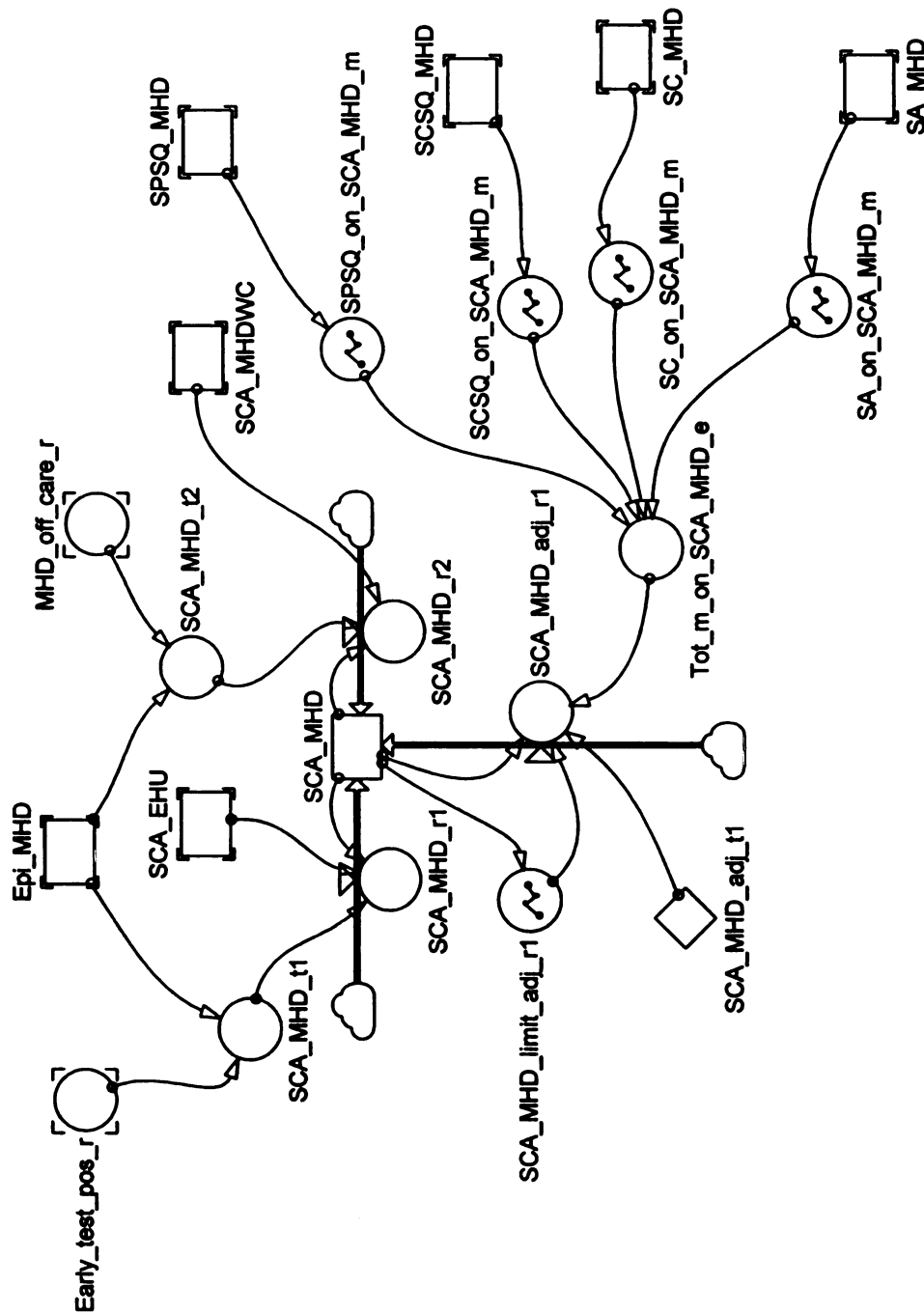


Figure G.59 - System change action among mid-stage diagnosed persons [Construct M]

APPENDIX G (continued)

System Change Action (Empowerment) [Construct M]

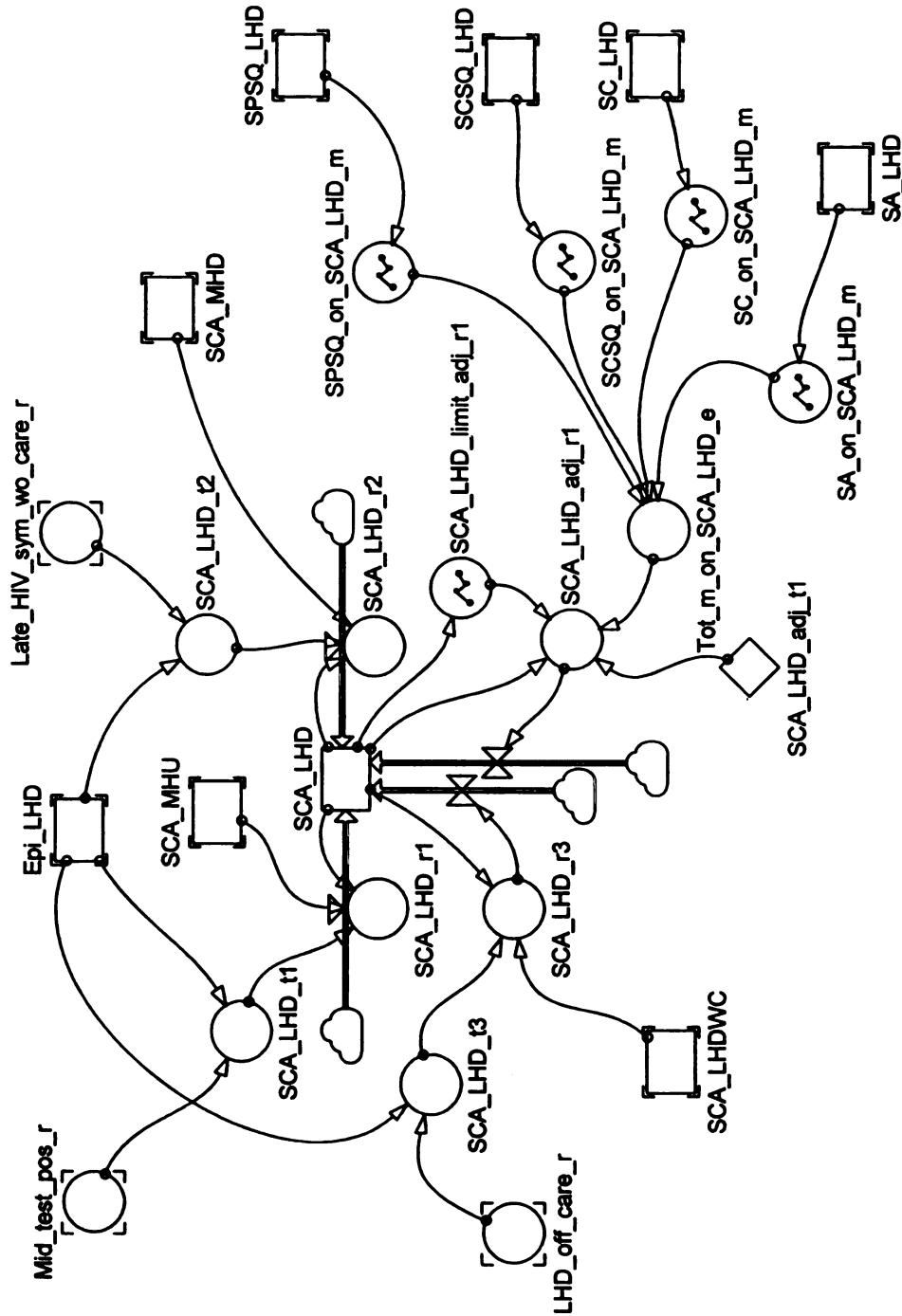


Figure G.60 - System change action among late stage diagnosed persons [Construct M]

APPENDIX G (continued)

System Change Action (Empowerment) [Construct M]

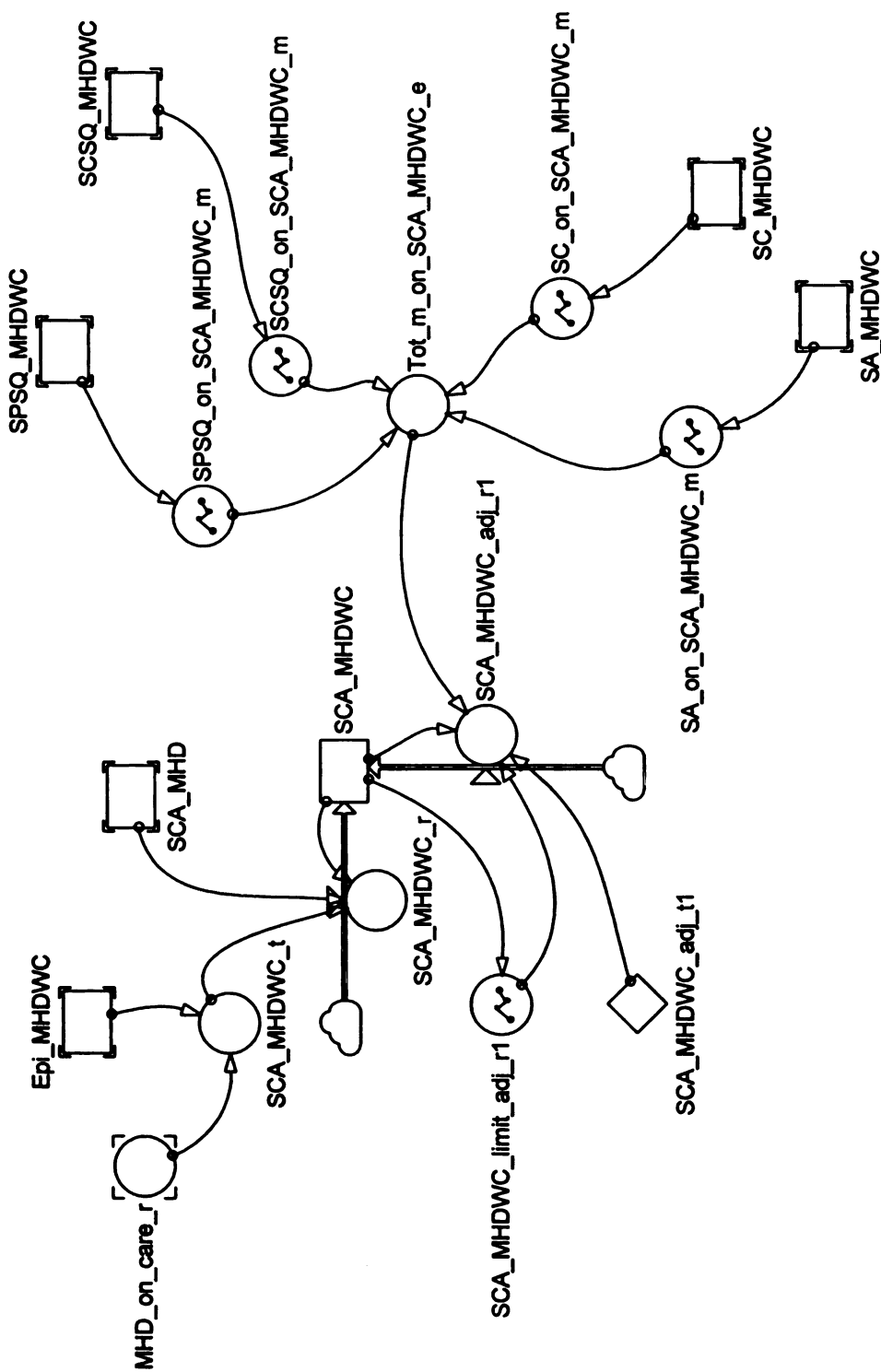


Figure G.61 - System change action among mid-stage persons with care [Construct M]

APPENDIX G (continued)

System Change Action (Empowerment) [Construct M]

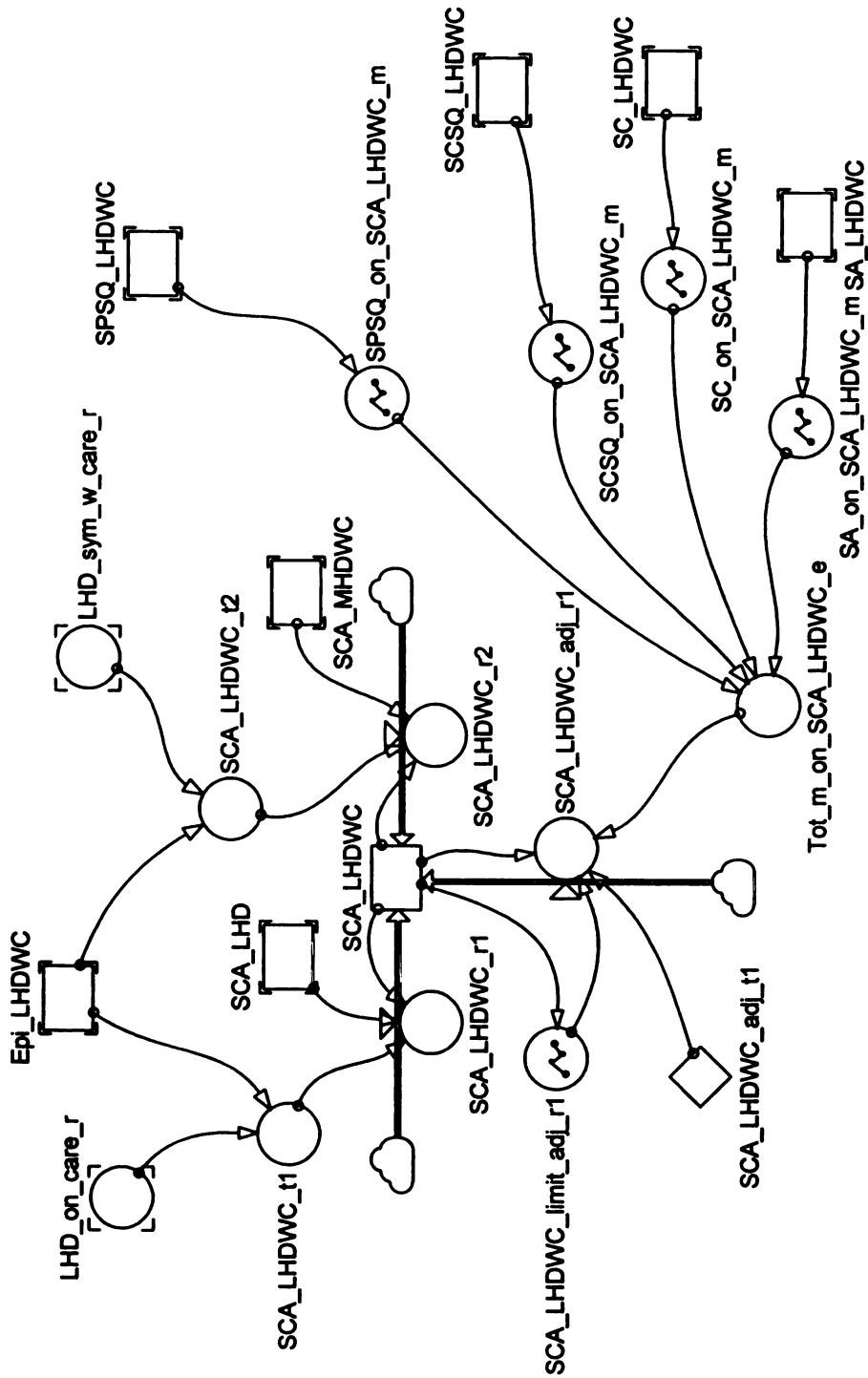


Figure G.62 - System change action among late state persons with care [Construct M]

APPENDIX G (continued)

System Change Action (Empowerment) [Construct M]

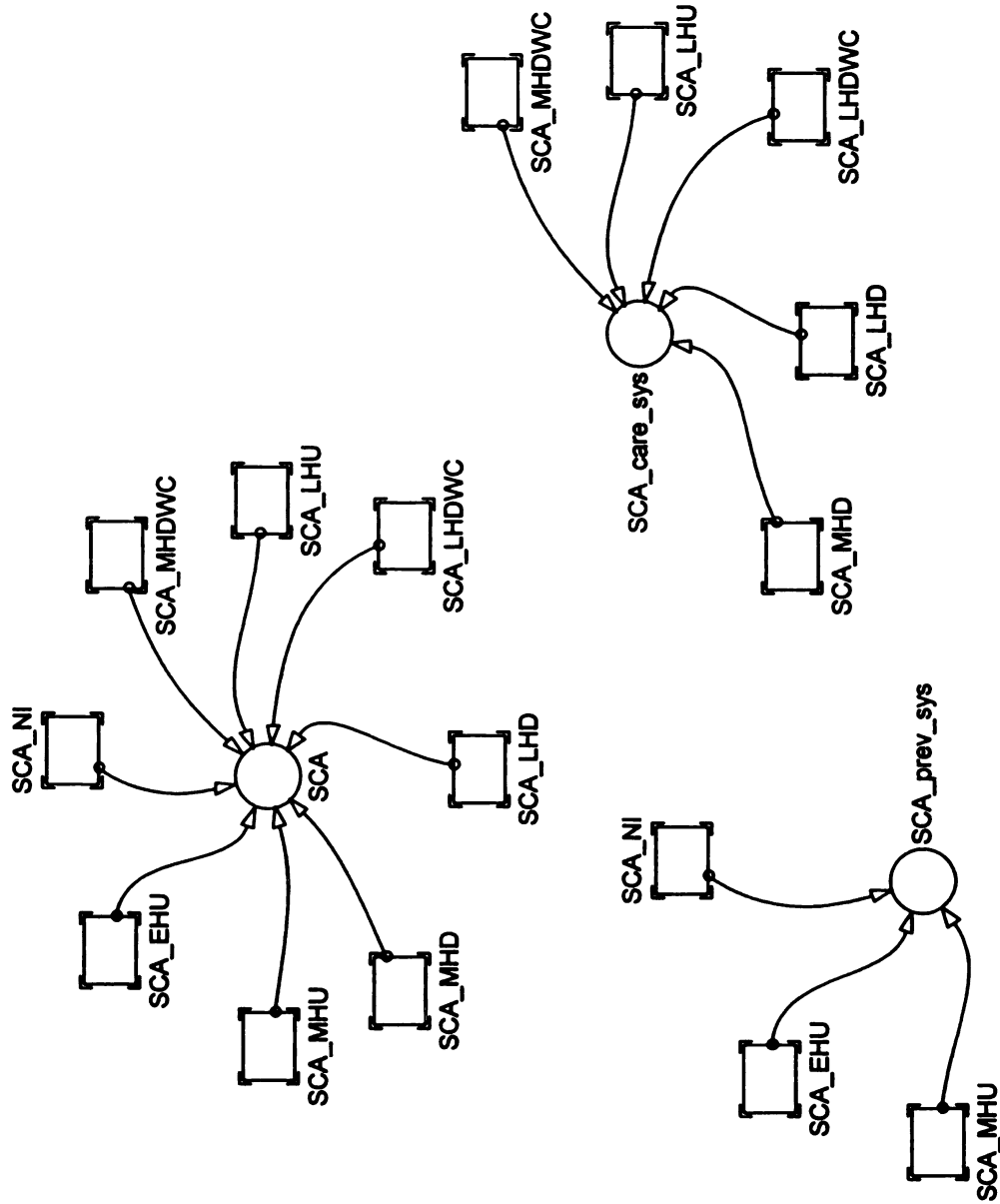


Figure G.63 - Aggregate system change action [Construct M]

APPENDIX G (continued)
Care Complacency [Construct N]

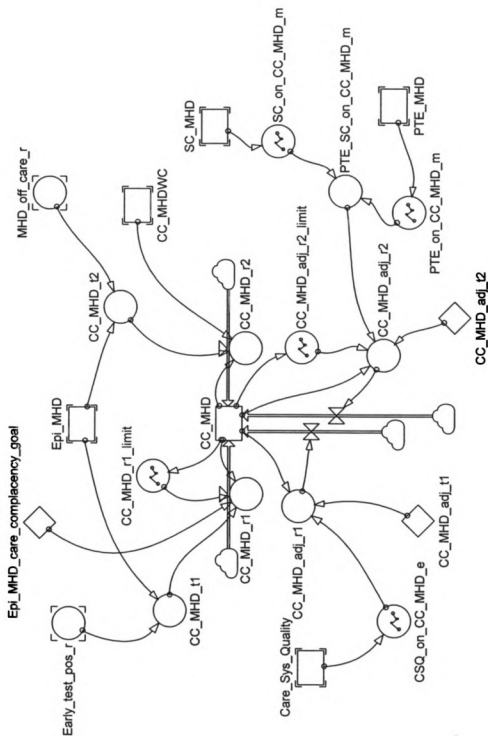


Figure G.64 - Care complacency among mid-stage diagnosed persons [Construct N]

APPENDIX G (continued)

Care Complacency [Construct N]

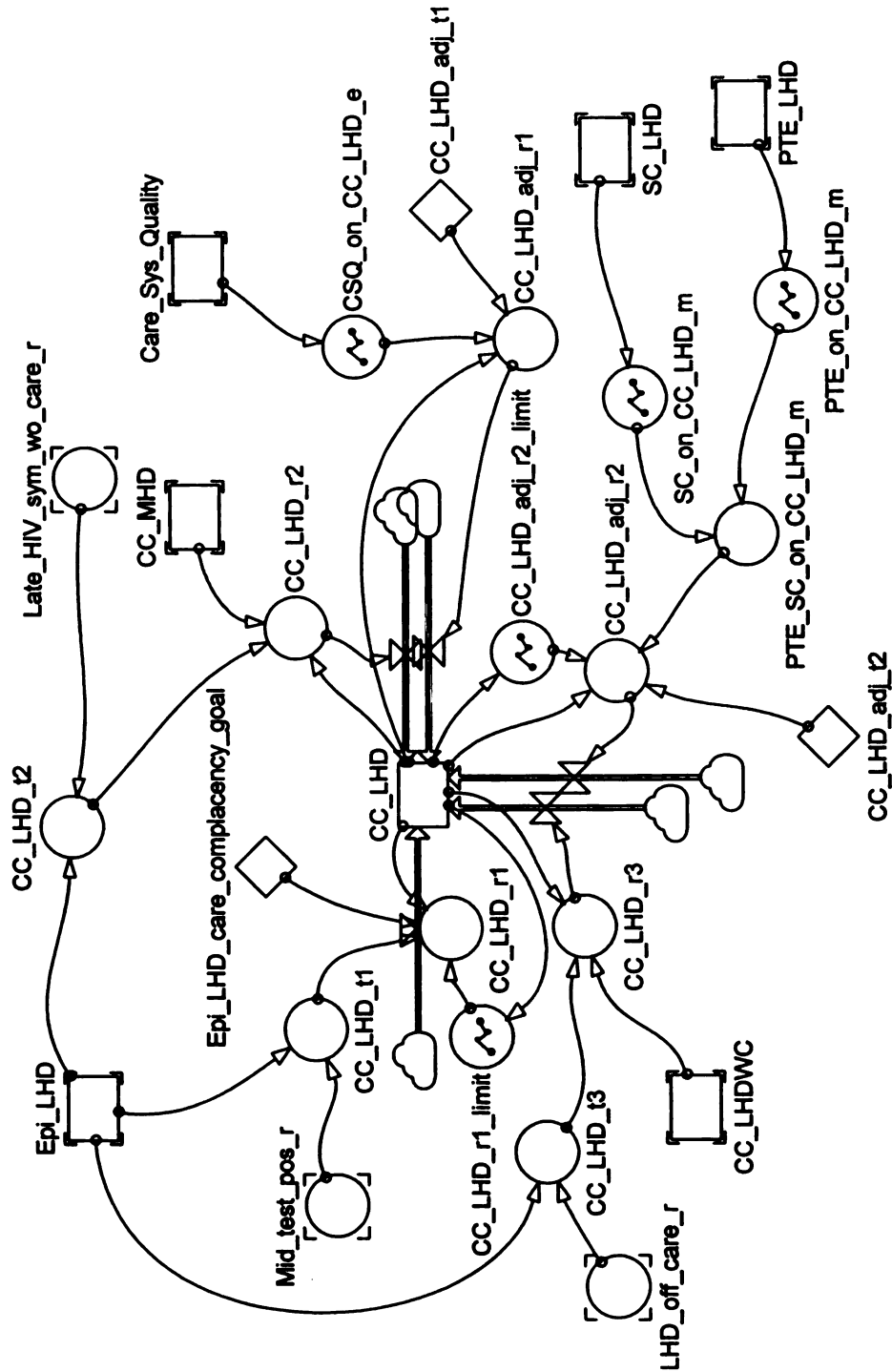


Figure G.65 - Care complacency among late stage diagnosed persons [Construct N]

APPENDIX G (continued)
Care Complacency [Construct N]

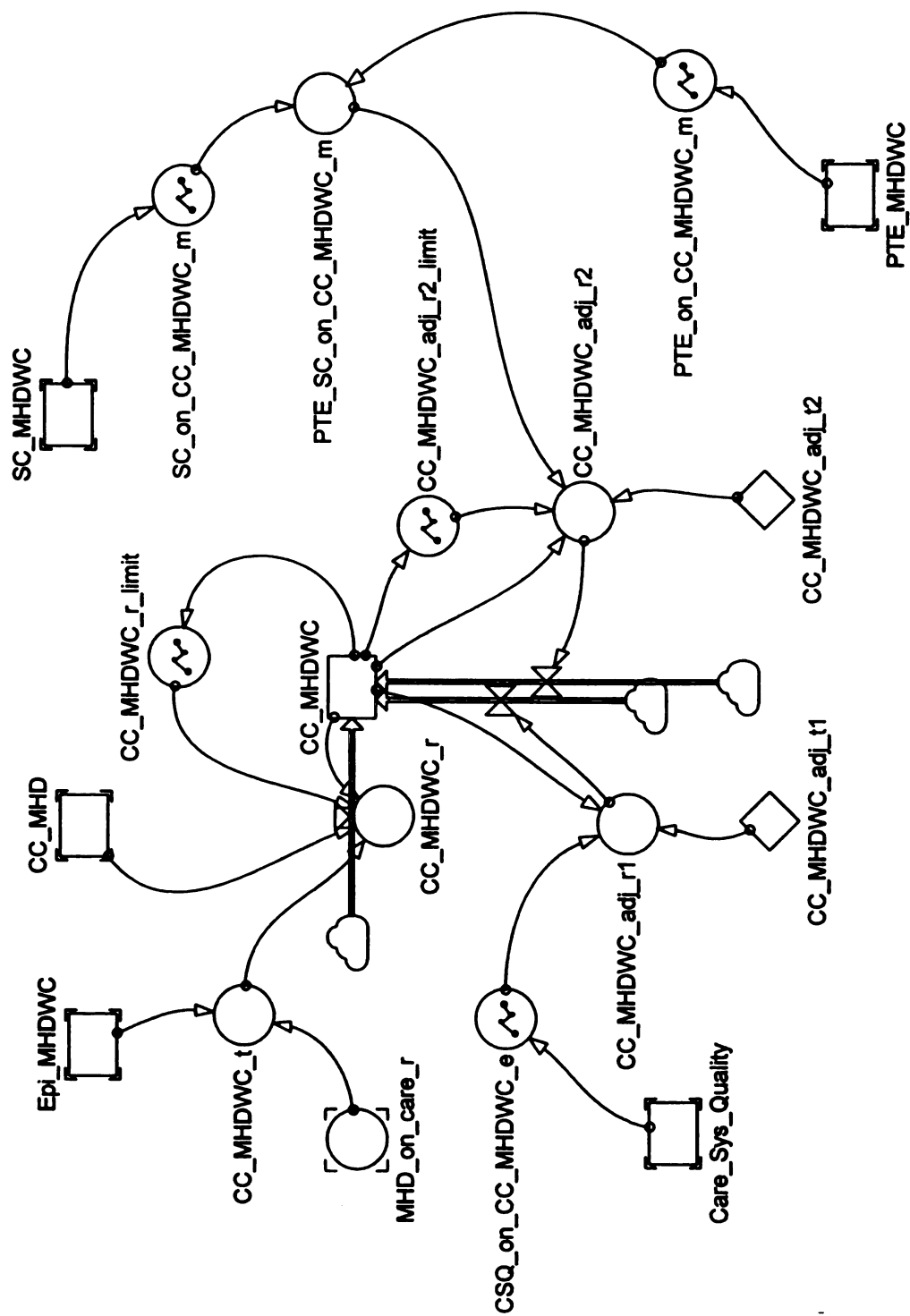


Figure G.66 - Care complacency among mid-stage persons with care [Construct N]

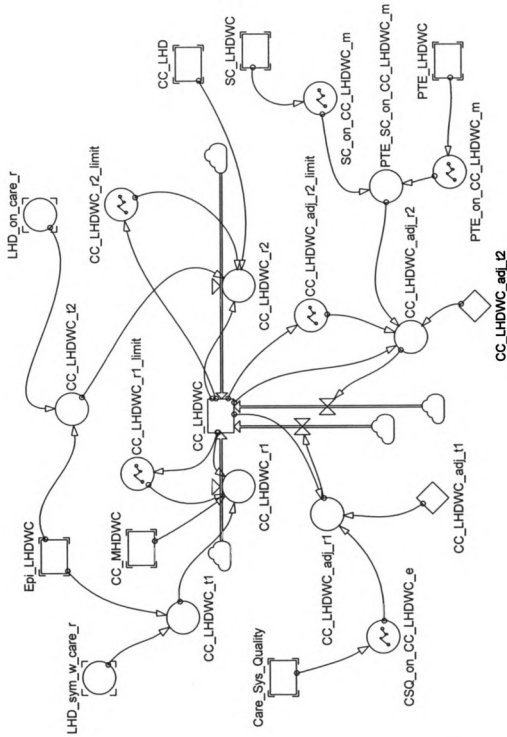
Care Complacency [Construct N]

Figure G.67 - Care complacency among late state persons with care [Construct N]

APPENDIX G (continued)

Care Complacency [Construct N]

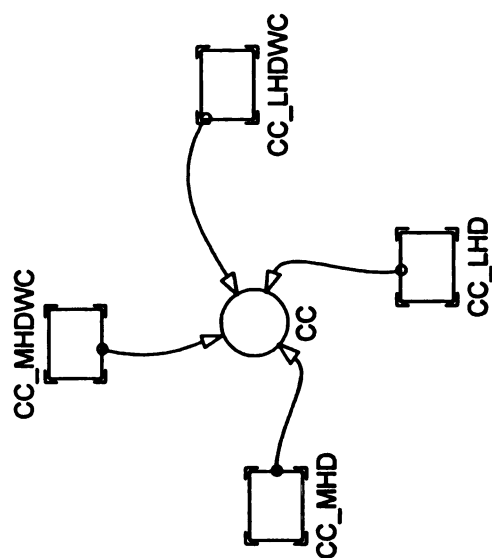


Figure G.68 - Aggregate care complacency [Construct N]

APPENDIX G (continued)

Prevention Complacency [Construct O]

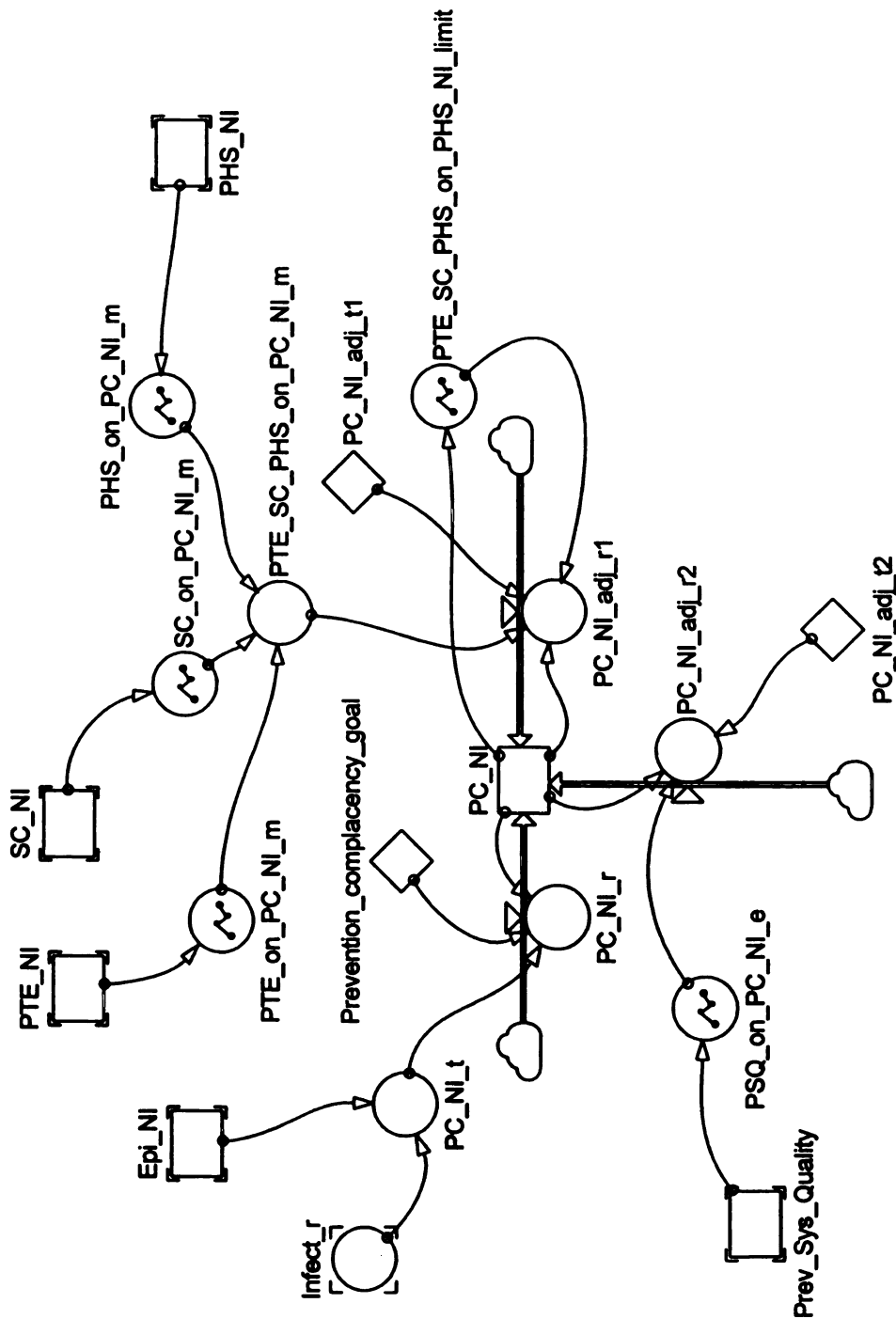


Figure G.69 - Prevention complacency among newly infected persons [Construct O]

APPENDIX G (continued)

Prevention Complacency [Construct O]

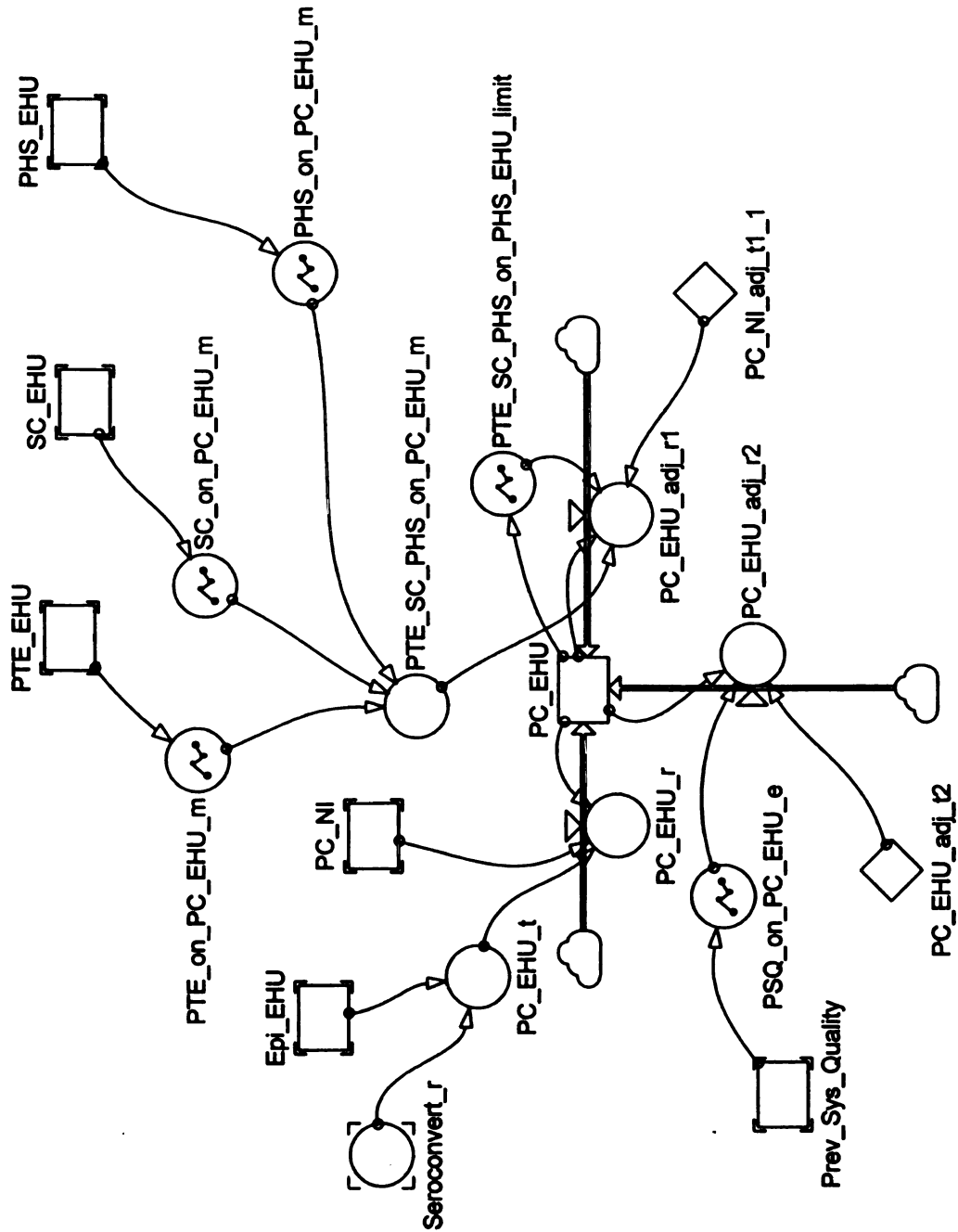


Figure G.70 - Prevention complacency among early stage undiagnosed persons [Construct O]

APPENDIX G (continued)

Prevention Complacency [Construct O]

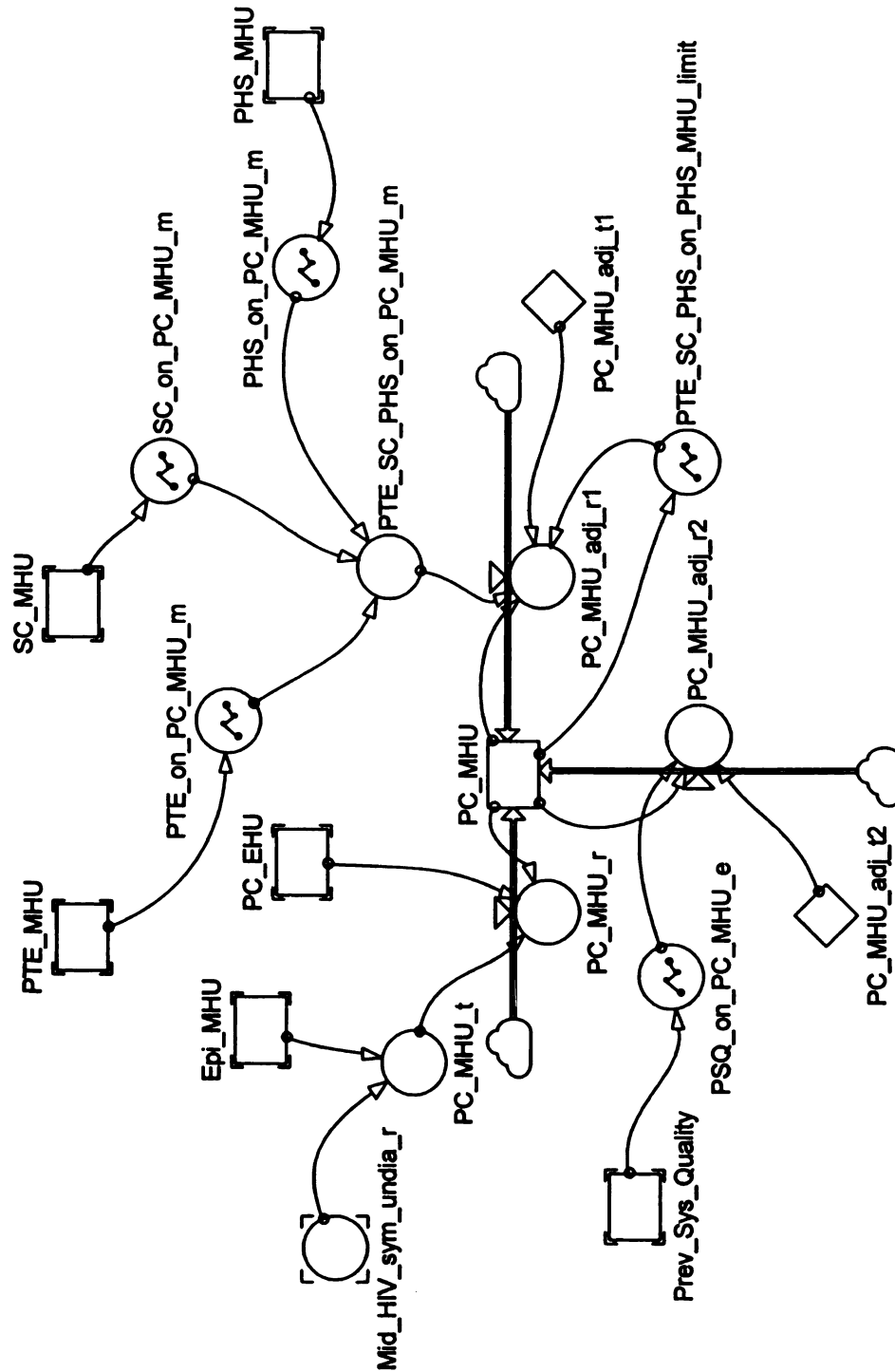


Figure G.71 - Prevention complacency among mid-stage undiagnosed persons [Construct O]

APPENDIX G (continued)

Prevention Complacency [Construct O]

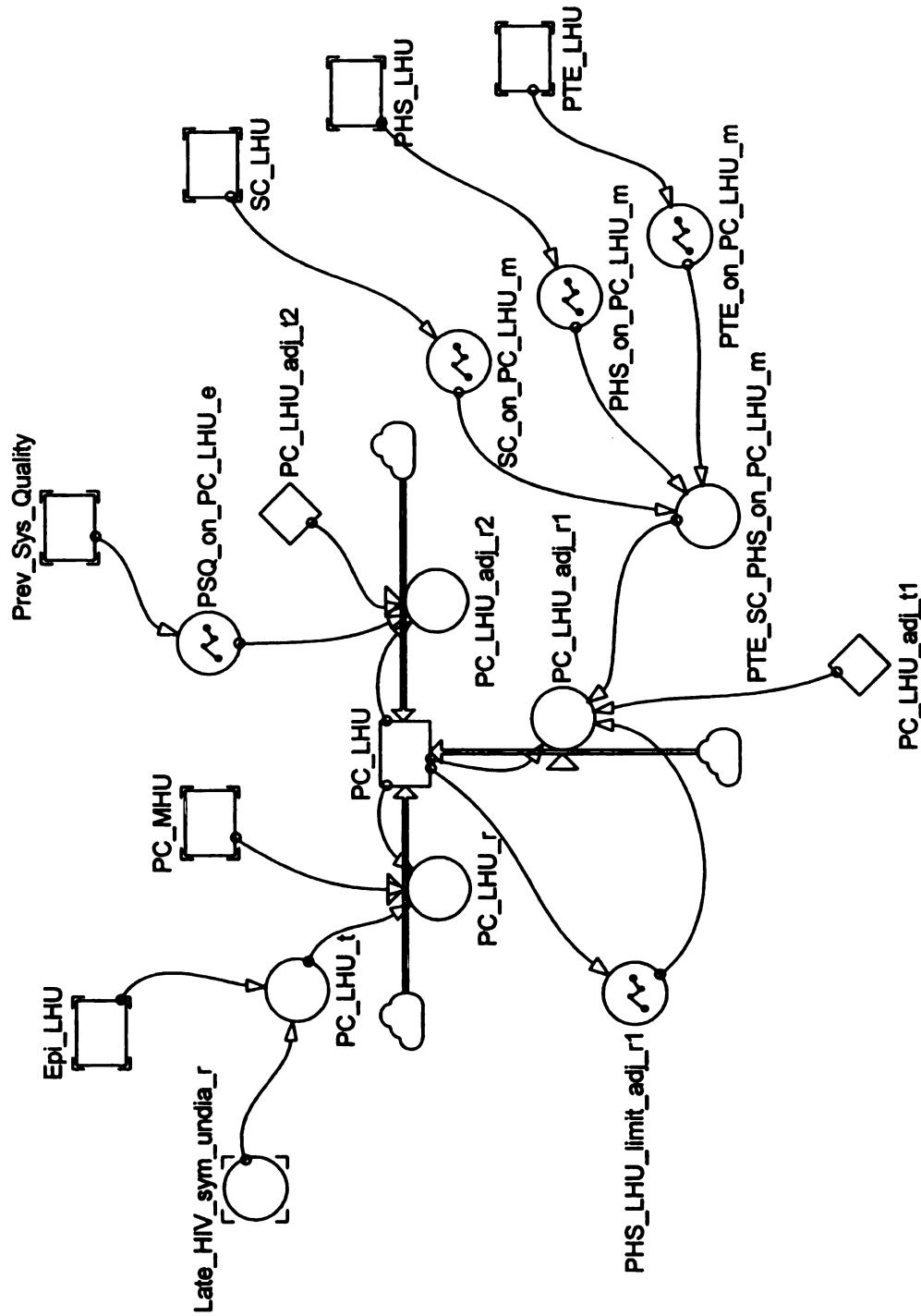


Figure G.72 - Prevention complacency among late stage undiagnosed persons [Construct O]

Prevention Complacency [Construct O]



Prevention Complacency [Construct O]

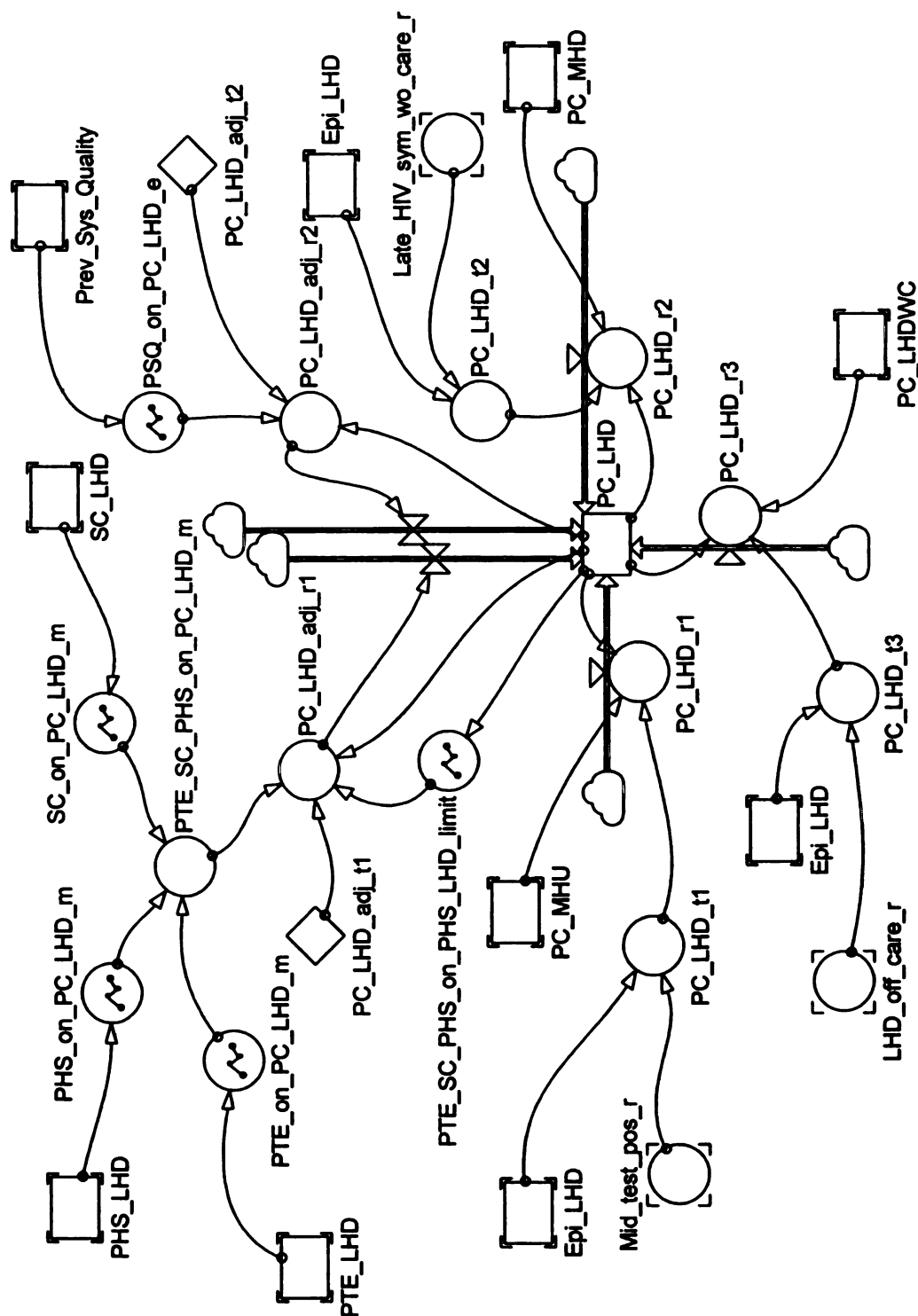
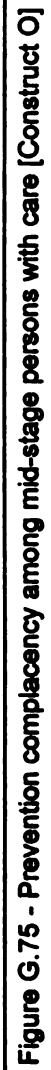


Figure G.74 - Prevention complacency among late stage diagnosed persons [Construct O]

Prevention Complacency [Construct O]



Prevention Complacency [Construct O]

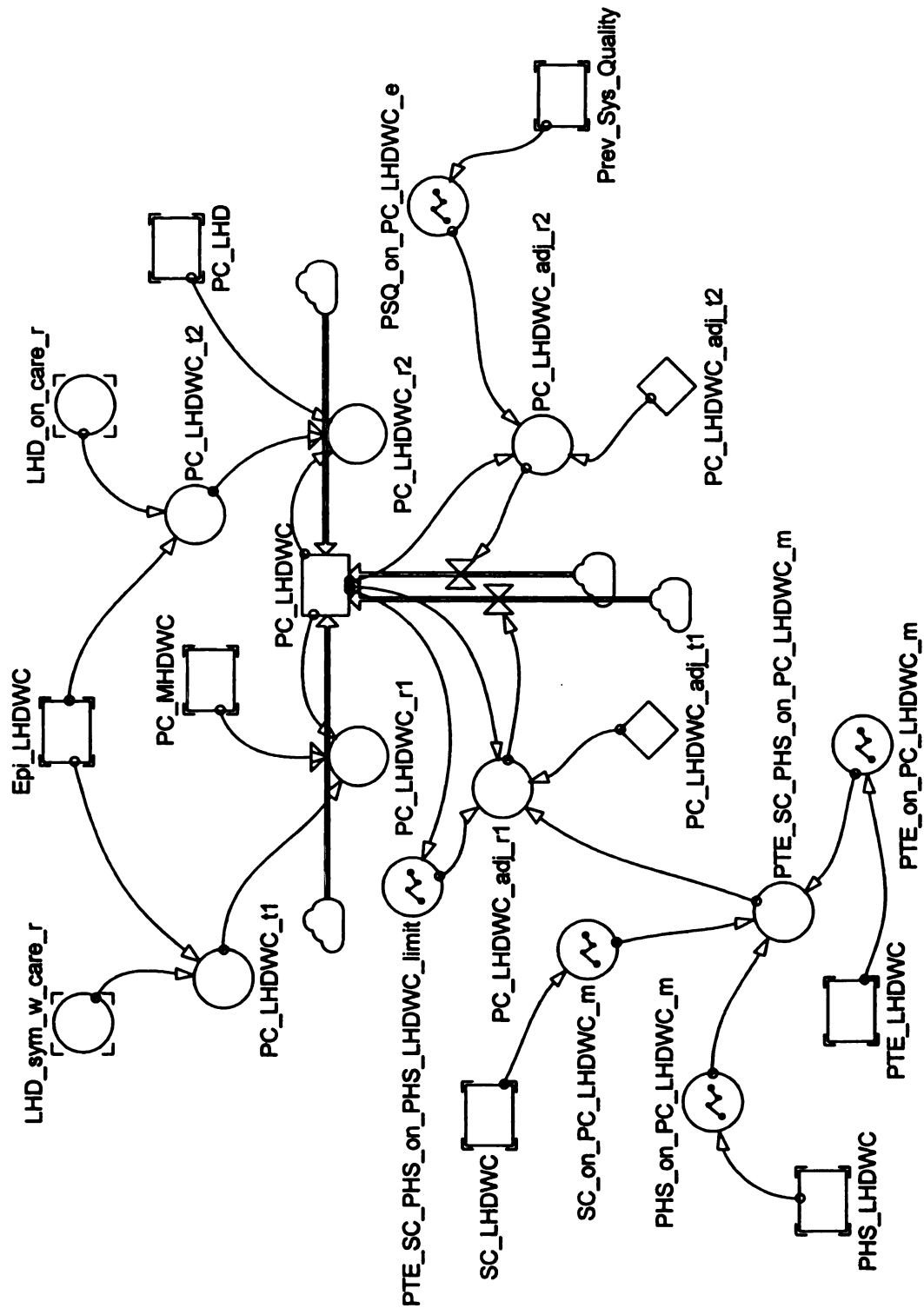


Figure G.76 - Prevention complacency among late state persons with care [Construct O]

APPENDIX G (continued)

Prevention Complacency [Construct O]

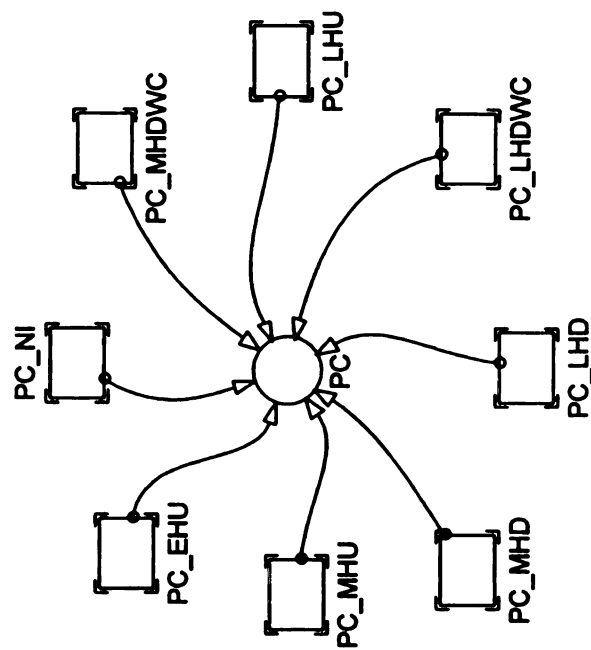


Figure G.77 - Aggregate prevention complacency [Construct O]

APPENDIX H

Base Case Model Equations by Variable Type Stocks

Type	Equation
init	Care_resources = 1
flow	Care_resources = -dt*CR_outflow_r +dt*CR_inflow_r
unit	Care_resources = Resource units
init	Care_Sys_Quality = 1
flow	Care_Sys_Quality = +dt*CSQ_inc_r -dt*CSQ_dec_r
unit	Care_Sys_Quality = System quality units
init	CC_LHD = 60
flow	CC_LHD = +dt*CC_LHD_r1 +dt*CC_LHD_adj_r1 +dt*CC_LHD_r2 +dt*CC_LHD_r3 +dt*CC_LHD_adj_r2
unit	CC_LHD = Care complacency units/Person
init	CC_LHDWC = 60
flow	CC_LHDWC = +dt*CC_LHDWC_adj_r2 +dt*CC_LHDWC_adj_r1 +dt*CC_LHDWC_r2 +dt*CC_LHDWC_r1
unit	CC_LHDWC = Care complacency units/Person
init	CC_MHD = 60
flow	CC_MHD = +dt*CC_MHD_adj_r2 +dt*CC_MHD_adj_r1 +dt*CC_MHD_r2 +dt*CC_MHD_r1
unit	CC_MHD = Care complacency units/Person
init	CC_MHDWC = 60
flow	CC_MHDWC = +dt*CC_MHDWC_adj_r2 +dt*CC_MHDWC_adj_r1 +dt*CC_MHDWC_r
unit	CC_MHDWC = Care complacency units/Person
init	Epi_ADD = ADD_p_init
flow	Epi_ADD = +dt*Late_test_pos_r +dt*AIDS_death_wo_care_r
unit	Epi_ADD = Persons
init	Epi_ADDWC = ADDWC_p_init
flow	Epi_ADDWC = +dt*AIDS_death_w_care_r
unit	Epi_ADDWC = Persons
init	Epi_ADU = ADU_p_init
flow	Epi_ADU = +dt*AIDS_death_undia_r
unit	Epi_ADU = Persons

APPENDIX H (continued)

Base Case Model Equations by Variable Type Stocks

Type	Equation
init flow unit	$\begin{aligned} \text{Epi_EHU} &= \text{EHU_p_init} \\ \text{Epi_EHU} &= -dt * \text{Early_test_pos_r} \\ &\quad -dt * \text{Mid_HIV_sym_undia_r} \\ &\quad +dt * \text{Seroconvert_r} \\ \text{Epi_EHU} &= \text{Persons} \end{aligned}$
init flow unit	$\begin{aligned} \text{Epi_LHD} &= \text{LHD_p_init} \\ \text{Epi_LHD} &= -dt * \text{LHD_on_care_r} \\ &\quad +dt * \text{LHD_off_care_r} \\ &\quad +dt * \text{Mid_test_pos_r} \\ &\quad -dt * \text{AIDS_death_wo_care_r} \\ &\quad +dt * \text{Late_HIV_sym_wo_care_r} \\ \text{Epi_LHD} &= \text{Persons} \end{aligned}$
init flow unit	$\begin{aligned} \text{Epi_LHDWC} &= \text{LHDWC_p_init} \\ \text{Epi_LHDWC} &= +dt * \text{LHD_sym_w_care_r} \\ &\quad -dt * \text{AIDS_death_w_care_r} \\ &\quad -dt * \text{LHD_off_care_r} \\ &\quad +dt * \text{LHD_on_care_r} \\ \text{Epi_LHDWC} &= \text{Persons} \end{aligned}$
init flow unit	$\begin{aligned} \text{Epi_LHU} &= \text{LHU_p_init} \\ \text{Epi_LHU} &= -dt * \text{Late_test_pos_r} \\ &\quad -dt * \text{AIDS_death_undia_r} \\ &\quad +dt * \text{Late_HIV_sym_undia_r} \\ \text{Epi_LHU} &= \text{Persons} \end{aligned}$
init flow unit	$\begin{aligned} \text{Epi_MHD} &= \text{MHD_p_init} \\ \text{Epi_MHD} &= +dt * \text{MHD_off_care_r} \\ &\quad -dt * \text{MHD_on_care_r} \\ &\quad +dt * \text{Early_test_pos_r} \\ &\quad -dt * \text{Late_HIV_sym_wo_care_r} \\ \text{Epi_MHD} &= \text{Persons} \end{aligned}$
init flow unit	$\begin{aligned} \text{Epi_MHDWC} &= \text{MHDWC_p_init} \\ \text{Epi_MHDWC} &= -dt * \text{LHD_sym_w_care_r} \\ &\quad -dt * \text{MHD_off_care_r} \\ &\quad +dt * \text{MHD_on_care_r} \\ \text{Epi_MHDWC} &= \text{Persons} \end{aligned}$
init flow unit	$\begin{aligned} \text{Epi_MHU} &= \text{MHU_p_init} \\ \text{Epi_MHU} &= -dt * \text{Mid_test_pos_r} \\ &\quad -dt * \text{Late_HIV_sym_undia_r} \\ &\quad +dt * \text{Mid_HIV_sym_undia_r} \\ \text{Epi_MHU} &= \text{Persons} \end{aligned}$
init flow unit	$\begin{aligned} \text{Epi_NI} &= \text{NI_p_init} \\ \text{Epi_NI} &= -dt * \text{Seroconvert_r} \\ &\quad +dt * \text{Infect_r} \\ \text{Epi_NI} &= \text{Persons} \end{aligned}$

APPENDIX H (continued)

Base Case Model Equations by Variable Type Stocks

Type	Equation
init	PC_EHU = 90
flow	PC_EHU = +dt*PC_EHU_adj_r1 +dt*PC_EHU_adj_r2 +dt*PC_EHU_r
unit	PC_EHU = Prevention complacency units/Person
init	PC_LHD = 90
flow	PC_LHD = +dt*PC_LHD_adj_r2 +dt*PC_LHD_adj_r1 +dt*PC_LHD_r3 +dt*PC_LHD_r2 +dt*PC_LHD_r1
unit	PC_LHD = Prevention complacency units/Person
init	PC_LHDWC = 90
flow	PC_LHDWC = +dt*PC_LHDWC_adj_r2 +dt*PC_LHDWC_adj_r1 +dt*PC_LHDWC_r2 +dt*PC_LHDWC_r1
unit	PC_LHDWC = Prevention complacency units/Person
init	PC_LHU = 90
flow	PC_LHU = +dt*PC_LHU_adj_r1 +dt*PC_LHU_adj_r2 +dt*PC_LHU_r
unit	PC_LHU = Prevention complacency units/Person
init	PC_MHD = 90
flow	PC_MHD = +dt*PC_MHD_adj_r2 +dt*PC_MHD_adj_r1 +dt*PC_MHD_r2 +dt*PC_MHD_r1
unit	PC_MHD = Prevention complacency units/Person
init	PC_MHDWC = 90
flow	PC_MHDWC = +dt*PC_MHDWC_adj_r1 +dt*PC_MHDWC_adj_r2 +dt*PC_MHDWC_r
unit	PC_MHDWC = Prevention complacency units/Person
init	PC_MHU = 90
flow	PC_MHU = +dt*PC_MHU_adj_r1 +dt*PC_MHU_adj_r2 +dt*PC_MHU_r
unit	PC_MHU = Prevention complacency units/Person
init	PC_NI = 90
flow	PC_NI = +dt*PC_NI_adj_r2 +dt*PC_NI_adj_r1 +dt*PC_NI_r
unit	PC_NI = Prevention complacency units/Person

APPENDIX H (continued)

Base Case Model Equations by Variable Type Stocks

Type	Equation
init	PHS_EHU = 90
flow	PHS_EHU = +dt*PHS_EHU_adj_r2 +dt*PHS_EHU_adj_r1 +dt*PHS_EHU_r
unit	PHS_EHU = Perceived HIV related stigma units/Person
init	PHS_LHD = 90
flow	PHS_LHD = +dt*PHS_LHD_adj_r1 +dt*PHS_LHD_adj_r2 +dt*PHS_LHD_r3 +dt*PHS_LHD_r2 +dt*PHS_LHD_r1
unit	PHS_LHD = Perceived HIV related stigma units/Person
init	PHS_LHDWC = 90
flow	PHS_LHDWC = +dt*PHS_LHDWC_adj_r2 +dt*PHS_LHDWC_adj_r1 +dt*PHS_LHDWC_r2 +dt*PHS_LHDWC_r1
unit	PHS_LHDWC = Perceived HIV related stigma units/Person
init	PHS_LHU = 90
flow	PHS_LHU = +dt*PHS_LHU_adj_r2 +dt*PHS_LHU_adj_r1 +dt*PHS_LHU_r
unit	PHS_LHU = Perceived HIV related stigma units/Person
init	PHS_MHD = 90
flow	PHS_MHD = +dt*PHS_MHD_r1 +dt*PHS_MHD_r2 +dt*PHS_MHD_adj_r2 +dt*PHS_MHD_adj_r1
unit	PHS_MHD = Perceived HIV related stigma units/Person
init	PHS_MHDWC = 90
flow	PHS_MHDWC = +dt*PHS_LHU_adj_r2_2 +dt*PHS_MHDWC_adj_r1 +dt*PHS_MHDWC_r
unit	PHS_MHDWC = Perceived HIV related stigma units/Person
init	PHS_MHU = 90
flow	PHS_MHU = +dt*PHS_MHU_adj_r2 +dt*PHS_MHU_adj_r1 +dt*PHS_MHU_r
unit	PHS_MHU = Perceived HIV related stigma units/Person
init	PHS_NI = 90
flow	PHS_NI = +dt*PHS_NI_adj_r2 +dt*PHS_NI_adj_r1 +dt*PHS_NI_r
unit	PHS_NI = Perceived HIV related stigma units/Person

APPENDIX H (continued)

Base Case Model Equations by Variable Type Stocks

Type	Equation
init	Prev_resources = 1
flow	Prev_resources = -dt*PR_outflow_r +dt*PR_inflow_r
unit	Prev_resources = Resource units
init	Prev_Sys_Quality = 1
flow	Prev_Sys_Quality = +dt*PSQ_inc_r -dt*PSQ_dec_r
unit	Prev_Sys_Quality = System quality units
init	PTE_EHU = 20
flow	PTE_EHU = +dt*PTE_EHU_adj_r1 +dt*PTE_EHU_r
unit	PTE_EHU = Perceived treatment efficacy units/Person
init	PTE_LHD = 20
flow	PTE_LHD = +dt*PTE_LHD_adj_r1 +dt*PTE_LHD_r2 +dt*PTE_LHD_r3 +dt*PTE_LHD_r1
unit	PTE_LHD = Perceived treatment efficacy units/Person
init	PTE_LHDWC = 20
flow	PTE_LHDWC = +dt*PTE_LHDWC_adj_r1 +dt*PTE_LHDWC_r2 +dt*PTE_LHDWC_r1
unit	PTE_LHDWC = Perceived treatment efficacy units/Person
init	PTE_LHU = 20
flow	PTE_LHU = +dt*PTE_LHU_adj_r1 +dt*PTE_LHU_r
unit	PTE_LHU = Perceived treatment efficacy units/Person
init	PTE_MHD = 20
flow	PTE_MHD = +dt*PTE_MHD_r2 +dt*PTE_MHD_adj_r1 +dt*PTE_MHD_r1
unit	PTE_MHD = Perceived treatment efficacy units/Person
init	PTE_MHDWC = 20
flow	PTE_MHDWC = +dt*PTE_MHDWC_adj_r1 +dt*PTE_MHDWC_r
unit	PTE_MHDWC = Perceived treatment efficacy units/Person
init	PTE_MHU = 20
flow	PTE_MHU = +dt*PTE_MHU_adj_r1 +dt*PTE_MHU_r
unit	PTE_MHU = Perceived treatment efficacy units/Person
init	PTE_NI = 20
flow	PTE_NI = +dt*PTE_NI_adj_r1 +dt*PTE_NI_r
unit	PTE_NI = Perceived treatment efficacy units/Person

APPENDIX H (continued)

Base Case Model Equations by Variable Type Stocks

Type	Equation
init	SA_EHU = 0
flow	SA_EHU = +dt*SA_EHU_adj_r1 +dt*SA_EHU_adj_r2 +dt*SA_EHU_r
unit	SA_EHU = System awareness units/Person
init	SA_LHD = 0
flow	SA_LHD = +dt*SA_LHD_adj_r2 +dt*SA_LHD_adj_r1 +dt*SA_LHD_r3 +dt*SA_LHD_r2 +dt*SA_LHD_r1
unit	SA_LHD = System awareness units/Person
init	SA_LHDWC = 0
flow	SA_LHDWC = +dt*SA_LHDWC_adj_r2 +dt*SA_LHDWC_adj_r1 +dt*SA_LHDWC_r2 +dt*SA_LHDWC_r1
unit	SA_LHDWC = System awareness units/Person
init	SA_LHU = 0
flow	SA_LHU = +dt*SA_LHU_adj_r2 +dt*SA_LHU_adj_r1 +dt*SA_LHU_r
unit	SA_LHU = System awareness units/Person
init	SA_MHD = 0
flow	SA_MHD = +dt*SA_MHD_adj_r2 +dt*SA_MHD_adj_r1 +dt*SA_MHD_r2 +dt*SA_MHD_r1
unit	SA_MHD = System awareness units/Person
init	SA_MHDWC = 0
flow	SA_MHDWC = +dt*SA_MHDWC_adj_r2 +dt*SA_MHDWC_adj_r1 +dt*SA_MHDWC_r
unit	SA_MHDWC = System awareness units/Person
init	SA_MHU = 0
flow	SA_MHU = +dt*SA_MHU_adj_r2 +dt*SA_MHU_adj_r1 +dt*SA_MHU_r
unit	SA_MHU = System awareness units/Person
init	SA_NI = 0
flow	SA_NI = +dt*SA_NI_adj_r2 +dt*SA_NI_adj_r1 +dt*SA_NI_r
unit	SA_NI = System awareness units/Person

APPENDIX H (continued)

Base Case Model Equations by Variable Type Stocks

Type	Equation
init	SC_EHU = 50
flow	$SC_EHU = +dt*SCA_on_SC_EHU_adj_r3$ $+dt*SA_on_SC_EHU_adj_r2$ $+dt*PHS_on_SC_EHU_adj_r1$ $+dt*SC_EHU_r$
unit	SC_EHU = Self concept units/Person
init	SC_LHD = 50
flow	$SC_LHD = +dt*SCA_on_SC_LHD_adj_r3$ $+dt*SC_LHD_r2$ $+dt*SA_on_SC_LHD_adj_r2$ $+dt*PHS_on_SC_LHD_adj_r1$ $+dt*SC_LHD_r3$ $+dt*SC_LHD_r1$
unit	SC_LHD = Self concept units/Person
init	SC_LHDWC = 50
flow	$SC_LHDWC = +dt*SCA_on_SC_LHDWC_adj_r3$ $+dt*SA_on_SC_LHDWC_adj_r2$ $+dt*PHS_on_SC_LHDWC_adj_r1$ $+dt*SC_LHDWC_r2$ $+dt*SC_LHDWC_r1$
unit	SC_LHDWC = Self concept units/Person
init	SC_LHU = 50
flow	$SC_LHU = +dt*PHS_on_SC_LHU_adj_r1$ $+dt*SCA_on_SC_LHU_adj_r3$ $+dt*SA_on_SC_LHU_adj_r2$ $+dt*SC_LHU_r$
unit	SC_LHU = Self concept units/Person
init	SC_MHD = 50
flow	$SC_MHD = +dt*SCA_on_SC_MHD_adj_r3$ $+dt*SA_on_SC_MHD_adj_r2$ $+dt*PHS_on_SC_MHD_adj_r1$ $+dt*SC_MHD_r2$ $+dt*SC_MHD_r1$
unit	SC_MHD = Self concept units/Person
init	SC_MHDWC = 50
flow	$SC_MHDWC = +dt*SCA_on_SC_MHDWC_adj_r3$ $+dt*SA_on_SC_MHDWC_adj_r2$ $+dt*PHS_on_SC_MHDWC_adj_r1$ $+dt*SC_MHDWC_r$
unit	SC_MHDWC = Self concept units/Person

APPENDIX H (continued)

Base Case Model Equations by Variable Type Stocks

Type	Equation
init	SC_MHU = 50
flow	SC_MHU = +dt*PHS_on_SC_MHU_adj_r1 +dt*SCA_on_SC_MHU_adj_r3 +dt*SA_on_SC_MHU_adj_r2 +dt*SC_MHU_r
unit	SC_MHU = Self concept units/Person
init	SC_NI = 50
flow	SC_NI = +dt*SCA_on_SC_NI_adj_r3 +dt*SA_on_SC_NI_adj_r2 +dt*PHS_on_SC_NI_adj_r1 +dt*SC_NI_r
unit	SC_NI = Self concept units/Person
init	SCA_EHU = 0
flow	SCA_EHU = +dt*SCA_EHU_adj_r1 +dt*SCA_EHU_r
unit	SCA_EHU = System change action units/Person/Month
init	SCA_LHD = 0
flow	SCA_LHD = +dt*SCA_LHD_adj_r1 +dt*SCA_LHD_r3 +dt*SCA_LHD_r2 +dt*SCA_LHD_r1
unit	SCA_LHD = System change action units/Person
init	SCA_LHDWC = 0
flow	SCA_LHDWC = +dt*SCA_LHDWC_adj_r1 +dt*SCA_LHDWC_r2 +dt*SCA_LHDWC_r1
unit	SCA_LHDWC = System change action units/Person
init	SCA_LHU = 0
flow	SCA_LHU = +dt*SCA_LHU_adj_r1 +dt*SCA_LHU_r
unit	SCA_LHU = System change action units/Person
init	SCA_MHD = 0
flow	SCA_MHD = +dt*SCA_MHD_adj_r1 +dt*SCA_MHD_r2 +dt*SCA_MHD_r1
unit	SCA_MHD = System change action units/Person
init	SCA_MHDWC = 0
flow	SCA_MHDWC = +dt*SCA_MHDWC_adj_r1 +dt*SCA_MHDWC_r
unit	SCA_MHDWC = System change action units/Person
init	SCA_MHU = 0
flow	SCA_MHU = +dt*SCA_MHU_adj_r1 +dt*SCA_MHU_r
unit	SCA_MHU = System change action units/Person/Month

APPENDIX H (continued)

Base Case Model Equations by Variable Type Stocks

Type	Equation
init	SCA_NI = 0
flow	SCA_NI = +dt*SCA_NI_adj_r1 +dt*SCA_NI_r
unit	SCA_NI = System change action units/Person
init	SCSQ_EHU = 50
flow	SCSQ_EHU = +dt*SCSQ_EHU_adj_r1_1 +dt*SCSQ_EHU_r
unit	SCSQ_EHU = Satisfaction units/Person
init	SCSQ_LHD = 50
flow	SCSQ_LHD = +dt*SCSQ_LHD_adj_r1 +dt*SCSQ_LHD_r3 +dt*SCSQ_LHD_r2 +dt*SCSQ_LHD_r1
unit	SCSQ_LHD = Satisfaction units/Person
init	SCSQ_LHDWC = 50
flow	SCSQ_LHDWC = +dt*SCSQ_LHDWC_adj_r1 +dt*SCSQ_LHDWC_r2 +dt*SCSQ_LHDWC_r1
unit	SCSQ_LHDWC = Satisfaction units/Person
init	SCSQ_LHU = 50
flow	SCSQ_LHU = +dt*SCSQ_LHU_adj_r1 +dt*SCSQ_LHU_r
unit	SCSQ_LHU = Satisfaction units/Person
init	SCSQ_MHD = 50
flow	SCSQ_MHD = +dt*SCSQ_MHD_adj_r1 +dt*SCSQ_MHD_r2 +dt*SCSQ_MHD_r1
unit	SCSQ_MHD = Satisfaction units/Person
init	SCSQ_MHDWC = 50
flow	SCSQ_MHDWC = +dt*SCSQ_MHDWC_adj_r1 +dt*SCSQ_MHDWC_r
unit	SCSQ_MHDWC = Satisfaction units/Person
init	SCSQ_MHU = 50
flow	SCSQ_MHU = +dt*SCSQ_MHU_adj_r1 +dt*SCSQ_MHU_r
unit	SCSQ_MHU = Satisfaction units/Person
init	SCSQ_NI = 50
flow	SCSQ_NI = +dt*SCSQ_NI_adj_r1 +dt*SCSQ_NI_r
unit	SCSQ_NI = Satisfaction units/Person
init	SPSQ_EHU = 50
flow	SPSQ_EHU = +dt*SPSQ_EHU_adj_r1 +dt*SPSQ_EHU_r
unit	SPSQ_EHU = Satisfaction units/Person

APPENDIX H (continued)

Base Case Model Equations by Variable Type Stocks

Type	Equation
init	SPSQ_LHD = 50
flow	$\text{SPSQ_LHD} = +dt * \text{SPSQ_LHD_adj_r1}$ $+ dt * \text{SPSQ_LHD_r3}$ $+ dt * \text{SPSQ_LHD_r2}$ $+ dt * \text{SPSQ_LHD_r1}$
unit	SPSQ_LHD = Satisfaction units/Person
init	SPSQ_LHDWC = 50
flow	$\text{SPSQ_LHDWC} = +dt * \text{SPSQ_LHDWC_adj_r1}$ $+ dt * \text{SPSQ_LHDWC_r2}$ $+ dt * \text{SPSQ_LHDWC_r1}$
unit	SPSQ_LHDWC = Satisfaction units/Person
init	SPSQ_LHU = 50
flow	$\text{SPSQ_LHU} = +dt * \text{SPSQ_LHU_adj_r1}$ $+ dt * \text{SPSQ_LHU_r}$
unit	SPSQ_LHU = Satisfaction units/Person
init	SPSQ_MHD = 50
flow	$\text{SPSQ_MHD} = +dt * \text{SPSQ_MHD_adj_r1}$ $+ dt * \text{SPSQ_MHD_r2}$ $+ dt * \text{SPSQ_MHD_r1}$
unit	SPSQ_MHD = Satisfaction units/Person
init	SPSQ_MHDWC = 50
flow	$\text{SPSQ_MHDWC} = +dt * \text{SPSQ_MHDWC_adj_r1}$ $+ dt * \text{SPSQ_MHDWC_r}$
unit	SPSQ_MHDWC = Satisfaction units/Person
init	SPSQ_MHU = 50
flow	$\text{SPSQ_MHU} = +dt * \text{SPSQ_MHU_adj_r1}$ $+ dt * \text{SPSQ_MHU_r}$
unit	SPSQ_MHU = Satisfaction units/Person
init	SPSQ_NI = 50
flow	$\text{SPSQ_NI} = +dt * \text{SPSQ_NI_adj_r1}$ $+ dt * \text{SPSQ_NI_r}$
unit	SPSQ_NI = Satisfaction units/Person
init	Tot_symptom_EHU = Sympt_EHU_intensity_fraction
flow	$\text{Tot_symptom_EHU} = -dt * \text{Sympt_drain_EHU_r}$ $+ dt * \text{Sympt_prod_EHU_r}$
unit	Tot_symptom_EHU = Symptoms
init	Tot_symptom_LHD = Sympt_LHD_intensity_fraction
flow	$\text{Tot_symptom_LHD} = +dt * \text{Sympt_LHD_adj_r1}$ $+ dt * \text{Sympt_prod_LHD_r2}$ $+ dt * \text{Sympt_prod_LHD_r3}$ $+ dt * \text{Sympt_prod_LHD_r}$ $- dt * \text{Sympt_drain_LHD_r}$
unit	Tot_symptom_LHD = Symptoms

APPENDIX H (continued)

Base Case Model Equations by Variable Type Stocks

Type	Equation
init	Tot_symptom_LHDWC = Sympt_LHDWC_intensity_fraction
flow	$\begin{aligned} \text{Tot_symptom_LHDWC} = & +dt * \text{Sympt_LHDWC_adj_r1_1} \\ & +dt * \text{Sympt_prod_LHDWC_r1} \\ & +dt * \text{Sympt_prod_LHDWC_r} \\ & -dt * \text{Sympt_drain_LHDWC_r} \end{aligned}$
unit	Tot_symptom_LHDWC = Symptoms
init	Tot_symptom_LHU = Sympt_LHU_intensity_fraction
flow	$\begin{aligned} \text{Tot_symptom_LHU} = & +dt * \text{Sympt_prod_LHU_r} \\ & -dt * \text{Sympt_drain_LHU_r} \end{aligned}$
unit	Tot_symptom_LHU = Symptoms
init	Tot_symptom_MHD = Sympt_MHD_intensity_fraction
flow	$\begin{aligned} \text{Tot_symptom_MHD} = & +dt * \text{Sympt_MHD_adj_r1} \\ & +dt * \text{Sympt_prod_MHD_r2} \\ & -dt * \text{Sympt_drain_MHD_r} \\ & +dt * \text{Sympt_prod_MHD_r1} \end{aligned}$
unit	Tot_symptom_MHD = Symptoms
init	Tot_symptom_MHDWC = Sympt_MHDWC_intensity_fraction
flow	$\begin{aligned} \text{Tot_symptom_MHDWC} = & +dt * \text{Sympt_MHDWC_adj_r1} \\ & +dt * \text{Sympt_prod_MHDWC_r} \\ & -dt * \text{Sympt_drain_MHDWC_r} \end{aligned}$
unit	Tot_symptom_MHDWC = Symptoms
init	Tot_symptom_MHU = Sympt_MHU_intensity_fraction
flow	$\begin{aligned} \text{Tot_symptom_MHU} = & -dt * \text{Sympt_drain_MHU_r} \\ & +dt * \text{Sympt_prod_MHU_r} \end{aligned}$
unit	Tot_symptom_MHU = Symptoms
init	Tot_symptom_NI = Sympt_NI_intensity_fraction
flow	$\begin{aligned} \text{Tot_symptom_NI} = & -dt * \text{Sympt_drain_NI_r} \\ & +dt * \text{Sympt_prod_NI_r} \end{aligned}$
unit	Tot_symptom_NI = Symptoms

Note: Start = 0.00; stop = 216 (months); dt = 1.000; method = Euler (fixed step).

APPENDIX H (continued)

Base Case Model Equations by Variable Type Rates

Type	Equation
rate unit	$AIDS_death_undia_r = ((1*(1-PC_on_LTP_frac))*Epi_LHU)/AD_undiag_t$ AIDS death undia r = Persons/Month
rate unit	$AIDS_death_w_care_r = (((1-CC_LHD_off_care_frac)*Epi_LHDWC)*HAART_effect)/AIDS_death_w_care_t$ AIDS death w care r = Persons/Month
rate unit	$AIDS_death_wo_care_r = ((1-CC_LHD_on_care_frac)*Epi_LHD)/AD_diag_t$ AIDS death wo care r = Persons/Month
rate unit	$CC_LHD_adj_r1 = (CSQ_on_CC_LHD_e-CC_LHD)/CC_LHD_adj_t1$ CC LHD adj r1 = Care complacency units/Person/Month
rate unit	$CC_LHD_adj_r2 = (((PTE_SC_on_CC_LHD_m*CC_LHD)-CC_LHD)*CC_LHD_adj_r2_limit)/CC_LHD_adj_t2$ CC LHD adj r2 = Care complacency units/Person/Month
rate unit	$CC_LHD_r1 = ((Epi_LHD_care_complacency_goal-CC_LHD)*CC_LHD_r1_limit)/CC_LHD_t1$ CC LHD r1 = Care complacency units/Person/Month
rate unit	$CC_LHD_r2 = (CC_MHD-CC_LHD)/CC_LHD_t2$ CC LHD r2 = Care complacency units/Person/Month
rate unit	$CC_LHD_r3 = (CC_LHDWC-CC_LHD)/CC_LHD_t3$ CC LHD r3 = Care complacency units/Person/Month
rate unit	$CC_LHDWC_adj_r1 = (CSQ_on_CC_LHDWC_e-CC_LHDWC)/CC_LHDWC_adj_t1$ CC LHDWC adj r1 = Care complacency units/Person/Month
rate unit	$CC_LHDWC_adj_r2 = (((PTE_SC_on_CC_LHDWC_m*CC_LHDWC)-CC_LHDWC)*CC_LHDWC_adj_r2_limit)/CC_LHDWC_adj_t2$ CC LHDWC adj r2 = Perceived treatment efficacy units/Person/Month
rate unit	$CC_LHDWC_r1 = ((CC_MHDWC-CC_LHDWC)*CC_LHDWC_r1_limit)/CC_LHDWC_t1$ CC LHDWC r1 = Care complacency units/Person/Month
rate unit	$CC_LHDWC_r2 = ((CC_LHD-CC_LHDWC)*CC_LHDWC_r2_limit)/CC_LHDWC_t2$ CC LHDWC r2 = Care complacency units/Person/Month
rate unit	$CC_MHD_adj_r1 = (CSQ_on_CC_MHD_e-CC_MHD)/CC_MHD_adj_t1$ CC MHD adj r1 = Care complacency units/Person/Month
rate unit	$CC_MHD_adj_r2 = (((PTE_SC_on_CC_MHD_m*CC_MHD)-CC_MHD)*CC_MHD_adj_r2_limit)/CC_MHD_adj_t2$ CC MHD adj r2 = Perceived treatment efficacy units/Person/Month
rate unit	$CC_MHD_r1 = (((Epi_MHD_care_complacency_goal-CC_MHD)*CC_MHD_r1_limit)/CC_MHD_t1)$ CC MHD r1 = Care complacency units/Person/Month
rate unit	$CC_MHD_r2 = (CC_MHDWC-CC_MHD)/CC_MHD_t2$ CC MHD r2 = Care complacency units/Person/Month
rate unit	$CC_MHDWC_adj_r1 = (CSQ_on_CC_MHDWC_e-CC_MHDWC)/CC_MHDWC_adj_t1$ CC MHDWC adj r1 = Care complacency units/Person
rate unit	$CC_MHDWC_adj_r2 = (((PTE_SC_on_CC_MHDWC_m*CC_MHDWC)-CC_MHDWC)*CC_MHDWC_adj_r2_limit)/CC_MHDWC_adj_t2$ CC MHDWC adj r2 = Care complacency units/Person/Month

APPENDIX H (continued)

Base Case Model Equations by Variable Type Rates

Type	Equation
rate unit	$CC_MHDWC_r = ((CC_MHD - CC_MHDWC) * CC_MHDWC_r_limit) / CC_MHDWC_t$ CC_MHDWC_r = Care complacency units/Person/Month
rate unit	$CR_inflow_r = Care_funding_input * CR_convert_prod_frac$ CR_inflow_r = Resource units/Month
rate unit	$CR_outflow_r = Care_resources * CR_drain_frac$ CR_outflow_r = Resource units/Month
rate unit	$CSQ_dec_r = Care_Sys_Quality / Care_Sys_Quality_t$ CSQ_dec_r = System quality units/Month
rate unit	$CSQ_inc_r =$ $CR_on_CSQ_e * SCA_on_CSQ_e * CSQ_base_compound_frac * Care_Sys_Quality$ CSQ_inc_r = System quality units/Month
rate unit	$Early_test_pos_r = ((PC_on_ETP_frac) * Epi_EHU) / MHS_diag_t$ Early_test_pos_r = Persons/Month
rate unit	$Infect_r = Total_HIV_pos_p * Contacts_per_at_risk_p * Chance_infection$ Infect_r = Persons/Month
rate unit	$Late_HIV_sym_undia_r = ((1 - PC_on_MTP_frac) * Epi_MHU) / LHS_undiag_t$ Late_HIV_sym_undia_r = Persons/Month
rate unit	$Late_HIV_sym_wo_care_r = ((1 -$ $CC_MHD_on_care_frac) * Epi_MHD) / LHS_diag_wo_care_t$ Late_HIV_sym_wo_care_r = Persons/Month
rate unit	$Late_test_pos_r = ((1 * PC_on_LTP_frac) * Epi_LHU) / AD_diag_t$ Late_test_pos_r = Persons/Month
rate unit	$LHD_off_care_r = ((CC_LHD_off_care_frac) * Epi_LHDWC) / LHD_off_care_t$ LHD_off_care_r = Persons/Month
rate unit	$LHD_on_care_r = ((CC_LHD_on_care_frac) * Epi_LHD) / LHD_on_care_t$ LHD_on_care_r = Persons/Month
rate unit	$LHD_sym_w_care_r = ((CC_MHD_off_care_frac) * Epi_MHDWC) / LHD_w_care_t$ LHD_sym_w_care_r = Persons/Month
rate unit	$MHD_off_care_r = ((1 - CC_MHD_off_care_frac) * Epi_MHDWC) / MHD_off_care_t$ MHD_off_care_r = Persons/Month
rate unit	$MHD_on_care_r = ((CC_MHD_on_care_frac) * Epi_MHD) / MHD_on_care_t$ MHD_on_care_r = Persons/Month
rate unit	$Mid_HIV_sym_undia_r = ((1 - PC_on_ETP_frac) * Epi_EHU) / MHS_undiag_t$ Mid_HIV_sym_undia_r = Persons/Month
rate unit	$Mid_test_pos_r = ((PC_on_MTP_frac) * Epi_MHU) / LHS_diag_t$ Mid_test_pos_r = Persons/Month
rate unit	$PC_EHU_adj_r1 = (((PTE_SC_PHS_on_PC_MNU_m * PC_EHU) -$ $PC_EHU) * PTE_SC_PHS_on_PHS_EHU_limit) / PC_NI_adj_t1_1$ PC_EHU_adj_r1 = Prevention complacency units/Person/Month
rate unit	$PC_EHU_adj_r2 = (PSQ_on_PC_EHU_e - PC_EHU) / PC_EHU_adj_t2$ PC_EHU_adj_r2 = Prevention complacency units/Person/Month
rate unit	$PC_EHU_r = (PC_NI - PC_EHU) / PC_EHU_t$ PC_EHU_r = Prevention complacency units/Person/Month

APPENDIX H (continued)

Base Case Model Equations by Variable Type Rates

Type	Equation
rate	$PC_LHD_adj_r1 = (((PTE_SC_PHS_on_PC_LHD_m * PC_LHD) - PC_LHD) * PTE_SC_PHS_on_PHS_LHD_limit) / PC_LHD_adj_t1$
unit	PC_LHD_adj_r1 = Prevention complacency units/Person/Month
rate	$PC_LHD_adj_r2 = (PSQ_on_PC_LHD_e - PC_LHD) / PC_LHD_adj_t2$
unit	PC_LHD_adj_r2 = Prevention complacency units/Person/Month
rate	$PC_LHD_r1 = (PC_MHU - PC_LHD) / PC_LHD_t1$
unit	PC_LHD_r1 = Prevention complacency units/Person/Month
rate	$PC_LHD_r2 = (PC_MHD - PC_LHD) / PC_LHD_t2$
unit	PC_LHD_r2 = Prevention complacency units/Person/Month
rate	$PC_LHD_r3 = (PC_LHDWC - PC_LHD) / PC_LHD_t3$
unit	PC_LHD_r3 = Prevention complacency units/Person/Month
rate	$PC_LHDWC_adj_r1 = (((PTE_SC_PHS_on_PC_LHDWC_m * PC_LHDWC) - PC_LHDWC) * PTE_SC_PHS_on_PHS_LHDWC_limit) / PC_LHDWC_adj_t1$
unit	PC_LHDWC_adj_r1 = Prevention complacency units/Person/Month
rate	$PC_LHDWC_adj_r2 = (PSQ_on_PC_LHDWC_e - PC_LHDWC) / PC_LHDWC_adj_t2$
unit	PC_LHDWC_adj_r2 = Prevention complacency units/Person/Month
rate	$PC_LHDWC_r1 = (PC_MHDWC - PC_LHDWC) / PC_LHDWC_t1$
unit	PC_LHDWC_r1 = Prevention complacency units/Person/Month
rate	$PC_LHDWC_r2 = (PC_LHD - PC_LHDWC) / PC_LHDWC_t2$
unit	PC_LHDWC_r2 = Prevention complacency units/Person/Month
rate	$PC_LHU_adj_r1 = (((PTE_SC_PHS_on_PC_LHU_m * PC_LHU) - PC_LHU) * PHS_LHU_limit_adj_r1) / PC_LHU_adj_t1$
unit	PC_LHU_adj_r1 = Prevention complacency units/Person/Month
rate	$PC_LHU_adj_r2 = (PSQ_on_PC_LHU_e - PC_LHU) / PC_LHU_adj_t2$
unit	PC_LHU_adj_r2 = Prevention complacency units/Person/Month
rate	$PC_LHU_r = (PC_MHU - PC_LHU) / PC_LHU_t$
unit	PC_LHU_r = Prevention complacency units/Person/Month
rate	$PC_MHD_adj_r1 = (((PTE_SC_PHS_on_PC_MHD_m * PC_MHD) - PC_MHD) * PTE_SC_PHS_on_PHS_MHD_limit) / PC_MHD_adj_t1$
unit	PC_MHD_adj_r1 = Prevention complacency units/Person/Month
rate	$PC_MHD_adj_r2 = (PSQ_on_PC_MHD_e - PC_MHD) / PC_MHD_adj_t2$
unit	PC_MHD_adj_r2 = Prevention complacency units/Person/Month
rate	$PC_MHD_r1 = (PC_EHU - PC_MHD) / PC_MHD_t1$
unit	PC_MHD_r1 = Prevention complacency units/Person/Month
rate	$PC_MHD_r2 = (PC_MHDWC - PC_MHD) / PC_MHD_t2$
unit	PC_MHD_r2 = Prevention complacency units/Person/Month
rate	$PC_MHDWC_adj_r1 = (((PTE_SC_PHS_on_PC_MHDWC_m * PC_MHDWC) - PC_MHDWC) * PHS_MHDWC_limit_adj_r1) / PC_MHDWC_adj_t1$
unit	PC_MHDWC_adj_r1 = Prevention complacency units/Person/Month
rate	$PC_MHDWC_adj_r2 = (PSQ_on_PC_MHDWC_e - PC_MHDWC) / PC_MHDWC_adj_t2$
unit	PC_MHDWC_adj_r2 = Prevention complacency units/Person/Month
rate	$PC_MHDWC_r = (PC_MHD - PC_MHDWC) / PC_MHDWC_t$
unit	PC_MHDWC_r = Prevention complacency units/Person/Month

APPENDIX H (continued)

Base Case Model Equations by Variable Type Rates

Type	Equation
rate	$PC_MHU_adj_r1 = (((PTE_SC_PHS_on_PC_MHU_m * PC_MHU) - PC_MHU) * PTE_SC_PHS_on_PHS_MHU_limit) / PC_MHU_adj_t1$
unit	PC_MHU_adj_r1 = Prevention complacency units/Person/Month
rate	$PC_MHU_adj_r2 = (PSQ_on_PC_MHU_e - PC_MHU) / PC_MHU_adj_t2$
unit	PC_MHU_adj_r2 = Prevention complacency units/Person/Month
rate	$PC_MHU_r = (PC_EHU - PC_MHU) / PC_MHU_t$
unit	PC_MHU_r = Prevention complacency units/Person/Month
rate	$PC_NI_adj_r1 = (((PTE_SC_PHS_on_PC_NI_m * PC_NI) - PC_NI) * PTE_SC_PHS_on_PHS_NI_limit) / PC_NI_adj_t1$
unit	PC_NI_adj_r1 = Prevention complacency units/Person/Month
rate	$PC_NI_adj_r2 = (PSQ_on_PC_NI_e - PC_NI) / PC_NI_adj_t2$
unit	PC_NI_adj_r2 = Prevention complacency units/Person/Month
rate	$PC_NI_r = (Prevention_complacency_goal - PC_NI) / PC_NI_t$
unit	PC_NI_r = Prevention complacency units/Person/Month
rate	$PHS_EHU_adj_r1 = (PSQ_on_PHS_EHU_e - PHS_EHU) / PHS_EHU_adj_t1$
unit	PHS_EHU_adj_r1 = Perceived HIV related stigma units/Person/Month
rate	$PHS_EHU_adj_r2 = (((Sympt_on_PHS_EHU_m * PHS_EHU) - PHS_EHU) * Sympt_on_PHS_EHU_limit) / PHS_EHU_adj_t2$
unit	PHS_EHU_adj_r2 = Perceived HIV related stigma units/Person/Month
rate	$PHS_EHU_r = (PHS_NI - PHS_EHU) / PHS_EHU_t$
unit	PHS_EHU_r = Perceived HIV related stigma units/Person/Month
rate	$PHS_LHD_adj_r1 = (PSQ_on_PHS_LHD_e - PHS_LHD) / PHS_LHD_adj_t1$
unit	PHS_LHD_adj_r1 = Perceived HIV related stigma units/Person/Month
rate	$PHS_LHD_adj_r2 = (((Sympt_on_PHS_LHD_m * PHS_LHD) - PHS_LHD) * Sympt_on_PHS_LHD_limit) / PHS_LHD_adj_t2$
unit	PHS_LHD_adj_r2 = Perceived HIV related stigma units/Person/Month
rate	$PHS_LHD_r1 = (PHS_MHU - PHS_LHD) / PHS_LHD_t$
unit	PHS_LHD_r1 = Perceived HIV related stigma units/Person/Month
rate	$PHS_LHD_r2 = (PHS_MHD - PHS_LHD) / PHS_LHD_t2$
unit	PHS_LHD_r2 = Perceived treatment efficacy units/Person/Month
rate	$PHS_LHD_r3 = (PHS_MHDWC - PHS_LHD) / PHS_LHD_t3$
unit	PHS_LHD_r3 = Perceived HIV related stigma units/Person/Month
rate	$PHS_LHDWC_adj_r1 = (PSQ_on_PHS_LHDWC_e - PHS_LHDWC) / PHS_LHDWC_adj_t1$
unit	PHS_LHDWC_adj_r1 = Perceived HIV related stigma units/Person/Month
rate	$PHS_LHDWC_adj_r2 = (((Sympt_on_PHS_LHDWC_m * PHS_LHDWC) - PHS_LHDWC) * Sympt_on_PHS_LHDWC_limit) / PHS_LHDWC_adj_t2$
unit	PHS_LHDWC_adj_r2 = Perceived HIV related stigma units/Person/Month
rate	$PHS_LHDWC_r1 = (PHS_MHDWC - PHS_LHDWC) / PHS_LHDWC_t1$
unit	PHS_LHDWC_r1 = Perceived HIV related stigma units/Person/Month
rate	$PHS_LHDWC_r2 = (PHS_LHD - PHS_LHDWC) / PHS_LHDWC_t2$
unit	PHS_LHDWC_r2 = Perceived HIV related stigma units/Person/Month
rate	$PHS_LHU_adj_r1 = (PSQ_on_PHS_LHU_e - PHS_LHU) / PHS_LHU_adj_t1$
unit	PHS_LHU_adj_r1 = Perceived HIV related stigma units/Person/Month

APPENDIX H (continued)

Base Case Model Equations by Variable Type Rates

Type	Equation
rate	$PHS_LHU_adj_r2 = (((Sympt_on_PHS_LHU_m * PHS_LHU) - PHS_LHU) * Sympt_on_PHS_LHU_limit) / PHS_LHU_adj_t2$
unit	PHS_LHU_adj_r2 = Perceived HIV related stigma units/Person/Month
rate	$PHS_LHU_adj_r2_2 = (((Sympt_on_PHS_MHDWC_m * PHS_MHDWC) - PHS_MHDWC) * Sympt_on_PHS_MHDWC_limit) / PHS_MHDWC_adj_t2$
unit	PHS_LHU_adj_r2_2 = Perceived HIV related stigma units/Person/Month
rate	$PHS_LHU_r = (PHS_MHU - PHS_LHU) / PHS_LHU_t$
unit	PHS_LHU_r = Perceived HIV related stigma units/Person/Month
rate	$PHS_MHD_adj_r1 = (PSQ_on_PHS_MHD_e - PHS_MHD) / PHS_MHD_adj_t1$
unit	PHS_MHD_adj_r1 = Perceived HIV related stigma units/Person/Month
rate	$PHS_MHD_adj_r2 = (((Sympt_on_PHS_MHD_m * PHS_MHD) - PHS_MHD) * PHS_MHD_adj_r2_limit) / PHS_MHD_adj_t2$
unit	PHS_MHD_adj_r2 = Perceived HIV related stigma units/Person/Month
rate	$PHS_MHD_r1 = (PHS_EHU - PHS_MHD) / PHS_MHD_t1$
unit	PHS_MHD_r1 = Perceived HIV related stigma units/Person/Month
rate	$PHS_MHD_r2 = (PHS_MHDWC - PHS_MHD) / PHS_MHD_t2$
unit	PHS_MHD_r2 = Perceived HIV related stigma units/Person/Month
rate	$PHS_MHDWC_adj_r1 = (PSQ_on_PHS_MHDWC_e - PHS_MHDWC) / PHS_MHDWC_adj_t1$
unit	PHS_MHDWC_adj_r1 = Perceived HIV related stigma units/Person/Month
rate	$PHS_MHDWC_r = (PHS_MHD - PHS_MHDWC) / PHS_MHDWC_t$
unit	PHS_MHDWC_r = Perceived HIV related stigma units/Person/Month
rate	$PHS_MHU_adj_r1 = (PSQ_on_PHS_MHU_e - PHS_MHU) / PHS_MHU_adj_t1$
unit	PHS_MHU_adj_r1 = Perceived HIV related stigma units/Person/Month
rate	$PHS_MHU_adj_r2 = (((Sympt_on_PHS_MHU_m * PHS_MHU) - PHS_MHU) * Sympt_on_PHS_MHU_limit) / PHS_MHU_adj_t2$
unit	PHS_MHU_adj_r2 = Perceived HIV related stigma units/Person/Month
rate	$PHS_MHU_r = (PHS_EHU - PHS_MHU) / PHS_MHU_t$
unit	PHS_MHU_r = Perceived HIV related stigma units/Person/Month
rate	$PHS_NI_adj_r1 = (PSQ_on_PHS_NI_e - PHS_NI) / PHS_NI_adj_t1$
unit	PHS_NI_adj_r1 = Perceived HIV related stigma units/Person/Month
rate	$PHS_NI_adj_r2 = (((Sympt_on_PHS_NI_m * PHS_NI) - PHS_NI) * Sympt_on_PHS_NI_limit) / PHS_NI_adj_t2$
unit	PHS_NI_adj_r2 = Perceived HIV related stigma units/Person/Month
rate	$PHS_NI_r = (Perceived_HIV_related_Stigma_goal - PHS_NI) / PHS_NI_t$
unit	PHS_NI_r = Perceived HIV related stigma units/Person/Month
rate	$PHS_on_SC_EHU_adj_r1 = (PHS_on_SC_EHU_e - SC_EHU) / PHS_on_SC_EHU_adj_t1$
unit	PHS_on_SC_EHU_adj_r1 = Self concept units/Person/Month
rate	$PHS_on_SC_LHD_adj_r1 = (PHS_on_SC_LHD_e - SC_LHD) / PHS_on_SC_LHD_adj_t1$
unit	PHS_on_SC_LHD_adj_r1 = Self concept units/Person/Month
rate	$PHS_on_SC_LHDWC_adj_r1 = (PHS_on_SC_LHDWC_e - SC_LHDWC) / PHS_on_SC_LHDWC_adj_t1$
unit	PHS_on_SC_LHDWC_adj_r1 = Self concept units/Person/Month

APPENDIX H (continued)

Base Case Model Equations by Variable Type Rates

Type	Equation
rate	$PHS_on_SC_LHU_adj_r1 = (PHS_on_SC_LHU_e - SC_LHU) / PHS_on_SC_LHU_adj_t1$
unit	$PHS_on_SC_LHU_adj_r1 = \text{Self concept units/Person/Month}$
rate	$PHS_on_SC_MHD_adj_r1 = (PHS_on_SC_MHD_e - SC_MHD) / PHS_on_SC_MHD_adj_t1$
unit	$PHS_on_SC_MHD_adj_r1 = \text{Self concept units/Person/Month}$
rate	$PHS_on_SC_MHDWC_adj_r1 = (PHS_on_SC_MHDWC_e - SC_MHDWC) / PHS_on_SC_MHDWC_adj_t1$
unit	$PHS_on_SC_MHDWC_adj_r1 = \text{Self concept units/Person/Month}$
rate	$PHS_on_SC_MHU_adj_r1 = (PHS_on_SC_MHU_e - SC_MHU) / PHS_on_SC_MHU_adj_t1$
unit	$PHS_on_SC_MHU_adj_r1 = \text{Self concept units/Person/Month}$
rate	$PHS_on_SC_NI_adj_r1 = (PHS_on_SC_NI_e - SC_NI) / PHS_on_SC_NI_adj_t1$
unit	$PHS_on_SC_NI_adj_r1 = \text{Self concept units/Person/Month}$
rate	$PR_inflow_r = Prev_funding_input * PR_convert_prod_frac$
unit	$PR_inflow_r = \text{Resource units/Month}$
rate	$PR_outflow_r = Prev_resources * PR_drain_frac$
unit	$PR_outflow_r = \text{Resource units/Month}$
rate	$PSQ_dec_r = Prev_Sys_Quality / Prev_Sys_Quality_t$
unit	$PSQ_dec_r = \text{System quality units/Month}$
rate	$PSQ_inc_r = PR_on_PSQ_e * SCA_on_PSQ_e * PSQ_base_compound_frac * Prev_Sys_Quality$
unit	$PSQ_inc_r = \text{System quality units/Month}$
rate	$PTE_EHU_adj_r1 = (((Deaths_on_PTE_EHU_m * PTE_EHU) - PTE_EHU) * PTE_EHU_adj_r1_limit) / PTE_EHU_adj_t1$
unit	$PTE_EHU_adj_r1 = \text{Perceived treatment efficacy units/Person/Month}$
rate	$PTE_EHU_r = (PTE_NI - PTE_EHU) / PTE_EHU_t$
unit	$PTE_EHU_r = \text{Perceived treatment efficacy units/Person/Month}$
rate	$PTE_LHD_adj_r1 = (((Deaths_on_PTE_LHD_m * PTE_LHD) - PTE_LHD) * PTE_LHD_adj_r1_limit) / PTE_LHD_adj_t1$
unit	$PTE_LHD_adj_r1 = \text{Perceived treatment efficacy units/Person/Month}$
rate	$PTE_LHD_r1 = (PTE_MHU - PTE_LHD) / PTE_LHD_t1$
unit	$PTE_LHD_r1 = \text{Perceived treatment efficacy units/Person/Month}$
rate	$PTE_LHD_r2 = (PTE_MHD - PTE_LHD) / PTE_LHD_t2$
unit	$PTE_LHD_r2 = \text{Perceived treatment efficacy units/Person/Month}$
rate	$PTE_LHD_r3 = (PTE_LHDWC - PTE_LHD) / PTE_LHD_t3$
unit	$PTE_LHD_r3 = \text{Perceived treatment efficacy units/Person/Month}$
rate	$PTE_LHDWC_adj_r1 = (((Deaths_on_PTE_LHDWC_m * PTE_LHDWC) - PTE_LHDWC) * PTE_LHDWC_adj_r1_limit) / PTE_LHDWC_adj_t1$
unit	$PTE_LHDWC_adj_r1 = \text{Perceived treatment efficacy units/Person/Month}$
rate	$PTE_LHDWC_r1 = (PTE_LHD - PTE_LHDWC) / PTE_LHDWC_t1$
unit	$PTE_LHDWC_r1 = \text{Perceived treatment efficacy units/Person/Month}$
rate	$PTE_LHDWDC_r2 = (PTE_MHDWC - PTE_LHDWC) / PTE_LHDWC_t2$
unit	$PTE_LHDWDC_r2 = \text{Perceived treatment efficacy units/Person/Month}$

APPENDIX H (continued)

Base Case Model Equations by Variable Type Rates

Type	Equation
rate	$PTE_LHU_adj_r1 = (((Deaths_on_PTE_LHU_m * PTE_LHU) - PTE_LHU) * PTE_LHU_adj_r1_limit) / PTE_LHU_adj_t1$
unit	PTE_LHU_adj_r1 = Perceived treatment efficacy units/Person/Month
rate	$PTE_LHU_r = (PTE_MHU - PTE_LHU) / PTE_LHU_t$
unit	PTE_LHU_r = Perceived treatment efficacy units/Person/Month
rate	$PTE_MHD_adj_r1 = (((Deaths_on_PTE_MHD_m * PTE_MHD) - PTE_MHD) * PTE_MHD_adj_r1_limit) / PTE_MHD_adj_t1$
unit	PTE_MHD_adj_r1 = Perceived treatment efficacy units/Person/Month
rate	$PTE_MHD_r1 = (PTE_EHU - PTE_MHD) / PTE_MHD_t1$
unit	PTE_MHD_r1 = Perceived treatment efficacy units/Person/Month
rate	$PTE_MHD_r2 = (PTE_MHDWC - PTE_MHD) / PTE_MHD_t2$
unit	PTE_MHD_r2 = Perceived treatment efficacy units/Person/Month
rate	$PTE_MHDWC_adj_r1 = (((Deaths_on_PTE_MHDWC_m * PTE_MHDWC) - PTE_MHDWC) * PTE_MHDWC_adj_r1_limit) / PTE_MHDWC_adj_t1$
unit	PTE_MHDWC_adj_r1 = Perceived treatment efficacy units/Person/Month
rate	$PTE_MHDWC_r = (PTE_MHD - PTE_MHDWC) / PTE_MHDWC_t$
unit	PTE_MHDWC_r = Perceived treatment efficacy units/Person/Month
rate	$PTE_MHU_adj_r1 = (((Deaths_on_PTE_MHU_m * PTE_MHU) - PTE_MHU) * PTE_MHU_adj_r1_limit) / PTE_MHU_adj_t1$
unit	PTE_MHU_adj_r1 = Perceived treatment efficacy units/Person/Month
rate	$PTE_MHU_r = (PTE_EHU - PTE_MHU) / PTE_MHU_t$
unit	PTE_MHU_r = Perceived treatment efficacy units/Person/Month
rate	$PTE_NI_adj_r1 = (((Deaths_on_PTE_NI_m * PTE_NI) - PTE_NI) * PTE_NI_adj_r1_limit) / PTE_NI_adj_t1$
unit	PTE_NI_adj_r1 = Perceived treatment efficacy units/Person/Month
rate	$PTE_NI_r = (Perceived_Treatment_Efficacy_goal - PTE_NI) / PTE_NI_t$
unit	PTE_NI_r = Perceived treatment efficacy units/Person/Month
rate	$SA_EHU_adj_r1 = (SC_on_SA_EHU_e - SA_EHU) / SC_on_SA_EHU_adj_t1$
unit	SA_EHU_adj_r1 = System awareness units/Person/Month
rate	$SA_EHU_adj_r2 = (SCA_on_SA_EHU_e - SA_EHU) / SCA_SA_EHU_adj_t2$
unit	SA_EHU_adj_r2 = System awareness units/Person/Month
rate	$SA_EHU_r = (SA_NI - SA_EHU) / SA_EHU_t$
unit	SA_EHU_r = System awareness units/Person/Month
rate	$SA_LHD_adj_r1 = (SC_on_SA_LHD_e - SA_LHD) / SC_on_SA_LHD_adj_t1$
unit	SA_LHD_adj_r1 = System awareness units/Person/Month
rate	$SA_LHD_adj_r2 = (SCA_on_SA_LHD_e - SA_LHD) / SCA_SA_LHD_adj_t2$
unit	SA_LHD_adj_r2 = System awareness units/Person/Month
rate	$SA_LHD_r1 = (SA_MHU - SA_LHD) / SA_LHD_t1$
unit	SA_LHD_r1 = System awareness units/Person/Month
rate	$SA_LHD_r2 = (SA_MHD - SA_LHD) / SA_LHD_t2$
unit	SA_LHD_r2 = System awareness units/Person/Month
rate	$SA_LHD_r3 = (SA_LHDWC - SA_LHD) / SA_LHD_t3$
unit	SA_LHD_r3 = System awareness units/Person/Month

APPENDIX H (continued)

Base Case Model Equations by Variable Type Rates

Type	Equation
rate	$SA_LHDWC_adj_r1 = (SC_on_SA_LHDWC_e - SA_LHDWC) / SC_on_SA_LHDWC_adj_t1$
unit	$SA_LHDWC_adj_r1 = \text{System awareness units/Person/Month}$
rate	$SA_LHDWC_adj_r2 = (SCA_on_SA_LHDWC_e - SA_LHDWC) / SCA_SA_LHDWC_adj_t2$
unit	$SA_LHDWC_adj_r2 = \text{System awareness units/Person/Month}$
rate	$SA_LHDWC_r1 = (SA_MHDWC - SA_LHDWC) / SA_LHDWC_t1$
unit	$SA_LHDWC_r1 = \text{System awareness units/Person/Month}$
rate	$SA_LHDWC_r2 = (SA_LHD - SA_LHDWC) / SA_LHDWC_t2$
unit	$SA_LHDWC_r2 = \text{System awareness units/Person/Month}$
rate	$SA_LHU_adj_r1 = (SC_on_SA_LHU_e - SA_LHU) / SC_on_SA_LHU_adj_t1$
unit	$SA_LHU_adj_r1 = \text{System awareness units/Person/Month}$
rate	$SA_LHU_adj_r2 = (SCA_on_SA_LHU_e - SA_LHU) / SCA_SA_LHU_adj_t2$
unit	$SA_LHU_adj_r2 = \text{System awareness units/Person/Month}$
rate	$SA_LHU_r = (SA_MHU - SA_LHU) / SA_LHU_t$
unit	$SA_LHU_r = \text{System awareness units/Person/Month}$
rate	$SA_MHD_adj_r1 = (SC_on_SA_MHD_e - SA_MHD) / SC_on_SA_MHD_adj_t1$
unit	$SA_MHD_adj_r1 = \text{System awareness units/Person/Month}$
rate	$SA_MHD_adj_r2 = (SCA_on_SA_MHD_e - SA_MHD) / SCA_SA_MHD_adj_t2$
unit	$SA_MHD_adj_r2 = \text{System awareness units/Person/Month}$
rate	$SA_MHD_r1 = (SA_EHU - SA_MHD) / SA_MHD_t1$
unit	$SA_MHD_r1 = \text{System awareness units/Person/Month}$
rate	$SA_MHD_r2 = (SA_MHDWC - SA_MHD) / SA_MHD_t2$
unit	$SA_MHD_r2 = \text{System awareness units/Person/Month}$
rate	$SA_MHDWC_adj_r1 = (SC_on_SA_MHDWC_e - SA_MHDWC) / SC_on_SA_MHDWC_adj_t1$
unit	$SA_MHDWC_adj_r1 = \text{System awareness units/Person/Month}$
rate	$SA_MHDWC_adj_r2 = (SCA_on_SA_MHDWC_e - SA_MHDWC) / SCA_SA_MHDWC_adj_t2$
unit	$SA_MHDWC_adj_r2 = \text{System awareness units/Person/Month}$
rate	$SA_MHDWC_r = (SA_MHD - SA_MHDWC) / SA_MHDWC_t$
unit	$SA_MHDWC_r = \text{System awareness units/Person/Month}$
rate	$SA_MHU_adj_r1 = (SC_on_SA_MHU_e - SA_MHU) / SC_on_SA_MHU_adj_t1$
unit	$SA_MHU_adj_r1 = \text{System awareness units/Person/Month}$
rate	$SA_MHU_adj_r2 = (SCA_on_SA_MHU_e - SA_MHU) / SCA_SA_MHU_adj_t2$
unit	$SA_MHU_adj_r2 = \text{System awareness units/Person/Month}$
rate	$SA_MHU_r = (SA_EHU - SA_MHU) / SA_MHU_t$
unit	$SA_MHU_r = \text{System awareness units/Person/Month}$
rate	$SA_NI_adj_r1 = (SC_on_SA_NI_e - SA_NI) / SC_on_SA_NI_adj_t1$
unit	$SA_NI_adj_r1 = \text{System awareness units/Person/Month}$
rate	$SA_NI_adj_r2 = (SCA_on_SA_NI_e - SA_NI) / SCA_SA_NI_adj_t2$
unit	$SA_NI_adj_r2 = \text{System awareness units/Person/Month}$
rate	$SA_NI_r = (System_Awareness_goal - SA_NI) / SA_NI_t$
unit	$SA_NI_r = \text{System awareness units/Person/Month}$

APPENDIX H (continued)

Base Case Model Equations by Variable Type Rates

Type	Equation
rate unit	$SA_on_SC_EHU_adj_r2 = (SA_on_SC_EHU_e - SC_EHU) / SA_SC_EHU_adj_t2$ $SA_on_SC_EHU_adj_r2 = \text{Self concept units/Person/Month}$
rate unit	$SA_on_SC_LHD_adj_r2 = (SA_on_SC_LHD_e - SC_LHD) / SA_on_SC_LHD_adj_t2$ $SA_on_SC_LHD_adj_r2 = \text{Self concept units/Person/Month}$
rate unit	$SA_on_SC_LHDWC_adj_r2 = (SA_on_SC_LHDWC_e - SC_LHDWC) / SA_on_SC_LHDWC_adj_t2$ $SA_on_SC_LHDWC_adj_r2 = \text{Self concept units/Person/Month}$
rate unit	$SA_on_SC_LHU_adj_r2 = (SA_on_SC_LHU_e - SC_LHU) / SA_on_SC_LHU_adj_t2$ $SA_on_SC_LHU_adj_r2 = \text{Self concept units/Person/Month}$
rate unit	$SA_on_SC_MHD_adj_r2 = (SA_on_SC_MHD_e - SC_MHD) / SA_on_SC_MHD_adj_t2$ $SA_on_SC_MHD_adj_r2 = \text{Self concept units/Person/Month}$
rate unit	$SA_on_SC_MHDWC_adj_r2 = (SA_on_SC_MHDWC_e - SC_MHDWC) / SA_on_SC_MHDWC_adj_t2$ $SA_on_SC_MHDWC_adj_r2 = \text{Self concept units/Person/Month}$
rate unit	$SA_on_SC_MHU_adj_r2 = (SA_on_SC_MHU_e - SC_MHU) / SA_SC_MHU_adj_t2$ $SA_on_SC_MHU_adj_r2 = \text{Self concept units/Person/Month}$
rate unit	$SA_on_SC_NI_adj_r2 = (SA_on_SC_NI_e - SC_NI) / SA_SC_NI_adj_t2$ $SA_on_SC_NI_adj_r2 = \text{Self concept units/Person/Month}$
rate unit	$SC_EHU_r = (SC_NI - SC_EHU) / SC_EHU_t$ $SC_EHU_r = \text{Self concept units/Person/Month}$
rate unit	$SC_LHD_r1 = (SC_MHU - SC_LHD) / SC_LHD_t1$ $SC_LHD_r1 = \text{Self concept units/Person/Month}$
rate unit	$SC_LHD_r2 = (SC_MHD - SC_LHD) / SC_LHD_t2$ $SC_LHD_r2 = \text{Self concept units/Person/Month}$
rate unit	$SC_LHD_r3 = (SC_LHDWC - SC_LHD) / SC_LHD_t3$ $SC_LHD_r3 = \text{Self concept units/Person/Month}$
rate unit	$SC_LHDWC_r1 = (SC_MHDWC - SC_LHDWC) / SC_LHDWC_t1$ $SC_LHDWC_r1 = \text{Self concept units/Person/Month}$
rate unit	$SC_LHDWC_r2 = (SC_LHD - SC_LHDWC) / SC_LHDWC_t2$ $SC_LHDWC_r2 = \text{Self concept units/Person/Month}$
rate unit	$SC_LHU_r = (SC_MHU - SC_LHU) / SC_LHU_t$ $SC_LHU_r = \text{Self concept units/Person/Month}$
rate unit	$SC_MHD_r1 = (SC_EHU - SC_MHD) / SC_MHD_t1$ $SC_MHD_r1 = \text{Self concept units/Person/Month}$
rate unit	$SC_MHD_r2 = (SC_MHDWC - SC_MHD) / SC_MHD_t2$ $SC_MHD_r2 = \text{Self concept units/Person/Month}$
rate unit	$SC_MHDWC_r = (SC_MHD - SC_MHDWC) / SC_MHDWC_t$ $SC_MHDWC_r = \text{Self concept units/Person/Month}$
rate unit	$SC_MHU_r = (SC_EHU - SC_MHU) / SC_MHU_t$ $SC_MHU_r = \text{Self concept units/Person/Month}$
rate unit	$SC_NI_r = (\text{Self_Concept_goal} - SC_NI) / SC_NI_t$ $SC_NI_r = \text{Self concept units/Person/Month}$

APPENDIX H (continued)

Base Case Model Equations by Variable Type Rates

Type	Equation
rate	$SCA_EHU_adj_r1 = (((Tot_e_on_SCA_EHU_m * SCA_EHU) - SCA_EHU) * SCA_EHU_limit_adj_r1) / SCA_EHU_adj_t1$
unit	SCA_EHU_adj_r1 = System change action units/Person/Month
rate	$SCA_EHU_r = (SCA_NI - SCA_EHU) / SCA_EHU_t$
unit	SCA_EHU_r = System change action units/Person/Month
rate	$SCA_LHD_adj_r1 = (((Tot_m_on_SCA_LHD_e * SCA_LHD) - SCA_LHD) * SCA_LHD_limit_adj_r1) / SCA_LHD_adj_t1$
unit	SCA_LHD_adj_r1 = System change action units/Person/Month
rate	$SCA_LHD_r1 = (SCA_MHU - SCA_LHD) / SCA_LHD_t1$
unit	SCA_LHD_r1 = System change action units/Person/Month
rate	$SCA_LHD_r2 = (SCA_MHD - SCA_LHD) / SCA_LHD_t2$
unit	SCA_LHD_r2 = System change action units/Person/Month
rate	$SCA_LHD_r3 = (SCA_LHDWC - SCA_LHD) / SCA_LHD_t3$
unit	SCA_LHD_r3 = System change action units/Person/Month
rate	$SCA_LHDWC_adj_r1 = (((Tot_m_on_SCA_LHDWC_e * SCA_LHDWC) - SCA_LHDWC) * SCA_LHDWC_limit_adj_r1) / SCA_LHDWC_adj_t1$
unit	SCA_LHDWC_adj_r1 = System change action units/Person/Month
rate	$SCA_LHDWC_r1 = (SCA_LHD - SCA_LHDWC) / SCA_LHDWC_t1$
unit	SCA_LHDWC_r1 = System change action units/Person/Month
rate	$SCA_LHDWC_r2 = (SCA_MHDWC - SCA_LHDWC) / SCA_LHDWC_t2$
unit	SCA_LHDWC_r2 = System change action units/Person/Month
rate	$SCA_LHU_adj_r1 = (((Tot_m_on_SCA_LHU_e * SCA_LHU) - SCA_LHU) * SCA_LHU_limit_adj_r1) / SCA_LHU_adj_t1$
unit	SCA_LHU_adj_r1 = System change action units/Person/Month
rate	$SCA_LHU_r = (SCA_MHU - SCA_LHU) / SCA_LHU_t$
unit	SCA_LHU_r = System change action units/Person/Month
rate	$SCA_MHD_adj_r1 = (((Tot_m_on_SCA_MHD_e * SCA_MHD) - SCA_MHD) * SCA_MHD_limit_adj_r1) / SCA_MHD_adj_t1$
unit	SCA_MHD_adj_r1 = System change action units/Person/Month
rate	$SCA_MHD_r1 = (SCA_EHU - SCA_MHD) / SCA_MHD_t1$
unit	SCA_MHD_r1 = System change action units/Person/Month
rate	$SCA_MHD_r2 = (SCA_MHDWC - SCA_MHD) / SCA_MHD_t2$
unit	SCA_MHD_r2 = System change action units/Person/Month
rate	$SCA_MHDWC_adj_r1 = (((Tot_m_on_SCA_MHDWC_e * SCA_MHDWC) - SCA_MHDWC) * SCA_MHDWC_limit_adj_r1) / SCA_MHDWC_adj_t1$
unit	SCA_MHDWC_adj_r1 = System change action units/Person/Month
rate	$SCA_MHDWC_r = (SCA_MHD - SCA_MHDWC) / SCA_MHDWC_t$
unit	SCA_MHDWC_r = System change action units/Person/Month
rate	$SCA_MHU_adj_r1 = (((Tot_m_on_SCA_MHU_e * SCA_MHU) - SCA_MHU) * SCA_MHU_limit_adj_r1) / SCA_MHU_adj_t1$
unit	SCA_MHU_adj_r1 = System change action units/Person/Month
rate	$SCA_MHU_r = (SCA_EHU - SCA_MHU) / SCA_MHU_t$
unit	SCA_MHU_r = System change action units/Person/Month

APPENDIX H (continued)

Base Case Model Equations by Variable Type Rates

Type	Equation
rate	$SCA_NI_adj_r1 = (((Tot_e_on_SCA_NI_m * SCA_NI) - SCA_NI) * SCA_NI_limit_adj_r1) / SCA_NI_adj_t1$
unit	SCA_NI_adj_r1 = System change action units/Person/Month
rate	$SCA_NI_r = (System_Change_Action_goal - SCA_NI) / SCA_NI_t$
unit	SCA_NI_r = System change action units/Person/Month
rate	$SCA_on_SC_EHU_adj_r3 = (SCA_on_SC_EHU_e - SC_EHU) / SCA_on_SC_EHU_adj_t3$
unit	SCA_on_SC_EHU_adj_r3 = Self concept units/Person/Month
rate	$SCA_on_SC_LHD_adj_r3 = (SCA_on_SC_LHD_e - SC_LHD) / SCA_on_SC_LHD_adj_t3$
unit	SCA_on_SC_LHD_adj_r3 = Self concept units/Person/Month
rate	$SCA_on_SC_LHDWC_adj_r3 = (SCA_on_SC_LHDWC_e - SC_LHDWC) / SCA_on_SC_LHDWC_adj_t3$
unit	SCA_on_SC_LHDWC_adj_r3 = Self concept units/Person/Month
rate	$SCA_on_SC_LHU_adj_r3 = (SCA_on_SC_LHU_e - SC_LHU) / SCA_on_SC_LHU_adj_t3$
unit	SCA_on_SC_LHU_adj_r3 = Self concept units/Person/Month
rate	$SCA_on_SC_MHD_adj_r3 = (SCA_on_SC_MHD_e - SC_MHD) / SCA_on_SC_MHD_adj_t3$
unit	SCA_on_SC_MHD_adj_r3 = Self concept units/Person/Month
rate	$SCA_on_SC_MHDWC_adj_r3 = (SCA_on_SC_MHDWC_e - SC_MHDWC) / SCA_on_SC_MHDWC_adj_t3$
unit	SCA_on_SC_MHDWC_adj_r3 = Self concept units/Person/Month
rate	$SCA_on_SC_MHU_adj_r3 = (SCA_on_SC_MHU_e - SC_MHU) / SCA_on_SC_MHU_adj_t3$
unit	SCA_on_SC_MHU_adj_r3 = Self concept units/Person/Month
rate	$SCA_on_SC_NI_adj_r3 = (SCA_on_SC_NI_e - SC_NI) / SCA_on_SC_NI_adj_t3$
unit	SCA_on_SC_NI_adj_r3 = Self concept units/Person/Month
rate	$SCSQ_EHU_adj_r1_1 = (CSQ_on_SCSQ_EHU_e - SCSQ_EHU) / SCSQ_EHU_adj_t1$
unit	SCSQ_EHU_adj_r1_1 = Satisfaction units/Person/Month
rate	$SCSQ_EHU_r = (SCSQ_NI - SCSQ_EHU) / SCSQ_EHU_t$
unit	SCSQ_EHU_r = Satisfaction units/Person/Month
rate	$SCSQ_LHD_adj_r1 = (CSQ_on_SCSQ_LHD_e - SCSQ_LHD) / SCSQ_LHD_adj_t1$
unit	SCSQ_LHD_adj_r1 = Satisfaction units/Person/Month
rate	$SCSQ_LHD_r1 = (SCSQ_MHU - SCSQ_LHD) / SCSQ_LHD_t1$
unit	SCSQ_LHD_r1 = Satisfaction units/Person/Month
rate	$SCSQ_LHD_r2 = (SCSQ_MHD - SCSQ_LHD) / SCSQ_LHD_t2$
unit	SCSQ_LHD_r2 = Satisfaction units/Person/Month
rate	$SCSQ_LHD_r3 = (SCSQ_LHDWC - SCSQ_LHD) / SCSQ_LHD_t3$
unit	SCSQ_LHD_r3 = Satisfaction units/Person/Month
rate	$SCSQ_LHDWC_adj_r1 = (CSQ_on_SCSQ_LHDWC_e - SCSQ_LHDWC) / SCSQ_LHDWC_adj_t1$
unit	SCSQ_LHDWC_adj_r1 = Satisfaction units/Person/Month
rate	$SCSQ_LHDWC_r1 = (SCSQ_LHD - SCSQ_LHDWC) / SCSQ_LHDWC_t1$
unit	SCSQ_LHDWC_r1 = Satisfaction units/Person/Month

APPENDIX H (continued)

Base Case Model Equations by Variable Type Rates

Type	Equation
rate	$SCSQ_LHDWC_r2 = (SCSQ_MHDWC - SCSQ_LHDWC) / SCSQ_LHDWC_t2$
unit	$SCSQ_LHDWC_r2 = \text{Satisfaction units/Person/Month}$
rate	$SCSQ_LHU_adj_r1 = (CSQ_on_SCSQ_LHU_e - SCSQ_LHU) / SCSQ_LHU_adj_t1$
unit	$SCSQ_LHU_adj_r1 = \text{Satisfaction units/Person/Month}$
rate	$SCSQ_LHU_r = (SCSQ_MHU - SCSQ_LHU) / SCSQ_LHU_t$
unit	$SCSQ_LHU_r = \text{Satisfaction units/Person/Month}$
rate	$SCSQ_MHD_adj_r1 = (CSQ_on_SCSQ_MHD_e - SCSQ_MHD) / SCSQ_MHD_adj_t1$
unit	$SCSQ_MHD_adj_r1 = \text{Satisfaction units/Person/Month}$
rate	$SCSQ_MHD_r1 = (SCSQ_EHU - SCSQ_MHD) / SCSQ_MHD_t1$
unit	$SCSQ_MHD_r1 = \text{Satisfaction units/Person/Month}$
rate	$SCSQ_MHD_r2 = (SCSQ_MHDWC - SCSQ_MHD) / SCSQ_MHD_t2$
unit	$SCSQ_MHD_r2 = \text{Satisfaction units/Person/Month}$
rate	$SCSQ_MHDWC_adj_r1 = (CSQ_on_SCSQ_MHDWC_e - SCSQ_MHDWC) / SCSQ_MHDWC_adj_t1$
unit	$SCSQ_MHDWC_adj_r1 = \text{Satisfaction units/Person/Month}$
rate	$SCSQ_MHDWC_r = (SCSQ_MHD - SCSQ_MHDWC) / SCSQ_MHDWC_t$
unit	$SCSQ_MHDWC_r = \text{Satisfaction units/Person/Month}$
rate	$SCSQ_MHU_adj_r1 = (CSQ_on_SCSQ_MHU_e - SCSQ_MHU) / SCSQ_MHU_adj_t1$
unit	$SCSQ_MHU_adj_r1 = \text{Satisfaction units/Person/Month}$
rate	$SCSQ_MHU_r = (SCSQ_EHU - SCSQ_MHU) / SCSQ_MHU_t$
unit	$SCSQ_MHU_r = \text{Satisfaction units/Person/Month}$
rate	$SCSQ_NI_adj_r1 = (CSQ_on_SCSQ_NI_e - SCSQ_NI) / SCSQ_NI_adj_t1$
unit	$SCSQ_NI_adj_r1 = \text{Satisfaction units/Person/Month}$
rate	$SCSQ_NI_r = (\text{Satisfaction_with_Care_System_Quality_goal} - SCSQ_NI) / SCSQ_NI_t$
unit	$SCSQ_NI_r = \text{Satisfaction units/Person/Month}$
rate	$Seroconvert_r = Epi_NI / SC_t$
unit	$Seroconvert_r = \text{Persons/Month}$
rate	$SPSQ_EHU_adj_r1 = (PSQ_on_SPSQ_EHU_e - SPSQ_EHU) / SPSQ_EHU_adj_t1$
unit	$SPSQ_EHU_adj_r1 = \text{Satisfaction units/Person/Month}$
rate	$SPSQ_EHU_r = (SPSQ_NI - SPSQ_EHU) / SPSQ_EHU_t$
unit	$SPSQ_EHU_r = \text{Satisfaction units/Person/Month}$
rate	$SPSQ_LHD_adj_r1 = (PSQ_on_SPSQ_LHD_e - SPSQ_LHD) / SPSQ_LHD_adj_t1$
unit	$SPSQ_LHD_adj_r1 = \text{Satisfaction units/Person/Month}$
rate	$SPSQ_LHD_r1 = (SPSQ_MHU - SPSQ_LHD) / SPSQ_LHD_t1$
unit	$SPSQ_LHD_r1 = \text{Satisfaction units/Person/Month}$
rate	$SPSQ_LHD_r2 = (SPSQ_MHD - SPSQ_LHD) / SPSQ_LHD_t2$
unit	$SPSQ_LHD_r2 = \text{Satisfaction units/Person/Month}$
rate	$SPSQ_LHD_r3 = (SPSQ_LHDWC - SPSQ_LHD) / SPSQ_LHD_t3$
unit	$SPSQ_LHD_r3 = \text{Satisfaction units/Person/Month}$
rate	$SPSQ_LHDWC_adj_r1 = (PSQ_on_SPSQ_LHDWC_e - SPSQ_LHDWC) / SPSQ_LHDWC_adj_t1$
unit	$SPSQ_LHDWC_adj_r1 = \text{Satisfaction units/Person/Month}$
rate	$SPSQ_LHDWC_r1 = (SPSQ_LHD - SPSQ_LHDWC) / SPSQ_LHDWC_t1$
unit	$SPSQ_LHDWC_r1 = \text{Satisfaction units/Person/Month}$

APPENDIX H (continued)

Base Case Model Equations by Variable Type Rates

Type	Equation
rate unit	$\text{SPSQ_LHDWC_r2} = (\text{SPSQ_MHDWC} - \text{SPSQ_LHDWC}) / \text{SPSQ_LHDWC_t2}$ $\text{SPSQ_LHDWC_r2} = \text{Satisfaction units/Person/Month}$
rate unit	$\text{SPSQ_LHU_adj_r1} = (\text{PSQ_on_SPSQ_LHU_e} - \text{SPSQ_LHU}) / \text{SPSQ_LHU_adj_t1}$ $\text{SPSQ_LHU_adj_r1} = \text{Satisfaction units/Person/Month}$
rate unit	$\text{SPSQ_LHU_r} = (\text{SPSQ_MHU} - \text{SPSQ_LHU}) / \text{SPSQ_LHU_t}$ $\text{SPSQ_LHU_r} = \text{Satisfaction units/Person/Month}$
rate unit	$\text{SPSQ_MHD_adj_r1} = (\text{PSQ_on_SPSQ_MHD_e} - \text{SPSQ_MHD}) / \text{SPSQ_MHD_adj_t1}$ $\text{SPSQ_MHD_adj_r1} = \text{Satisfaction units/Person/Month}$
rate unit	$\text{SPSQ_MHD_r1} = (\text{SPSQ_EHU} - \text{SPSQ_MHD}) / \text{SPSQ_MHD_t1}$ $\text{SPSQ_MHD_r1} = \text{Satisfaction units/Person/Month}$
rate unit	$\text{SPSQ_MHD_r2} = (\text{SPSQ_MHDWC} - \text{SPSQ_MHD}) / \text{SPSQ_MHD_t2}$ $\text{SPSQ_MHD_r2} = \text{Satisfaction units/Person/Month}$
rate unit	$\text{SPSQ_MHDWC_adj_r1} = (\text{PSQ_on_SPSQ_MHDWC_e} - \text{SPSQ_MHDWC}) / \text{SPSQ_MHDWC_adj_t1}$ $\text{SPSQ_MHDWC_adj_r1} = \text{Satisfaction units/Person/Month}$
rate unit	$\text{SPSQ_MHDWC_r} = (\text{SPSQ_MHD} - \text{SPSQ_MHDWC}) / \text{SPSQ_MHDWC_t}$ $\text{SPSQ_MHDWC_r} = \text{Satisfaction units/Person/Month}$
rate unit	$\text{SPSQ_MHU_adj_r1} = (\text{PSQ_on_SPSQ_MHU_e} - \text{SPSQ_MHU}) / \text{SPSQ_MHU_adj_t1}$ $\text{SPSQ_MHU_adj_r1} = \text{Satisfaction units/Person/Month}$
rate unit	$\text{SPSQ_MHU_r} = (\text{SPSQ_EHU} - \text{SPSQ_MHU}) / \text{SPSQ_MHU_t}$ $\text{SPSQ_MHU_r} = \text{Satisfaction units/Person/Month}$
rate unit	$\text{SPSQ_NI_adj_r1} = (\text{PSQ_on_SPSQ_NI_e} - \text{SPSQ_NI}) / \text{SPSQ_NI_adj_t1}$ $\text{SPSQ_NI_adj_r1} = \text{Satisfaction units/Person/Month}$
rate unit	$\text{SPSQ_NI_r} = (\text{Satisfaction_with_Prevention_System_Quality_goal} - \text{SPSQ_NI}) / \text{SPSQ_NI_t}$ $\text{SPSQ_NI_r} = \text{Satisfaction units/Person/Month}$
rate unit	$\text{Sympt_drain_EHU_r} = \text{Tot_symptom_EHU} / \text{Sympt_EHU_drain_t}$ $\text{Sympt_drain_EHU_r} = \text{Symptoms/Month}$
rate unit	$\text{Sympt_drain_LHD_r} = \text{Tot_symptom_LHD} / \text{Sympt_LHD_drain_t}$ $\text{Sympt_drain_LHD_r} = \text{Symptoms/Month}$
rate unit	$\text{Sympt_drain_LHDWC_r} = \text{Tot_symptom_LHDWC} / \text{Sympt_LHDWC_drain_t}$ $\text{Sympt_drain_LHDWC_r} = \text{Symptoms/Month}$
rate unit	$\text{Sympt_drain_LHU_r} = \text{Tot_symptom_LHU} / \text{Sympt_LHU_drain_t}$ $\text{Sympt_drain_LHU_r} = \text{Symptoms/Month}$
rate unit	$\text{Sympt_drain_MHD_r} = \text{Tot_symptom_MHD} / \text{Sympt_MHD_drain_t}$ $\text{Sympt_drain_MHD_r} = \text{Symptoms/Month}$
rate unit	$\text{Sympt_drain_MHDWC_r} = \text{Tot_symptom_MHDWC} / \text{Sympt_MHDWC_drain_t}$ $\text{Sympt_drain_MHDWC_r} = \text{Symptoms/Month}$
rate unit	$\text{Sympt_drain_MHU_r} = \text{Tot_symptom_MHU} / \text{Sympt_MHU_drain_t}$ $\text{Sympt_drain_MHU_r} = \text{Symptoms/Month}$
rate unit	$\text{Sympt_drain_NI_r} = \text{Tot_symptom_NI} / \text{Sympt_NI_drain_t}$ $\text{Sympt_drain_NI_r} = \text{Symptoms/Month}$
rate unit	$\text{Sympt_LHD_adj_r1} = (((\text{CC_on_Sympt_LHD_m} * \text{Tot_symptom_LHD}) - \text{Tot_symptom_LHD}) * \text{Sympt_LHD_limit_adj_r1}) / \text{Sympt_LHD_adj_t1}$ $\text{Sympt_LHD_adj_r1} = \text{Symptoms/Month}$

APPENDIX H (continued)

Base Case Model Equations by Variable Type Rates

Type	Equation
rate	$\text{Sympt_LHDWC_adj_r1_1} = (((\text{CC_on_Sympt_LHDWC_m} * \text{Tot_symptom_LHDWC}) - \text{Tot_symptom_LHDWC}) * \text{Sympt_LHDWC_limit_adj_r1}) / \text{Sympt_MHDWC_adj_t1_1}$
unit	Sympt LHDWC adj r1 1 = Symptoms/Month
rate	$\text{Sympt_MHD_adj_r1} = (((\text{CC_on_Sympt_MHD_m} * \text{Tot_symptom_MHD}) - \text{Tot_symptom_MHD}) * \text{Sympt_MHD_limit_adj_r1}) / \text{Sympt_MHD_adj_t1}$
unit	Sympt MHD adj r1 = Symptoms/Month
rate	$\text{Sympt_MHDWC_adj_r1} = (((\text{CC_on_Sympt_MHDWC_m} * \text{Tot_symptom_MHDWC}) - \text{Tot_symptom_MHDWC}) * \text{Sympt_MHDWC_limit_adj_r1}) / \text{Sympt_MHDWC_adj_t1}$
unit	Sympt MHDWC adj r1 = Symptoms/Month
rate	$\text{Sympt_prod_EHU_r} = \text{Seroconvert_r} * \text{Sympt_EHU_intensity_fraction}$
unit	Sympt prod EHU r = Symptoms/Month
rate	$\text{Sympt_prod_LHD_r} = \text{Mid_test_pos_r} * \text{Sympt_LHD_intensity_fraction}$
unit	Sympt prod LHD r = Symptoms/Month
rate	$\text{Sympt_prod_LHD_r2} = \text{Late_HIV_sym_wo_care_r} * \text{Sympt_LHD_intensity_fraction}$
unit	Sympt prod LHD r2 = Symptoms/Month
rate	$\text{Sympt_prod_LHD_r3} = \text{LHD_off_care_r} * \text{Sympt_LHD_intensity_fraction}$
unit	Sympt prod LHD r3 = Symptoms/Month
rate	$\text{Sympt_prod_LHDWC_r} = \text{LHD_on_care_r} * \text{Sympt_LHDWC_intensity_fraction}$
unit	Sympt prod LHDWC r = Symptoms/Month
rate	$\text{Sympt_prod_LHDWC_r1} = \text{LHD_sym_w_care_r} * \text{Sympt_LHDWC_intensity_fraction}$
unit	Sympt prod LHDWC r1 = Symptoms/Month
rate	$\text{Sympt_prod_LHU_r} = \text{Late_HIV_sym_undia_r} * \text{Sympt_LHU_intensity_fraction}$
unit	Sympt prod LHU r = Symptoms/Month
rate	$\text{Sympt_prod_MHD_r1} = \text{Early_test_pos_r} * \text{Sympt_MHD_intensity_fraction}$
unit	Sympt prod MHD r1 = Symptoms/Month
rate	$\text{Sympt_prod_MHD_r2} = \text{MHD_off_care_r} * \text{Sympt_MHD_intensity_fraction}$
unit	Sympt prod MHD r2 = Symptoms/Month
rate	$\text{Sympt_prod_MHDWC_r} = \text{MHD_on_care_r} * \text{Sympt_MHDWC_intensity_fraction}$
unit	Sympt prod MHDWC r = Symptoms/Month
rate	$\text{Sympt_prod_MHU_r} = \text{Mid_HIV_sym_undia_r} * \text{Sympt_MHU_intensity_fraction}$
unit	Sympt prod MHU r = Symptoms/Month
rate	$\text{Sympt_prod_NI_r} = \text{Infect_r} * \text{Sympt_NI_intensity_fraction}$
unit	Sympt prod NI r = Symptoms/Month

Note: Start = 0.00; stop = 216 (months); dt = 1.000; method = Euler (fixed step).

APPENDIX H (continued)

Base Case Model Equations by Variable Type Auxiliaries

Type	Equation
aux unit	Care_funding_input = 10*Care_serv_funding_mult Care_funding_input = Funding units
aux unit	Care_serv_funding_mult = GRAPH(TIME,0,10,[1,1.04,1.07,1.09,1.12,1.16,1.21,1.23,1.28,1.33,1.35,1.39,1.42,1.46,1.49,1.53,1.56,1.58,1.63,1.67,1.7,1.72,1.77"Min:0;Max:2;Zoom"]) Care_serv_funding_mult = Dimensionless
aux unit	Care_Sys_Quality_t = GRAPH(Care_Sys_Quality,0,10,[70,68.2,66.9,63.9,57.1,51,44.8,35.6,14.7,6.5,5"Min:0;Max:70;Zoom"]) Care_Sys_Quality_t = System quality units/Month
aux unit	CC = AVG(CC_LHDWC,CC_LHD,CC_MHDWC,CC_MHD) CC = Prevention complacency units/Person
aux unit	CC_LHD_adj_r2_limit = GRAPH(CC_LHD,0,10,[1,0.96,0.9,0.77,0.59,0.44,0.3,0.17,0.06,0.01,0"Min:0;Max:1;Zoom"]) CC_LHD_adj_r2_limit = Dimensionless
aux unit	CC_LHD_off_care_frac = GRAPH(CC_LHDWC,0,10,[0,0.01,0.03,0.05,0.07,0.1,0.14,0.24,0.32,0.44,1"Min:0;Max:1;Zoom"]) CC_LHD_off_care_frac = Population proportion (dimensionless)
aux unit	CC_LHD_on_care_frac = GRAPH(CC_LHD,0,10,[1,0.98,0.98,0.96,0.96,0.96,0.9,0.86,0.82,0.66,0.01"Min:0;Max:1;Zoom"]) CC_LHD_on_care_frac = Population proportion (dimensionless)
aux unit	CC_LHD_r1_limit = GRAPH(CC_LHD,0,10,[1,0.96,0.9,0.77,0.59,0.44,0.3,0.17,0.06,0.01,0"Min:0;Max:1;Zoom"]) CC_LHD_r1_limit = Dimensionless
aux unit	CC_LHD_t1 = Epi_LHD/Mid_test_pos_r CC_LHD_t1 = Months
aux unit	CC_LHD_t2 = Epi_LHD/Late_HIV_sym_wo_care_r CC_LHD_t2 = Months
aux unit	CC_LHD_t3 = Epi_LHD/LHD_off_care_r CC_LHD_t3 = Months
aux unit	CC_LHDWC_adj_r2_limit = GRAPH(CC_LHDWC,0,10,[1,0.96,0.9,0.77,0.59,0.44,0.3,0.17,0.06,0.01,0"Min:0;Max:1;Zoom"]) CC_LHDWC_adj_r2_limit = Dimensionless
aux unit	CC_LHDWC_r1_limit = GRAPH(CC_LHDWC,0,10,[1,0.96,0.9,0.77,0.45,0.13,0.04,0.02,0.02,0.01,0"Min:0;Max:1;Zoom"]) CC_LHDWC_r1_limit = Dimensionless

APPENDIX H (continued)

Base Case Model Equations by Variable Type Auxiliaries

Type	Equation
aux	CC_LHDWC_r2_limit = GRAPH(CC_LHDWC,0,10,[1,0.96,0.9,0.77,0.45,0.13,0.04,0.02,0.02,0.01,0"Min:0;Max:1;Zoom"])
unit	CC_LHDWC_r2_limit = Dimensionless
aux	CC_LHDWC_t1 = Epi_LHDWC/LHD_sym_w_care_r
unit	CC_LHDWC_t1 = Months
aux	CC_LHDWC_t2 = Epi_LHDWC/LHD_on_care_r
unit	CC_LHDWC_t2 = Months
aux	CC_MHD_adj_r2_limit = GRAPH(CC_MHD,0,10,[1,0.96,0.9,0.77,0.59,0.44,0.3,0.17,0.06,0.02,0"Min:0;Max:1;Zoom"])
unit	CC_MHD_adj_r2_limit = Dimensionless
aux	CC_MHD_off_care_frac = GRAPH(CC_MHDWC,0,10,[0,0.71,0.84,0.91,0.96,0.98,0.98,0.99,0.99,0.99,1"Min:0;Max:1;Zoom"])
unit	CC_MHD_off_care_frac = Persons/Persons (dimensionless)
aux	CC_MHD_on_care_frac = GRAPH(CC_MHD,0,10,[1,0.97,0.94,0.89,0.79,0.71,0.57,0.45,0.34,0.2,0"Min:0;Max:1;Zoom"])
unit	CC_MHD_on_care_frac = Persons/Persons (dimensionless)
aux	CC_MHD_r1_limit = GRAPH(CC_MHD,0,10,[1,0.76,0.17,0.13,0.1,0.04,0.03,0.02,0.02,0.01,0"Min:0;Max:1;Zoom"])
unit	CC_MHD_r1_limit = Dimensionless
aux	CC_MHD_t1 = Epi_MHD/Early_test_pos_r
unit	CC_MHD_t1 = Months
aux	CC_MHD_t2 = Epi_MHD/MHD_off_care_r
unit	CC_MHD_t2 = Months
aux	CC_MHDWC_adj_r2_limit = GRAPH(CC_MHDWC,0,10,[1,0.96,0.9,0.77,0.59,0.44,0.3,0.17,0.06,0.01,0"Min:0;Max:1;Zoom"])
unit	CC_MHDWC_adj_r2_limit = Dimensionless
aux	CC_MHDWC_r_limit = GRAPH(CC_MHDWC,0,10,[1,0.96,0.9,0.77,0.45,0.13,0.04,0.02,0.02,0.01,0"Min:0;Max:1;Zoom"])
unit	CC_MHDWC_r_limit = Dimensionless
aux	CC_MHDWC_t = Epi_MHDWC/MHD_on_care_r
unit	CC_MHDWC_t = Months
aux	CC_on_Sympt_LHD_m = GRAPH(CC_LHD,0,10,[0,0.02,0.02,0.04,0.04,0.07,0.09,0.15,0.25,0.48,1"Min:0;Max:1;Zoom"])
unit	CC_on_Sympt_LHD_m = Dimensionless

APPENDIX H (continued)

Base Case Model Equations by Variable Type Auxiliaries

Type	Equation
aux	CC_on_Sympt_LHDWC_m = GRAPH(CC_LHDWC,0,10,[0,0.02,0.02,0.04,0.04,0.07,0.09,0.15,0.25,0.48,1"Min:0;Max:1;Zoom"])
unit	CC_on_Sympt_LHDWC_m = Dimensionless
aux	CC_on_Sympt_MHD_m = GRAPH(CC_MHD,0,10,[0,0.02,0.02,0.04,0.04,0.07,0.09,0.15,0.25,0.48,1"Min:0;Max:1;Zoom"])
unit	CC_on_Sympt_MHD_m = Dimensionless
aux	CC_on_Sympt_MHDWC_m = GRAPH(CC_MHDWC,0,10,[0,0.02,0.02,0.04,0.04,0.07,0.09,0.15,0.25,0.48,1"Min:0;Max:1;Zoom"])
unit	CC_on_Sympt_MHDWC_m = Dimensionless
aux	Chance_infection = GRAPH(PC,0,10,[0,0.00021,0.00028,0.00035,0.00049,0.00063,0.0007,0.00161,0.00393,0.00607,0.008"Min:0;Max:0.008;Zoom"])
unit	Chance_infection = Dimensionless
aux	Contacts_per_at_risk_p = GRAPH(Prop_at_risk_pop,0,0.05,[0,2.18,3.02,3.93,4.49,4.98,5.68,5.96,6.18,6.46,6.74,7.02,7.23,7.44,7.51,7.72,7.79,7.86,7.93,8,8"Min:0;Max:8;Zoom"])
unit	Contacts_per_at_risk_p = Persons/Persons/Month
aux	CR_convert_prod_frac = (CS_fund_alloc_frac*10)/CR_production_t
unit	CR_convert_prod_frac = Resource units/Funding unit/Month
aux	CR_drain_frac = CR_drain_input/CR_drain_t
unit	CR_drain_frac = Dimensionless/Month
aux	CR_drain_input = Prop_p_recv_CS
unit	CR_drain_input = Dimensionless
aux	CR_on_CSQ_e = GRAPH(Prop_CR,0,0.1,[1.51,1.75,1.95,2,1.98,1.89,1.74,1.53,1.3,0.91,0"Min:0;Max:2;Zoom"])
unit	CR_on_CSQ_e = Dimensionless
aux	CS_fund_alloc_frac = GRAPH(Prop_p_recv_CS,0,0.1,[0,0.24,0.38,0.53,0.65,0.75,0.82,0.89,0.93,0.98,1"Min:0;Max:1;Zoom"])
unit	CS_fund_alloc_frac = Dimensionless
aux	CSQ_on_CC_LHD_e = GRAPH(Care_Sys_Quality,0,10,[100,62,46,31,21,16,11,7,5,1,0"Min:0;Max:100;Zoom"])
unit	CSQ_on_CC_LHD_e = Care complacency units/Person
aux	CSQ_on_CC_LHDWC_e = GRAPH(Care_Sys_Quality,0,10,[100,78,64,48,30,18,12,9,5,1,0"Min:0;Max:100;Zoom"])
unit	CSQ_on_CC_LHDWC_e = Care complacency units/Person
aux	CSQ_on_CC_MHD_e = GRAPH(Care_Sys_Quality,0,10,[100,54,34,25,18,13,11,7,4,1,1"Min:0;Max:100;Zoom"])
unit	CSQ_on_CC_MHD_e = Care complacency units/Person

APPENDIX H (continued)

Base Case Model Equations by Variable Type Auxiliaries

Type	Equation
aux	CSQ_on_CC_MHDWC_e = GRAPH(Care_Sys_Quality,0,10,[100,78,64,48,30,18,12,9,5,1,0"Min:0;Max:100;Zoom"])
unit	CSQ_on_CC_MHDWC_e = Care complacency units/Person
aux	CSQ_on_SCSQ_EHU_e = GRAPH(Care_Sys_Quality,0,10,[0,8,20,31,41,49,55,64,74,85,100"Min:0;Max:100;Zoom"])
unit	CSQ_on_SCSQ_EHU_e = Satisfaction units/Person
aux	CSQ_on_SCSQ_LHD_e = GRAPH(Care_Sys_Quality,0,10,[0,3,3,4,4,4,6,8,13,32,100"Min:0;Max:100;Zoom"])
unit	CSQ_on_SCSQ_LHD_e = Satisfaction units/Person
aux	CSQ_on_SCSQ_LHDWC_e = GRAPH(Care_Sys_Quality,0,10,[0,3,3,4,4,4,6,8,13,32,100"Min:0;Max:100;Zoom"])
unit	CSQ_on_SCSQ_LHDWC_e = Satisfaction units/Person
aux	CSQ_on_SCSQ_LHU_e = GRAPH(Care_Sys_Quality,0,10,[0,4,4,4,4,4,5,8,12,26,100"Min:0;Max:100;Zoom"])
unit	CSQ_on_SCSQ_LHU_e = Satisfaction units/Person
aux	CSQ_on_SCSQ_MHD_e = GRAPH(Care_Sys_Quality,0,10,[0,3,3,4,4,4,6,8,13,32,100"Min:0;Max:100;Zoom"])
unit	CSQ_on_SCSQ_MHD_e = Satisfaction units/Person
aux	CSQ_on_SCSQ_MHDWC_e = GRAPH(Care_Sys_Quality,0,10,[0,4,4,4,4,4,5,8,12,26,100"Min:0;Max:100;Zoom"])
unit	CSQ_on_SCSQ_MHDWC_e = Satisfaction units/Person
aux	CSQ_on_SCSQ_MHU_e = GRAPH(Care_Sys_Quality,0,10,[0,8,20,31,41,49,55,64,74,85,100"Min:0;Max:100;Zoom"])
unit	CSQ_on_SCSQ_MHU_e = Satisfaction units/Person
aux	CSQ_on_SCSQ_NI_e = GRAPH(Care_Sys_Quality,0,10,[0,49,71,82,89,93,95,97,98,99,100"Min:0;Max:100;Zoom"])
unit	CSQ_on_SCSQ_NI_e = Satisfaction units/Person
aux	Death_r_per_month = AIDS_death_undia_r+AIDS_death_w_care_r+AIDS_death_wo_care_r
unit	Death_r_per_month = Persons/Month
aux	Death_rate_per_year = Death_r_per_month*12
unit	Death_rate_per_year = Persons/Year
aux	Deaths_on_PTE_EHU_m = GRAPH(Death_r_per_month,0,2,[2,0.95,0.61,0.49,0.3,0.21,0.14,0.09,0.04,0.02,0"Min:0;Max:2;Zoom"])
unit	Deaths_on_PTE_EHU_m = Dimensionless
aux	Deaths_on_PTE_LHD_m = GRAPH(Death_r_per_month,0,2,[2,0.95,0.61,0.49,0.3,0.21,0.14,0.09,0.04,0.02,0"Min:0;Max:2;Zoom"])
unit	Deaths_on_PTE_LHD_m = Dimensionless

APPENDIX H (continued)

Base Case Model Equations by Variable Type Auxiliaries

Type	Equation
aux	Deaths_on_PTE_LHDWC_m = GRAPH(Death_r_per_month,0,2,[2,0.95,0.61,0.49,0.3,0.21,0.14,0.09,0.04,0.02,0"Min:0;Max:2;Zoom"])
unit	Deaths_on_PTE_LHDWC_m = Dimensionless
aux	Deaths_on_PTE_LHU_m = GRAPH(Death_r_per_month,0,2,[2,0.95,0.61,0.49,0.3,0.21,0.14,0.09,0.04,0.02,0"Min:0;Max:2;Zoom"])
unit	Deaths_on_PTE_LHU_m = Dimensionless
aux	Deaths_on_PTE_MHD_m = GRAPH(Death_r_per_month,0,2,[2,0.95,0.61,0.49,0.3,0.21,0.14,0.09,0.04,0.02,0"Min:0;Max:2;Zoom"])
unit	Deaths_on_PTE_MHD_m = Dimensionless
aux	Deaths_on_PTE_MHDWC_m = GRAPH(Death_r_per_month,0,2,[2,0.95,0.61,0.49,0.3,0.21,0.14,0.09,0.04,0.02,0"Min:0;Max:2;Zoom"])
unit	Deaths_on_PTE_MHDWC_m = Dimensionless
aux	Deaths_on_PTE_MHU_m = GRAPH(Death_r_per_month,0,2,[2,0.95,0.61,0.49,0.3,0.21,0.14,0.09,0.04,0.02,0"Min:0;Max:2;Zoom"])
unit	Deaths_on_PTE_MHU_m = Dimensionless
aux	Deaths_on_PTE_NI_m = GRAPH(Death_r_per_month,0,2,[2,0.95,0.61,0.49,0.3,0.21,0.14,0.09,0.04,0.02,0"Min:0;Max:2;Zoom"])
unit	Deaths_on_PTE_NI_m = Dimensionless
aux	HAART_dev_t_horizon = TIME
unit	HAART_dev_t_horizon = Months
aux	HAART_effect = GRAPH(HAART_dev_t_horizon,0,12,[1,1,1,1,1,1,1,1,1,1,0.7,0.5,0.3,0.22,0.2,0.17,0.15"Min:0;Max:2;Zoom"])
unit	HAART_effect = Dimensionless/Month
aux	Incidence_per_year = Infect_r*12
unit	Incidence_per_year = Persons/Year
aux	MI_pop_mult = GRAPH(TIME,0,120,[1,1.042809,1.046552,1.118964,1.133,1.146"Min:1;Max:1.2"])
unit	MI_pop_mult = Dimensionless
aux	MI_vul_pop = MI_pop_1970*MI_pop_mult*Percent_high_risk_p
unit	MI_vul_pop = Persons
aux	PC = AVG(PC_EHU,PC_LHDWC,PC_LHD,PC_LHU,PC_MHDWC,PC_MHD,PC_MHU,PC_NI)
unit	PC = Prevention complacency units/Person
aux	PC_EHU_t = Epi_EHU/Seroconvert_r
unit	PC_EHU_t = Months
aux	PC_LHD_t1 = Epi_LHD/Mid_test_pos_r
unit	PC_LHD_t1 = Months

APPENDIX H (continued)

Base Case Model Equations by Variable Type Auxiliaries

Type	Equation
aux unit	PC_LHD_t2 = Epi_LHD/Late_HIV_sym_wo_care_r PC_LHD_t2 = Months
aux unit	PC_LHD_t3 = Epi_LHD/LHD_off_care_r PC_LHD_t3 = Months
aux unit	PC_LHDWC_t1 = Epi_LHDWC/LHD_sym_w_care_r PC_LHDWC_t1 = Months
aux unit	PC_LHDWC_t2 = Epi_LHDWC/LHD_on_care_r PC_LHDWC_t2 = Months
aux unit	PC_LHU_t = Epi_LHU/Late_HIV_sym_undia_r PC_LHU_t = Months
aux unit	PC_MHD_t1 = Epi_MHD/Early_test_pos_r PC_MHD_t1 = Months
aux unit	PC_MHD_t2 = Epi_MHD/MHD_off_care_r PC_MHD_t2 = Months
aux unit	PC_MHDWC_t = Epi_MHDWC/MHD_on_care_r PC_MHDWC_t = Months
aux unit	PC_MHU_t = Epi_MHU/Mid_HIV_sym_undia_r PC_MHU_t = Months
aux unit	PC_NI_t = Epi_NI/Infect_r PC_NI_t = Months
aux unit	PC_on_ETP_frac = GRAPH(PC_EHU,0,10,[1,0.9,0.82,0.74,0.63,0.55,0.44,0.35,0.26,0.14,0"Min:0;Max:1;Zoom"]) PC_on_ETP_frac = Prevention complacency units/Person/Month
aux unit	PC_on_LTP_frac = GRAPH(PC_LHU,0,10,[1,1,1,1,1,1,1,1,1,0.97,0.97"Min:0;Max:1;Zoom"]) PC_on_LTP_frac = Prevention complacency units/Person/Month
aux unit	PC_on_MTP_frac = GRAPH(PC_MHU,0,10,[1,0.99,0.97,0.96,0.93,0.87,0.8,0.72,0.61,0.45,0"Min:0;Max:1;Zoom"]) PC_on_MTP_frac = Prevention complacency units/Person/Month
aux unit	PHS = AVG(PHS_EHU,PHS_LHDWC,PHS_LHD,PHS_LHU,PHS_MHDWC,PHS_MHD,PHS_MHU,PHS_NI) PHS = Prevention complacency units/Person
aux unit	PHS_EHU_t = Epi_EHU/Seroconvert_r PHS_EHU_t = Months
aux unit	PHS_LHD_t = Epi_LHD/Mid_test_pos_r PHS_LHD_t = Months
aux unit	PHS_LHD_t2 = Epi_LHD/Late_HIV_sym_wo_care_r PHS_LHD_t2 = Months
aux unit	PHS_LHD_t3 = Epi_LHD/LHD_off_care_r PHS_LHD_t3 = Months
aux unit	PHS_LHDWC_t1 = Epi_LHDWC/LHD_sym_w_care_r PHS_LHDWC_t1 = Months

APPENDIX H (continued)

Base Case Model Equations by Variable Type Auxiliaries

Type	Equation
aux unit	PHS_LHDWC_t2 = Epi_LHDWC/LHD_on_care_r PHS_LHDWC_t2 = Months
aux unit	PHS_LHU_limit_adj_r1 = GRAPH(PC_LHU,0,10,[1,0.96,0.9,0.77,0.59,0.44,0.3,0.17,0.06,0.01,0"Min:0;Max:1;Zoom"]) PHS_LHU_limit_adj_r1 = Dimensionless
aux unit	PHS_LHU_t = Epi_LHU/Late_HIV_sym_undia_r PHS_LHU_t = Months
aux unit	PHS_MHD_adj_r2_limit = GRAPH(PHS_MHD,0,10,[1,0.96,0.9,0.77,0.59,0.44,0.3,0.17,0.06,0.01,0"Min:0;Max:1;Zoom"]) PHS_MHD_adj_r2_limit = Dimensionless
aux unit	PHS_MHD_t1 = Epi_MHD/Early_test_pos_r PHS_MHD_t1 = Months
aux unit	PHS_MHD_t2 = Epi_MHD/MHD_off_care_r PHS_MHD_t2 = Months
aux unit	PHS_MHDWC_limit_adj_r1 = GRAPH(PC_MHDWC,0,10,[1,0.96,0.9,0.77,0.59,0.44,0.3,0.17,0.06,0.01,0"Min:0;Max:1;Zoom"]) PHS_MHDWC_limit_adj_r1 = Dimensionless
aux unit	PHS_MHDWC_t = Epi_MHDWC/MHD_on_care_r PHS_MHDWC_t = Months
aux unit	PHS_MHU_t = Epi_MHU/Mid_HIV_sym_undia_r PHS_MHU_t = Months
aux unit	PHS_NI_t = Epi_NI/Infect_r PHS_NI_t = Months
aux unit	PHS_on_PC_EHU_m = GRAPH(PHS_EHU,0,10,[2,1.77,1.56,1.37,1.16,1,0.81,0.58,0.42,0.16,0"Min:0;Max:2;Zoom"]) PHS_on_PC_EHU_m = Dimensionless
aux unit	PHS_on_PC_LHD_m = GRAPH(PHS_LHD,0,10,[2,1.77,1.56,1.37,1.16,1,0.81,0.58,0.42,0.16,0"Min:0;Max:2;Zoom"]) PHS_on_PC_LHD_m = Dimensionless
aux unit	PHS_on_PC_LHDWC_m = GRAPH(PHS_LHDWC,0,10,[2,1.77,1.56,1.37,1.16,1,0.81,0.58,0.42,0.16,0"Min:0;Max:2;Zoom"]) PHS_on_PC_LHDWC_m = Dimensionless
aux unit	PHS_on_PC_LHU_m = GRAPH(PHS_LHU,0,10,[2,1.77,1.56,1.37,1.16,1,0.81,0.58,0.42,0.16,0"Min:0;Max:2;Zoom"]) PHS_on_PC_LHU_m = Dimensionless

APPENDIX H (continued)

Base Case Model Equations by Variable Type Auxiliaries

Type	Equation
aux	PHS_on_PC_MHD_m = GRAPH(PHS_MHD,0,10,[2,1.77,1.56,1.37,1.16,1,0.81,0.58,0.42,0.16,0"Min:0;Max:2;Zoom"])
unit	PHS_on_PC_MHD_m = Dimensionless
aux	PHS_on_PC_MHDWC_m = GRAPH(PHS_MHDWC,0,10,[2,1.77,1.56,1.37,1.16,1,0.81,0.58,0.42,0.16,0"Min:0;Max:2;Zoom"])
unit	PHS_on_PC_MHDWC_m = Dimensionless
aux	PHS_on_PC_MHU_m = GRAPH(PHS_MHU,0,10,[2,1.77,1.56,1.37,1.16,1,0.81,0.58,0.42,0.16,0"Min:0;Max:2;Zoom"])
unit	PHS_on_PC_MHU_m = Dimensionless
aux	PHS_on_PC_NI_m = GRAPH(PHS_NI,0,10,[2,1.77,1.56,1.37,1.16,1,0.81,0.58,0.42,0.16,0"Min:0;Max:2;Zoom"])
unit	PHS_on_PC_NI_m = Dimensionless
aux	PHS_on_SC_EHU_e = GRAPH(PHS_EHU,0,10,[100,92,83,76,68,61,50,41,29,12,0"Min:0;Max:100;Zoom"])
unit	PHS_on_SC_EHU_e = Self concept units/Person
aux	PHS_on_SC_LHD_e = GRAPH(PHS_LHD,0,10,[100,86,76,67,53,46,34,25,13,4,0"Min:0;Max:100;Zoom"])
unit	PHS_on_SC_LHD_e = Self concept units/Person
aux	PHS_on_SC_LHDWC_e = GRAPH(PHS_LHDWC,0,10,[100,91,84,74,61,55,47,34,20,9,0"Min:0;Max:100;Zoom"])
unit	PHS_on_SC_LHDWC_e = Self concept units/Person
aux	PHS_on_SC_LHU_e = GRAPH(PHS_LHU,0,10,[100,89,82,74,68,61,49,37,25,10,0"Min:0;Max:100;Zoom"])
unit	PHS_on_SC_LHU_e = Self concept units/Person
aux	PHS_on_SC_MHD_e = GRAPH(PHS_MHD,0,10,[100,94,80,71,61,50,39,26,18,10,0"Min:0;Max:100;Zoom"])
unit	PHS_on_SC_MHD_e = Self concept units/Person
aux	PHS_on_SC_MHDWC_e = GRAPH(PHS_MHDWC,0,10,[100,90,81,68,60,49,42,31,19,6,0"Min:0;Max:100;Zoom"])
unit	PHS_on_SC_MHDWC_e = Self concept units/Person
aux	PHS_on_SC_MHU_e = GRAPH(PHS_MHU,0,10,[100,93,82,73,61,53,43,29,17,7,0"Min:0;Max:100;Zoom"])
unit	PHS_on_SC_MHU_e = Self concept units/Person
aux	PHS_on_SC_NI_e = GRAPH(PHS_NI,0,10,[100,92,84,76,67,58,46,35,20,9,0"Min:0;Max:100;Zoom"])
unit	PHS_on_SC_NI_e = Self concept units/Person
aux	PR_convert_prod_frac = (PS_fund_alloc_frac*10)/PR_production_t
unit	PR_convert_prod_frac = Resource units/Funding unit/Month
aux	PR_drain_frac = PR_drain_input/PR_drain_t
unit	PR_drain_frac = Dimensionless/Month

APPENDIX H (continued)

Base Case Model Equations by Variable Type Auxiliaries

Type	Equation
aux unit	PR_drain_input = Prop_p_recv_PS PR_drain_input = Dimensionless
aux unit	PR_on_PSQ_e = GRAPH(Prop_PR,0,0.1,[1.51,1.75,1.95,2,1.98,1.89,1.74,1.53,1.3,0.91,0"Min:0;Max:2;Zoom"]) PR_on_PSQ_e = Dimensionless
aux unit	Prev_funding_input = 10*Prev_serv_funding_mult Prev_funding_input = Funding units
aux unit	Prev_serv_funding_mult = GRAPH(TIME,0,10,[1,1.05,1.05,1.07,1.07,1.07,1.07,1.07,1.07,1.09,1.11,1.11,1.11,1.11,1.11,1.11,1.11,1.14,1.18,1.21,1.23,1.25"Min:0;Max:2;Zoom"]) Prev_serv_funding_mult = Dimensionless
aux unit	Prev_Sys_Quality_t = GRAPH(Prev_Sys_Quality,0,10,[40,33.7,21.3,3,1.1,0.9,0.8,0.7,0.6,0.5,0"Min:0;Max:40;Zoom"]) Prev_Sys_Quality_t = System quality units/Month
aux unit	Prop_at_risk_pop = MI_vul_pop/(MI_vul_pop+Total_HIV_pos_p) Prop_at_risk_pop = Dimensionless
aux unit	Prop_CR = Care_resources/(Care_resources+Prev_resources) Prop_CR = Dimensionless
aux unit	Prop_p_recv_CS = (Epi_MHDWC+Epi_LHDWC)/(Epi_MHD+Epi_MHDWC+Epi_LHD+Epi_LHDWC) Prop_p_recv_CS = Dimensionless
aux unit	Prop_p_recv_PS = (Early_test_pos_r+Late_test_pos_r+Mid_test_pos_r)/(Infect_r+Early_test_pos_r+Late_test_pos_r+Mid_test_pos_r) Prop_p_recv_PS = Persons/Month
aux unit	Prop_PR = 1-Prop_CR Prop_PR = Dimensionless
aux unit	PS_fund_alloc_frac = 1-CS_fund_alloc_frac PS_fund_alloc_frac = Dimensionless
aux unit	PSQ_on_PC_EHU_e = GRAPH(Prev_Sys_Quality,0,10,[100,99,97,96,93,89,81,72,61,44,0"Min:0;Max:100;Zoom"]) PSQ_on_PC_EHU_e = Prevention complacency units/Person
aux unit	PSQ_on_PC_LHD_e = GRAPH(Prev_Sys_Quality,0,10,[100,99,97,96,93,89,81,72,61,44,0"Min:0;Max:100;Zoom"]) PSQ_on_PC_LHD_e = Prevention complacency units/Person
aux unit	PSQ_on_PC_LHDWC_e = GRAPH(Prev_Sys_Quality,0,10,[100,99,97,96,93,89,81,72,61,44,0"Min:0;Max:100;Zoom"]) PSQ_on_PC_LHDWC_e = Prevention complacency units/Person

APPENDIX H (continued)

Base Case Model Equations by Variable Type Auxiliaries

Type	Equation
aux	PSQ_on_PC_LHU_e = GRAPH(Prev_Sys_Quality,0,10,[100,99,97,96,93,89,81,72,61,44,0"Min:0;Max:100;Zoom"
unit	PSQ_on_PC_LHU_e = Prevention complacency units/Person
aux	PSQ_on_PC_MHD_e = GRAPH(Prev_Sys_Quality,0,10,[100,99,97,96,93,89,81,72,61,44,0"Min:0;Max:100;Zoom"
unit	PSQ_on_PC_MHD_e = Prevention complacency units/Person
aux	PSQ_on_PC_MHDWC_e = GRAPH(Prev_Sys_Quality,0,10,[100,99,97,96,93,89,81,72,61,44,0"Min:0;Max:100;Zoom"
unit	PSQ_on_PC_MHDWC_e = Prevention complacency units/Person
aux	PSQ_on_PC_MHU_e = GRAPH(Prev_Sys_Quality,0,10,[100,99,97,96,93,89,81,72,61,44,0"Min:0;Max:100;Zoom"
unit	PSQ_on_PC_MHU_e = Prevention complacency units/Person
aux	PSQ_on_PC_NI_e = GRAPH(Prev_Sys_Quality,0,10,[100,99,97,96,93,89,81,72,61,44,0"Min:0;Max:100;Zoom"
unit	PSQ_on_PC_NI_e = Prevention complacency units/Person
aux	PSQ_on_PHS_EHU_e = GRAPH(Prev_Sys_Quality,0,10,[100,92,82,71,62,49,39,29,18,8,0"Min:0;Max:100;Zoom"])
unit	PSQ_on_PHS_EHU_e = Perceived HIV related stigma units/Person
aux	PSQ_on_PHS_LHD_e = GRAPH(Prev_Sys_Quality,0,10,[100,91,82,75,66,57,46,36,25,11,0"Min:0;Max:100;Zoom"
unit	PSQ_on_PHS_LHD_e = Perceived HIV related stigma units/Person
aux	PSQ_on_PHS_LHDWC_e = GRAPH(Prev_Sys_Quality,0,10,[100,94,85,74,61,52,40,30,22,9,0"Min:0;Max:100;Zoom"])
unit	PSQ_on_PHS_LHDWC_e = Perceived HIV related stigma units/Person
aux	PSQ_on_PHS_LHU_e = GRAPH(Prev_Sys_Quality,0,10,[100,91,79,70,60,48,39,28,18,9,0"Min:0;Max:100;Zoom"])
unit	PSQ_on_PHS_LHU_e = Perceived HIV related stigma units/Person
aux	PSQ_on_PHS_MHD_e = GRAPH(Prev_Sys_Quality,0,10,[100,92,82,69,58,49,41,32,22,8,0"Min:0;Max:100;Zoom"])
unit	PSQ_on_PHS_MHD_e = Perceived HIV related stigma units/Person
aux	PSQ_on_PHS_MHDWC_e = GRAPH(Prev_Sys_Quality,0,10,[100,89,81,74,66,55,46,35,25,13,0"Min:0;Max:100;Zoom"
unit	PSQ_on_PHS_MHDWC_e = Perceived HIV related stigma units/Person

APPENDIX H (continued)

Base Case Model Equations by Variable Type Auxiliaries

Type	Equation
aux	PSQ_on_PHS_MHU_e = GRAPH(Prev_Sys_Quality,0,10,[100,90,80,73,64,53,43,30,21,11,0"Min:0;Max:100;Zoom"
unit	PSQ_on_PHS_MHU_e = Perceived HIV related stigma units/Person
aux	PSQ_on_PHS_NI_e = GRAPH(Prev_Sys_Quality,0,10,[100,89,81,76,68,58,49,39,28,12,0"Min:0;Max:100;Zoom"
unit	PSQ_on_PHS_NI_e = Perceived HIV related stigma units/Person
aux	PSQ_on_SPSQ_EHU_e = GRAPH(Prev_Sys_Quality,0,10,[0,11,21,30,39,49,57,69,79,89,100"Min:0;Max:100;Zoom"
unit	PSQ_on_SPSQ_EHU_e = Satisfaction units/Person/Month
aux	PSQ_on_SPSQ_LHD_e = GRAPH(Prev_Sys_Quality,0,10,[0,3,5,9,11,18,24,33,43,60,100"Min:0;Max:100;Zoom"])
unit	PSQ_on_SPSQ_LHD_e = Satisfaction units/Person/Month
aux	PSQ_on_SPSQ_LHDWC_e = GRAPH(Prev_Sys_Quality,0,10,[0,3,3,3,5,6,9,12,18,35,100"Min:0;Max:100;Zoom"])
unit	PSQ_on_SPSQ_LHDWC_e = Satisfaction units/Person/Month
aux	PSQ_on_SPSQ_LHU_e = GRAPH(Prev_Sys_Quality,0,10,[0,11,23,31,39,46,55,66,74,85,100"Min:0;Max:100;Zoom"
unit	PSQ_on_SPSQ_LHU_e = Satisfaction units/Person/Month
aux	PSQ_on_SPSQ_MHD_e = GRAPH(Prev_Sys_Quality,0,10,[0,1,5,7,11,15,20,30,46,65,100"Min:0;Max:100;Zoom"])
unit	PSQ_on_SPSQ_MHD_e = Satisfaction units/Person/Month
aux	PSQ_on_SPSQ_MHDWC_e = GRAPH(Prev_Sys_Quality,0,10,[0,11,23,31,39,46,55,66,74,85,100"Min:0;Max:100;Zoom"
unit	PSQ_on_SPSQ_MHDWC_e = Satisfaction units/Person/Month
aux	PSQ_on_SPSQ_MHU_e = GRAPH(Prev_Sys_Quality,0,10,[0,11,23,31,39,46,55,66,74,85,100"Min:0;Max:100;Zoom"
unit	PSQ_on_SPSQ_MHU_e = Satisfaction units/Person/Month
aux	PSQ_on_SPSQ_NI_e = GRAPH(Prev_Sys_Quality,0,10,[1,10,21,30,38,48,89,95,97,98,100"Min:0;Max:100;Zoom"
unit	PSQ_on_SPSQ_NI_e = Satisfaction units/Person/Month
aux	PTE = AVG(PTE_EHU,PTE_LHDWC,PTE_LHD,PTE_LHU,PTE_MHDWC,PTE_MHD,PTE_MH U,PTE_NI)
unit	PTE = Prevention complacency units/Person

APPENDIX H (continued)

Base Case Model Equations by Variable Type Auxiliaries

Type	Equation
aux	PTE_EHU_adj_r1_limit = GRAPH(PTE_EHU,0,10,[1,0.96,0.9,0.77,0.59,0.44,0.3,0.17,0.06,0.01,0"Min:0;Max:1;Zoom"])
unit	PTE_EHU_adj_r1_limit = Dimensionless
aux	PTE_EHU_t = Epi_EHU/Seroconvert_r
unit	PTE_EHU_t = Months
aux	PTE_LHD_adj_r1_limit = GRAPH(PTE_LHD,0,10,[1,0.96,0.9,0.77,0.59,0.44,0.3,0.17,0.06,0.01,0"Min:0;Max:1;Zoom"])
unit	PTE_LHD_adj_r1_limit = Dimensionless
aux	PTE_LHD_t1 = Epi_LHD/Mid_test_pos_r
unit	PTE_LHD_t1 = Months
aux	PTE_LHD_t2 = Epi_LHD/Late_HIV_sym_wo_care_r
unit	PTE_LHD_t2 = Months
aux	PTE_LHD_t3 = Epi_LHD/LHD_off_care_r
unit	PTE_LHD_t3 = Months
aux	PTE_LHDWC_adj_r1_limit = GRAPH(PTE_LHDWC,0,10,[1,0.96,0.9,0.77,0.59,0.44,0.3,0.17,0.06,0.01,0"Min:0;Max:1;Zoom"])
unit	PTE_LHDWC_adj_r1_limit = Dimensionless
aux	PTE_LHDWC_t1 = Epi_LHDWC/LHD_on_care_r
unit	PTE_LHDWC_t1 = Months
aux	PTE_LHDWC_t2 = Epi_LHDWC/LHD_sym_w_care_r
unit	PTE_LHDWC_t2 = Months
aux	PTE_LHU_adj_r1_limit = GRAPH(PTE_LHU,0,10,[1,0.96,0.9,0.77,0.59,0.44,0.3,0.17,0.06,0.01,0"Min:0;Max:1;Zoom"])
unit	PTE_LHU_adj_r1_limit = Dimensionless
aux	PTE_LHU_t = Epi_LHU/Late_HIV_sym_undia_r
unit	PTE_LHU_t = Months
aux	PTE_MHD_adj_r1_limit = GRAPH(PTE_MHD,0,10,[1,0.96,0.9,0.77,0.59,0.44,0.3,0.17,0.06,0.01,0"Min:0;Max:1;Zoom"])
unit	PTE_MHD_adj_r1_limit = Dimensionless
aux	PTE_MHD_t1 = Epi_MHD/Early_test_pos_r
unit	PTE_MHD_t1 = Months
aux	PTE_MHD_t2 = Epi_MHD/MHD_off_care_r
unit	PTE_MHD_t2 = Months
aux	PTE_MHDWC_adj_r1_limit = GRAPH(PTE_MHDWC,0,10,[1,0.96,0.9,0.77,0.59,0.44,0.3,0.17,0.06,0.01,0"Min:0;Max:1;Zoom"])
unit	PTE_MHDWC_adj_r1_limit = Dimensionless
aux	PTE_MHDWC_t = Epi_MHDWC/MHD_on_care_r
unit	PTE_MHDWC_t = Months

APPENDIX H (continued)

Base Case Model Equations by Variable Type Auxiliaries

Type	Equation
aux	PTE_MHU_adj_r1_limit = GRAPH(PTE_MHU,0,10,[1,0.96,0.9,0.77,0.59,0.44,0.3,0.17,0.06,0.01,0"Min:0;Max:1;Zoom"m"))
unit	PTE_MHU_adj_r1_limit = Dimensionless
aux	PTE_MHU_t = Epi_MHU/Mid_HIV_sym_undia_r
unit	PTE_MHU_t = Months
aux	PTE_NI_adj_r1_limit = GRAPH(PTE_NI,0,10,[1,0.96,0.9,0.77,0.59,0.44,0.3,0.17,0.06,0.01,0"Min:0;Max:1;Zoom"m"))
unit	PTE_NI_adj_r1_limit = Dimensionless
aux	PTE_NI_t = Epi_NI/Infect_r
unit	PTE_NI_t = Months
aux	PTE_on_CC_LHD_m = GRAPH(PTE_LHD,0,10,[2,1.02,0.74,0.54,0.4,0.3,0.21,0.16,0.09,0.05,0"Min:0;Max:2;Zoom"m"))
unit	PTE_on_CC_LHD_m = Dimensionless
aux	PTE_on_CC_LHDWC_m = GRAPH(PTE_LHDWC,0,10,[2,1.82,1.46,1.25,1.04,0.89,0.66,0.5,0.29,0.15,0"Min:0;Max:2;Zoom"m"))
unit	PTE_on_CC_LHDWC_m = Dimensionless
aux	PTE_on_CC_MHD_m = GRAPH(PTE_MHD,0,10,[2,0.77,0.33,0.25,0.14,0.09,0.07,0.07,0.07,0.04,0"Min:0;Max:2;Zoom"m"))
unit	PTE_on_CC_MHD_m = Dimensionless
aux	PTE_on_CC_MHDWC_m = GRAPH(PTE_MHDWC,0,10,[2,0.65,0.42,0.25,0.18,0.14,0.14,0.12,0.11,0.07,0"Min:0;Max:2;Zoom"m"))
unit	PTE_on_CC_MHDWC_m = Dimensionless
aux	PTE_on_PC_EHU_m = GRAPH(PTE_EHU,0,10,[0,0.11,0.12,0.26,0.46,0.96,1.65,1.88,1.93,1.95,2"Min:0;Max:2;Zoom"m"))
unit	PTE_on_PC_EHU_m = Dimensionless
aux	PTE_on_PC_LHD_m = GRAPH(PTE_LHD,0,10,[0,0.11,0.12,0.26,0.46,0.96,1.65,1.88,1.93,1.95,2"Min:0;Max:2;Zoom"m"))
unit	PTE_on_PC_LHD_m = Dimensionless
aux	PTE_on_PC_LHDWC_m = GRAPH(PTE_LHDWC,0,10,[0,0.11,0.12,0.26,0.46,0.96,1.65,1.88,1.93,1.95,2"Min:0;Max:2;Zoom"m"))
unit	PTE_on_PC_LHDWC_m = Dimensionless
aux	PTE_on_PC_LHU_m = GRAPH(PTE_LHU,0,10,[0,0.11,0.12,0.26,0.46,0.96,1.65,1.88,1.93,1.95,2"Min:0;Max:2;Zoom"m"))
unit	PTE_on_PC_LHU_m = Dimensionless

APPENDIX H (continued)

Base Case Model Equations by Variable Type Auxiliaries

Type	Equation
aux	PTE_on_PC_MHD_m = GRAPH(PTE_MHD,0,10,[0,0.11,0.12,0.26,0.46,0.96,1.65,1.88,1.93,1.95,2"Min:0;Max:2;Zoom"])
unit	PTE_on_PC_MHD_m = Dimensionless
aux	PTE_on_PC_MHDWC_m = GRAPH(PTE_MHDWC,0,10,[0,0.11,0.12,0.26,0.46,0.96,1.65,1.88,1.93,1.95,2"Min:0;Max:2;Zoom"])
unit	PTE_on_PC_MHDWC_m = Dimensionless
aux	PTE_on_PC_MHU_m = GRAPH(PTE_MHU,0,10,[0,0.11,0.12,0.26,0.46,0.96,1.65,1.88,1.93,1.95,2"Min:0;Max:2;Zoom"])
unit	PTE_on_PC_MHU_m = Dimensionless
aux	PTE_on_PC_NI_m = GRAPH(PTE_NI,0,10,[0,0.11,0.12,0.26,0.46,0.96,1.65,1.88,1.93,1.95,2"Min:0;Max:2;Zoom"])
unit	PTE_on_PC_NI_m = Dimensionless
aux	PTE_SC_on_CC_LHD_m = PTE_on_CC_LHD_m*SC_on_CC_LHD_m
unit	PTE_SC_on_CC_LHD_m = Dimensionless
aux	PTE_SC_on_CC_LHDWC_m = PTE_on_CC_LHDWC_m*SC_on_CC_LHDWC_m
unit	PTE_SC_on_CC_LHDWC_m = Dimensionless
aux	PTE_SC_on_CC_MHD_m = PTE_on_CC_MHD_m*SC_on_CC_MHD_m
unit	PTE_SC_on_CC_MHD_m = Dimensionless
aux	PTE_SC_on_CC_MHDWC_m = PTE_on_CC_MHDWC_m*SC_on_CC_MHDWC_m
unit	PTE_SC_on_CC_MHDWC_m = Dimensionless
aux	PTE_SC_PHS_on_PC_LHD_m = PHS_on_PC_LHD_m*PTE_on_PC_LHD_m*SC_on_PC_LHD_m
unit	PTE_SC_PHS_on_PC_LHD_m = Dimensionless
aux	PTE_SC_PHS_on_PC_LHDWC_m = PHS_on_PC_LHDWC_m*PTE_on_PC_LHDWC_m*SC_on_PC_LHDWC_m
unit	PTE_SC_PHS_on_PC_LHDWC_m = Dimensionless
aux	PTE_SC_PHS_on_PC_LHU_m = PHS_on_PC_LHU_m*PTE_on_PC_LHU_m*SC_on_PC_LHU_m
unit	PTE_SC_PHS_on_PC_LHU_m = Dimensionless
aux	PTE_SC_PHS_on_PC_MHD_m = PHS_on_PC_MHD_m*PTE_on_PC_MHD_m*SC_on_PC_MHD_m
unit	PTE_SC_PHS_on_PC_MHD_m = Dimensionless
aux	PTE_SC_PHS_on_PC_MHDWC_m = PHS_on_PC_MHDWC_m*PTE_on_PC_MHDWC_m*SC_on_PC_MHDWC_m
unit	PTE_SC_PHS_on_PC_MHDWC_m = Dimensionless
aux	PTE_SC_PHS_on_PC_MHU_m = PHS_on_PC_MHU_m*PTE_on_PC_MHU_m*SC_on_PC_MHU_m
unit	PTE_SC_PHS_on_PC_MHU_m = Dimensionless
aux	PTE_SC_PHS_on_PC_MNU_m = PHS_on_PC_EHU_m*PTE_on_PC_EHU_m*SC_on_PC_EHU_m
unit	PTE_SC_PHS_on_PC_MNU_m = Dimensionless

APPENDIX H (continued)

Base Case Model Equations by Variable Type Auxiliaries

Type	Equation
aux	$PTE_SC_PHS_on_PC_NI_m =$ $PHS_on_PC_NI_m * PTE_on_PC_NI_m * SC_on_PC_NI_m$
unit	$PTE_SC_PHS_on_PC_NI_m = \text{Dimensionless}$
aux	$PTE_SC_PHS_on_PHS_EHU_limit =$ $GRAPH(PC_EHU, 0, 10, [1, 0.96, 0.9, 0.77, 0.59, 0.44, 0.3, 0.17, 0.06, 0.01, 0] \text{Min:0;Max:1;Zoom$ $"})$
unit	$PTE_SC_PHS_on_PHS_EHU_limit = \text{Dimensionless}$
aux	$PTE_SC_PHS_on_PHS_LHD_limit =$ $GRAPH(PC_LHD, 0, 10, [1, 0.96, 0.9, 0.77, 0.59, 0.44, 0.3, 0.17, 0.06, 0.01, 0] \text{Min:0;Max:1;Zoom$ $"})$
unit	$PTE_SC_PHS_on_PHS_LHD_limit = \text{Dimensionless}$
aux	$PTE_SC_PHS_on_PHS_LHDWC_limit =$ $GRAPH(PC_LHDWC, 0, 10, [1, 0.96, 0.9, 0.77, 0.59, 0.44, 0.3, 0.17, 0.06, 0.01, 0] \text{Min:0;Max:1;Zoom$ $"})$
unit	$PTE_SC_PHS_on_PHS_LHDWC_limit = \text{Dimensionless}$
aux	$PTE_SC_PHS_on_PHS_MHD_limit =$ $GRAPH(PC_MHD, 0, 10, [1, 0.96, 0.9, 0.77, 0.59, 0.44, 0.3, 0.17, 0.06, 0.01, 0] \text{Min:0;Max:1;Zoom$ $"})$
unit	$PTE_SC_PHS_on_PHS_MHD_limit = \text{Dimensionless}$
aux	$PTE_SC_PHS_on_PHS_MHU_limit =$ $GRAPH(PC_MHU, 0, 10, [1, 0.96, 0.9, 0.77, 0.59, 0.44, 0.3, 0.17, 0.06, 0.01, 0] \text{Min:0;Max:1;Zoom$ $"})$
unit	$PTE_SC_PHS_on_PHS_MHU_limit = \text{Dimensionless}$
aux	$PTE_SC_PHS_on_PHS_NI_limit =$ $GRAPH(PC_NI, 0, 10, [1, 0.96, 0.9, 0.77, 0.59, 0.44, 0.3, 0.17, 0.06, 0.01, 0] \text{Min:0;Max:1;Zoom$ $"})$
unit	$PTE_SC_PHS_on_PHS_NI_limit = \text{Dimensionless}$
aux	$SA =$ $AVG(SA_EHU, SA_LHDWC, SA_LHD, SA_LHU, SA_MHDWC, SA_MHD, SA_MHU, SA_NI)$
unit	$SA = \text{Prevention complacency units/Person}$
aux	$SA_EHU_t = Epi_EHU/Seroconvert_r$
unit	$SA_EHU_t = \text{Months}$
aux	$SA_LHD_t1 = Epi_LHD/Mid_test_pos_r$
unit	$SA_LHD_t1 = \text{Months}$
aux	$SA_LHD_t2 = Epi_LHD/Late_HIV_sym_wo_care_r$
unit	$SA_LHD_t2 = \text{Months}$
aux	$SA_LHD_t3 = Epi_LHD/LHD_off_care_r$
unit	$SA_LHD_t3 = \text{Months}$
aux	$SA_LHDWC_t1 = Epi_LHDWC/LHD_sym_w_care_r$
unit	$SA_LHDWC_t1 = \text{Months}$
aux	$SA_LHDWC_t2 = Epi_LHDWC/LHD_on_care_r$
unit	$SA_LHDWC_t2 = \text{Months}$
aux	$SA_LHU_t = Epi_LHU/Late_HIV_sym_undia_r$
unit	$SA_LHU_t = \text{Months}$

APPENDIX H (continued)

Base Case Model Equations by Variable Type Auxiliaries

Type	Equation
aux unit	SA_MHD_t1 = Epi_MHD/Early_test_pos_r SA_MHD_t1 = Months
aux unit	SA_MHD_t2 = Epi_MHD/MHD_off_care_r SA_MHD_t2 = Months
aux unit	SA_MHDWC_t = Epi_MHDWC/MHD_on_care_r SA_MHDWC_t = Months
aux unit	SA_MHU_t = Epi_MHU/Mid_HIV_sym_undia_r SA_MHU_t = Months
aux unit	SA_NI_t = Epi_NI/Infect_r SA_NI_t = Months
aux unit	SA_on_SC_EHU_e = GRAPH(SA_EHU,0,10,[0,11,20,33,43,53,61,68,74,83,100"Min:0;Max:100;Zoom"]) SA_on_SC_EHU_e = Self concept units/Person
aux unit	SA_on_SC_LHD_e = GRAPH(SA_LHD,0,10,[0,9,17,29,45,55,66,73,83,90,100"Min:0;Max:100;Zoom"]) SA_on_SC_LHD_e = Self concept units/Person
aux unit	SA_on_SC_LHDWC_e = GRAPH(SA_LHDWC,0,10,[0,14,20,26,34,41,53,64,75,90,100"Min:0;Max:100;Zoom"]) SA_on_SC_LHDWC_e = Self concept units/Person
aux unit	SA_on_SC_LHU_e = GRAPH(SA_LHU,0,10,[0,11,19,29,36,48,56,63,72,85,100"Min:0;Max:100;Zoom"]) SA_on_SC_LHU_e = Self concept units/Person
aux unit	SA_on_SC_MHD_e = GRAPH(SA_MHD,0,10,[0,11,25,34,45,53,61,67,78,88,100"Min:0;Max:100;Zoom"]) SA_on_SC_MHD_e = Self concept units/Person
aux unit	SA_on_SC_MHDWC_e = GRAPH(SA_MHDWC,0,10,[0,7,15,24,39,48,61,70,79,87,100"Min:0;Max:100;Zoom"]) SA_on_SC_MHDWC_e = Self concept units/Person
aux unit	SA_on_SC_MHU_e = GRAPH(SA_MHU,0,10,[0,9,18,29,38,51,63,74,83,90,100"Min:0;Max:100;Zoom"]) SA_on_SC_MHU_e = Self concept units/Person
aux unit	SA_on_SC_NI_e = GRAPH(SA_NI,0,10,[0,12,19,25,37,45,53,62,71,83,100"Min:0;Max:100;Zoom"]) SA_on_SC_NI_e = Self concept units/Person
aux unit	SA_on_SCA_EHU_m = GRAPH(SA_EHU,0,10,[0,0.02,0.02,0.09,0.16,0.33,0.6,1,1.7,1.98,2"Min:0;Max:2;Zoom"]) SA_on_SCA_EHU_m = Dimensionless
aux unit	SA_on_SCA_LHD_m = GRAPH(SA_LHD,0,10,[1,1.07,1.14,1.18,1.21,1.26,1.28,1.35,1.39,1.42,1.51"Min:0;Max:2;Zoom"]) SA_on_SCA_LHD_m = Dimensionless

APPENDIX H (continued)

Base Case Model Equations by Variable Type Auxiliaries

Type	Equation
aux	SA_on_SCA_LHDWC_m = GRAPH(SA_LHDWC,0,10,[0,0.75,1.21,1.42,1.6,1.75,1.84,1.91,1.93,1.96,2"Min:0;Max:2;Zoom"])
unit	SA_on_SCA_LHDWC_m = Dimensionless
aux	SA_on_SCA_LHU_m = GRAPH(SA_LHU,0,10,[0,0.02,0.02,0.09,0.16,0.33,0.6,1,1.7,1.98,2"Min:0;Max:2;Zoom"])
unit	SA_on_SCA_LHU_m = Dimensionless
aux	SA_on_SCA_MHD_m = GRAPH(SA_MHD,0,10,[1,1,1,1,1,1,1,1,1,1"Min:0;Max:2;Zoom"])
unit	SA_on_SCA_MHD_m = Dimensionless
aux	SA_on_SCA_MHDWC_m = GRAPH(SA_MHDWC,0,10,[0,0.88,1.25,1.47,1.63,1.75,1.88,1.93,1.96,1.98,2"Min:0;Max:2;Zoom"])
unit	SA_on_SCA_MHDWC_m = Dimensionless
aux	SA_on_SCA_MHU_m = GRAPH(SA_MHU,0,10,[0,0.02,0.02,0.09,0.16,0.33,0.6,1,1.7,1.98,2"Min:0;Max:2;Zoom"])
unit	SA_on_SCA_MHU_m = Dimensionless
aux	SA_on_SCA_NI_m = GRAPH(SA_NI,0,10,[0,0.07,0.18,0.26,0.33,0.39,0.47,0.58,0.72,0.86,1"Min:0;Max:2;Zoom"])
unit	SA_on_SCA_NI_m = Dimensionless
aux	SC = AVG(SC_EHU,SC_LHDWC,SC_LHD,SC_LHU,SC_MHDWC,SC_MHD,SC_MHU,SC_NI)
unit	SC = Prevention complacency units/Person
aux	SC_EHU_t = Epi_EHU/Seroconvert_r
unit	SC_EHU_t = Months
aux	SC_LHD_t1 = Epi_LHD/Mid_test_pos_r
unit	SC_LHD_t1 = Months
aux	SC_LHD_t2 = Epi_LHD/Late_HIV_sym_wo_care_r
unit	SC_LHD_t2 = Months
aux	SC_LHD_t3 = Epi_LHD/LHD_off_care_r
unit	SC_LHD_t3 = Months
aux	SC_LHDWC_t1 = Epi_LHDWC/LHD_sym_w_care_r
unit	SC_LHDWC_t1 = Months
aux	SC_LHDWC_t2 = Epi_LHDWC/LHD_on_care_r
unit	SC_LHDWC_t2 = Months
aux	SC_LHU_t = Epi_LHU/Late_HIV_sym_undia_r
unit	SC_LHU_t = Months
aux	SC_MHD_t1 = Epi_MHD/Early_test_pos_r
unit	SC_MHD_t1 = Months
aux	SC_MHD_t2 = Epi_MHD/MHD_off_care_r
unit	SC_MHD_t2 = Months
aux	SC_MHDWC_t = Epi_MHDWC/MHD_on_care_r
unit	SC_MHDWC_t = Months

APPENDIX H (continued)

Base Case Model Equations by Variable Type Auxiliaries

Type	Equation
aux unit	SC_MHU_t = Epi_MHU/Mid_HIV_sym_undia_r SC_MHU_t = Months
aux unit	SC_NI_t = Epi_NI/Infect_r SC_NI_t = Months
aux unit	SC_on_CC_LHD_m = GRAPH(SC_LHD,0,10,[2,0.7,0.35,0.23,0.19,0.12,0.12,0.11,0.09,0.04,0.02"Min:0;Max:2;Zoom"]) SC_on_CC_LHD_m = Dimensionless
aux unit	SC_on_CC_LHDWC_m = GRAPH(SC_LHDWC,0,10,[2,1.79,1.63,1.4,1.16,0.95,0.79,0.63,0.4,0.19,0"Min:0;Max:2;Zoom"]) SC_on_CC_LHDWC_m = Dimensionless
aux unit	SC_on_CC_MHD_m = GRAPH(SC_MHD,0,10,[2,0.79,0.46,0.37,0.3,0.21,0.16,0.12,0.07,0.04,0"Min:0;Max:2;Zoom"]) SC_on_CC_MHD_m = Dimensionless
aux unit	SC_on_CC_MHDWC_m = GRAPH(SC_MHDWC,0,10,[2,0.36,0.22,0.15,0.11,0.11,0.11,0.11,0.1,0.06,0"Min:0;Max:2;Zoom"]) SC_on_CC_MHDWC_m = Dimensionless
aux unit	SC_on_PC_EHU_m = GRAPH(SC_EHU,0,10,[2,1.98,1.95,1.93,1.93,1.88,1.82,1.72,1.58,1.25,0"Min:0;Max:2;Zoom"]) SC_on_PC_EHU_m = Dimensionless
aux unit	SC_on_PC_LHD_m = GRAPH(SC_LHD,0,10,[2,0.68,0.26,0.16,0.11,0.09,0.05,0.05,0.04,0.04,0"Min:0;Max:2;Zoom"]) SC_on_PC_LHD_m = Dimensionless
aux unit	SC_on_PC_LHDWC_m = GRAPH(SC_LHDWC,0,10,[2,1.41,1.01,0.66,0.43,0.34,0.25,0.17,0.11,0.06,0.01"Min:0;Max:2;Zoom"]) SC_on_PC_LHDWC_m = Dimensionless
aux unit	SC_on_PC_LHU_m = GRAPH(SC_LHU,0,10,[2,1.98,1.93,1.91,1.88,1.81,1.68,1.47,1.21,0.88,0"Min:0;Max:2;Zoom"]) SC_on_PC_LHU_m = Dimensionless
aux unit	SC_on_PC_MHD_m = GRAPH(SC_MHD,0,10,[2,1.98,1.95,1.93,1.93,1.88,1.82,1.72,1.58,1.25,0"Min:0;Max:2;Zoom"]) SC_on_PC_MHD_m = Dimensionless

APPENDIX H (continued)

Base Case Model Equations by Variable Type Auxiliaries

Type	Equation
aux	SC_on_PC_MHDWC_m = GRAPH(SC_MHDWC,0,10,[2,0.75,0.27,0.13,0.1,0.1,0.1,0.08,0.07,0.02,0"Min:0;Max:2;Zoom"])
unit	SC_on_PC_MHDWC_m = Dimensionless
aux	SC_on_PC_MHU_m = GRAPH(SC_MHU,0,10,[2,1.98,1.95,1.93,1.93,1.88,1.82,1.72,1.58,1.25,0"Min:0;Max:2;Zoom"])
unit	SC_on_PC_MHU_m = Dimensionless
aux	SC_on_PC_NI_m = GRAPH(SC_NI,0,10,[2,1.98,1.95,1.93,1.93,1.88,1.82,1.72,1.58,1.25,0"Min:0;Max:2;Zoom"])
unit	SC_on_PC_NI_m = Dimensionless
aux	SC_on_SA_EHU_e = GRAPH(SC_EHU,0,10,[0,11,21,32,43,50,60,66,74,82,100"Min:0;Max:100;Zoom"])
unit	SC_on_SA_EHU_e = Self concept units/Person
aux	SC_on_SA_LHD_e = GRAPH(SC_LHD,0,10,[0,11,21,32,43,50,60,66,74,82,100"Min:0;Max:100;Zoom"])
unit	SC_on_SA_LHD_e = Self concept units/Person
aux	SC_on_SA_LHDWC_e = GRAPH(SC_LHDWC,0,10,[0,11,21,32,43,50,60,66,74,82,100"Min:0;Max:100;Zoom"])
unit	SC_on_SA_LHDWC_e = Self concept units/Person
aux	SC_on_SA_LHU_e = GRAPH(SC_LHU,0,10,[0,11,21,32,43,50,60,66,74,82,100"Min:0;Max:100;Zoom"])
unit	SC_on_SA_LHU_e = Self concept units/Person
aux	SC_on_SA_MHD_e = GRAPH(SC_MHD,0,10,[0,11,21,32,43,50,60,66,74,82,100"Min:0;Max:100;Zoom"])
unit	SC_on_SA_MHD_e = Self concept units/Person
aux	SC_on_SA_MHDWC_e = GRAPH(SC_MHDWC,0,10,[0,11,21,32,43,50,60,66,74,82,100"Min:0;Max:100;Zoom"])
unit	SC_on_SA_MHDWC_e = Self concept units/Person
aux	SC_on_SA_MHU_e = GRAPH(SC_MHU,0,10,[0,11,21,32,43,50,60,66,74,82,100"Min:0;Max:100;Zoom"])
unit	SC_on_SA_MHU_e = Self concept units/Person
aux	SC_on_SA_NI_e = GRAPH(SC_NI,0,10,[1,0.75,0.54,0.4,0.3,0.23,0.18,0.09,0.07,0.04,0.02"Min:0;Max:2;Zoom"])
unit	SC_on_SA_NI_e = Self concept units/Person
aux	SC_on_SCA_EHU_m = GRAPH(SC_EHU,0,10,[0,0.04,0.04,0.04,0.05,0.07,0.07,0.07,0.16,1.11,2"Min:0;Max:2;Zoom"])
unit	SC_on_SCA_EHU_m = Dimensionless
aux	SC_on_SCA_LHD_m = GRAPH(SC_LHD,0,10,[1.02,1.07,1.14,1.21,1.28,1.32,1.35,1.39,1.42,1.47,1.5"Min:0;Max:2;Zoom"])
unit	SC_on_SCA_LHD_m = Dimensionless

APPENDIX H (continued)

Base Case Model Equations by Variable Type Auxiliaries

Type	Equation
aux	SC_on_SCA_LHDWC_m = GRAPH(SC_LHDWC,0,10,[0,1.16,1.53,1.68,1.81,1.86,1.89,1.91,1.96,1.98,2"Min:0;Max:2;Zoom"])
unit	SC_on_SCA_LHDWC_m = Dimensionless
aux	SC_on_SCA_LHU_m = GRAPH(SC_LHU,0,10,[0,0.04,0.04,0.04,0.05,0.07,0.07,0.07,0.16,1.11,2"Min:0;Max:2;Zoom"])
unit	SC_on_SCA_LHU_m = Dimensionless
aux	SC_on_SCA_MHD_m = GRAPH(SC_MHD,0,10,[1,1.07,1.14,1.18,1.21,1.23,1.28,1.35,1.37,1.44,1.5"Min:0;Max:2;Zoom"])
unit	SC_on_SCA_MHD_m = Dimensionless
aux	SC_on_SCA_MHDWC_m = GRAPH(SC_MHDWC,0,10,[0,1.09,1.39,1.63,1.77,1.84,1.88,1.93,1.95,1.96,2"Min:0;Max:2;Zoom"])
unit	SC_on_SCA_MHDWC_m = Dimensionless
aux	SC_on_SCA_MHU_m = GRAPH(SC_MHU,0,10,[0,0.04,0.04,0.04,0.05,0.07,0.07,0.07,0.16,1.11,2"Min:0;Max:2;Zoom"])
unit	SC_on_SCA_MHU_m = Dimensionless
aux	SC_on_SCA_NI_m = GRAPH(SC_NI,0,10,[0,0.04,0.04,0.04,0.05,0.07,0.07,0.08,0.18,1.11,2"Min:0;Max:2;Zoom"])
unit	SC_on_SCA_NI_m = Dimensionless
aux	SCA = AVG(SCA_EHU,SCA_LHDWC,SCA_LHD,SCA_LHU,SCA_MHDWC,SCA_MHD,SCA_MHU,SCA_NI)
unit	SCA = Prevention complacency units/Person
aux	SCA_care_sys = AVG(SCA_LHDWC,SCA_LHD,SCA_LHU,SCA_MHDWC,SCA_MHD)
unit	SCA_care_sys = Prevention complacency units/Person
aux	SCA_EHU_limit_adj_r1 = GRAPH(SCA_EHU,0,10,[1,0.96,0.9,0.77,0.59,0.44,0.3,0.17,0.06,0.01,0"Min:0;Max:1;Zoom"])
unit	SCA_EHU_limit_adj_r1 = Dimensionless
aux	SCA_EHU_t = Epi_EHU/Seroconvert_r
unit	SCA_EHU_t = Months
aux	SCA_LHD_limit_adj_r1 = GRAPH(SCA_LHD,0,10,[1,0.96,0.9,0.77,0.59,0.44,0.3,0.17,0.06,0.01,0"Min:0;Max:1;Zoom"])
unit	SCA_LHD_limit_adj_r1 = Dimensionless
aux	SCA_LHD_t1 = Epi_LHD/Mid_test_pos_r
unit	SCA_LHD_t1 = Months
aux	SCA_LHD_t2 = Epi_LHD/Late_HIV_sym_wo_care_r
unit	SCA_LHD_t2 = Months

APPENDIX H (continued)

Base Case Model Equations by Variable Type Auxiliaries

Type	Equation
aux unit	SCA_LHD_t3 = Epi_LHD/LHD_off_care_r SCA_LHD_t3 = Months
aux unit	SCA_LHDWC_limit_adj_r1 = GRAPH(SCA_LHDWC,0,10,[1,0.96,0.9,0.77,0.59,0.44,0.3,0.17,0.06,0.01,0"Min:0;Max:1;Zoom"]) SCA_LHDWC_limit_adj_r1 = Dimensionless
aux unit	SCA_LHDWC_t1 = Epi_LHDWC/LHD_on_care_r SCA_LHDWC_t1 = Months
aux unit	SCA_LHDWC_t2 = Epi_LHDWC/LHD_sym_w_care_r SCA_LHDWC_t2 = Months
aux unit	SCA_LHU_limit_adj_r1 = GRAPH(SCA_LHU,0,10,[1,0.96,0.9,0.77,0.59,0.44,0.3,0.17,0.06,0.01,0"Min:0;Max:1;Zoom"]) SCA_LHU_limit_adj_r1 = Dimensionless
aux unit	SCA_LHU_t = Epi_LHU/Late_HIV_sym_undia_r SCA_LHU_t = Months
aux unit	SCA_MHD_limit_adj_r1 = GRAPH(SCA_MHD,0,10,[1,0.96,0.9,0.77,0.59,0.44,0.3,0.17,0.06,0.01,0"Min:0;Max:1;Zoom"]) SCA_MHD_limit_adj_r1 = Dimensionless
aux unit	SCA_MHD_t1 = Epi_MHD/Early_test_pos_r SCA_MHD_t1 = Months
aux unit	SCA_MHD_t2 = Epi_MHD/MHD_off_care_r SCA_MHD_t2 = Months
aux unit	SCA_MHDWC_limit_adj_r1 = GRAPH(SCA_MHDWC,0,10,[1,0.96,0.9,0.77,0.59,0.44,0.3,0.17,0.06,0.01,0"Min:0;Max:1;Zoom"]) SCA_MHDWC_limit_adj_r1 = Dimensionless
aux unit	SCA_MHDWC_t = Epi_MHDWC/MHD_on_care_r SCA_MHDWC_t = Months
aux unit	SCA_MHU_limit_adj_r1 = GRAPH(SCA_MHU,0,10,[1,0.96,0.9,0.77,0.59,0.44,0.3,0.17,0.06,0.01,0"Min:0;Max:1;Zoom"]) SCA_MHU_limit_adj_r1 = Dimensionless
aux unit	SCA_MHU_t = Epi_MHU/Mid_HIV_sym_undia_r SCA_MHU_t = Months
aux unit	SCA_NI_limit_adj_r1 = GRAPH(SCA_NI,0,10,[1,0.96,0.9,0.77,0.59,0.44,0.3,0.17,0.06,0.01,0"Min:0;Max:1;Zoom"]) SCA_NI_limit_adj_r1 = Dimensionless
aux unit	SCA_NI_t = Epi_NI/Infect_r SCA_NI_t = Months

APPENDIX H (continued)

Base Case Model Equations by Variable Type Auxiliaries

Type	Equation
aux	SCA_on_CSQ_e = GRAPH(SCA_care_sys,0,10,[0.5,0.77,1.05,1.23,1.44,1.54,1.65,1.75,1.86,1.93,2"Min:0;Max:2;Zoom"])
unit	SCA on CSQ e = Dimensionless
aux	SCA_on_PSQ_e = GRAPH(SCA_prev_sys,0,10,[0.5,0.77,1.05,1.23,1.44,1.54,1.65,1.75,1.86,1.93,2"Min:0;Max:2;Zoom"])
unit	SCA on PSQ e = Dimensionless
aux	SCA_on_SA_EHU_e = GRAPH(SCA_EHU,0,10,[0,12,19,25,37,45,53,62,71,83,100"Min:0;Max:100;Zoom"])
unit	SCA on SA EHU e = Self concept units/Person
aux	SCA_on_SA_LHD_e = GRAPH(SCA_LHD,0,10,[0,12,19,25,37,45,53,62,71,83,100"Min:0;Max:100;Zoom"])
unit	SCA on SA LHD e = Self concept units/Person
aux	SCA_on_SA_LHDWC_e = GRAPH(SCA_LHDWC,0,10,[0,12,19,25,37,45,53,62,71,83,100"Min:0;Max:100;Zoom"])
unit	SCA on SA LHDWC e = Self concept units/Person
aux	SCA_on_SA_LHU_e = GRAPH(SCA_LHU,0,10,[0,12,19,25,37,45,53,62,71,83,100"Min:0;Max:100;Zoom"])
unit	SCA on SA LHU e = Self concept units/Person
aux	SCA_on_SA_MHD_e = GRAPH(SCA_MHD,0,10,[0,12,19,25,37,45,53,62,71,83,100"Min:0;Max:100;Zoom"])
unit	SCA on SA MHD e = Self concept units/Person
aux	SCA_on_SA_MHDWC_e = GRAPH(SCA_MHDWC,0,10,[0,12,19,25,37,45,53,62,71,83,100"Min:0;Max:100;Zoom"])
unit	SCA on SA MHDWC e = Self concept units/Person
aux	SCA_on_SA_MHU_e = GRAPH(SCA_MHU,0,10,[0,12,19,25,37,45,53,62,71,83,100"Min:0;Max:100;Zoom"])
unit	SCA on SA MHU e = Self concept units/Person
aux	SCA_on_SA_NI_e = GRAPH(SCA_NI,0,10,[0,1,1,1,1,2,3,4,8,20,100"Min:0;Max:100;Zoom"])
unit	SCA on SA NI e = Self concept units/Person
aux	SCA_on_SC_EHU_e = GRAPH(SCA_EHU,0,10,[0,11,25,33,41,49,58,67,76,86,100"Min:0;Max:100;Zoom"])
unit	SCA on SC EHU e = Self concept units/Person
aux	SCA_on_SC_LHD_e = GRAPH(SCA_LHD,0,10,[0,14,25,32,42,51,64,75,83,89,100"Min:0;Max:100;Zoom"])
unit	SCA on SC LHD e = Self concept units/Person
aux	SCA_on_SC_LHDWC_e = GRAPH(SCA_LHDWC,0,10,[0,10,18,29,35,44,54,68,83,93,100"Min:0;Max:100;Zoom"])
unit	SCA on SC LHDWC e = Self concept units/Person
aux	SCA_on_SC_LHU_e = GRAPH(SCA_LHU,0,10,[0,9,24,33,43,56,65,75,84,92,100"Min:0;Max:100;Zoom"])
unit	SCA on SC LHU e = Self concept units/Person

APPENDIX H (continued)

Base Case Model Equations by Variable Type Auxiliaries

Type	Equation
aux	SCA_on_SC_MHD_e = GRAPH(SCA_MHD,0,10,[0,14,23,30,36,46,56,68,84,91,100"Min:0;Max:100;Zoom"])
unit	SCA_on_SC_MHD_e = Self concept units/Person
aux	SCA_on_SC_MHDWC_e = GRAPH(SCA_MHDWC,0,10,[0,6,15,28,42,53,64,75,85,92,100"Min:0;Max:100;Zoom"])
unit	SCA_on_SC_MHDWC_e = Self concept units/Person
aux	SCA_on_SC_MHU_e = GRAPH(SCA_MHU,0,10,[0,8,19,32,43,52,59,68,76,90,100"Min:0;Max:100;Zoom"])
unit	SCA_on_SC_MHU_e = Self concept units/Person
aux	SCA_on_SC_NI_e = GRAPH(SCA_NI,0,10,[0,10,21,30,36,44,53,63,74,89,100"Min:0;Max:100;Zoom"])
unit	SCA_on_SC_NI_e = Self concept units/Person
aux	SCA_prev_sys = AVG(SCA_EHU,SCA_MHU,SCA_NI)
unit	SCA_prev_sys = Prevention complacency units/Person
aux	SCSQ = AVG(SCSQ_EHU,SCSQ_LHDWC,SCSQ_LHD,SCSQ_LHU,SCSQ_MHDWC,SCSQ_MHD, SCSQ_MHU,SCSQ_NI)
unit	SCSQ = Prevention complacency units/Person
aux	SCSQ_EHU_t = Epi_EHU/Seroconvert_r
unit	SCSQ_EHU_t = Months
aux	SCSQ_LHD_t1 = Epi_LHD/Mid_test_pos_r
unit	SCSQ_LHD_t1 = Months
aux	SCSQ_LHD_t2 = Epi_LHD/Late_HIV_sym_wo_care_r
unit	SCSQ_LHD_t2 = Months
aux	SCSQ_LHD_t3 = Epi_LHD/LHD_off_care_r
unit	SCSQ_LHD_t3 = Months
aux	SCSQ_LHDWC_t1 = Epi_LHDWC/LHD_on_care_r
unit	SCSQ_LHDWC_t1 = Months
aux	SCSQ_LHDWC_t2 = Epi_LHDWC/LHD_sym_w_care_r
unit	SCSQ_LHDWC_t2 = Months
aux	SCSQ_LHU_t = Epi_LHU/Late_HIV_sym_undia_r
unit	SCSQ_LHU_t = Months
aux	SCSQ_MHD_t1 = Epi_MHD/Early_test_pos_r
unit	SCSQ_MHD_t1 = Months
aux	SCSQ_MHD_t2 = Epi_MHD/MHD_off_care_r
unit	SCSQ_MHD_t2 = Months
aux	SCSQ_MHDWC_t = Epi_MHDWC/MHD_on_care_r
unit	SCSQ_MHDWC_t = Months
aux	SCSQ_MHU_t = Epi_MHU/Mid_HIV_sym_undia_r
unit	SCSQ_MHU_t = Months
aux	SCSQ_NI_t = Epi_NI/Infect_r
unit	SCSQ_NI_t = Months

Base Case Model Equations by Variable Type

Auxiliaries

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APPENDIX H (continued)

Base Case Model Equations by Variable Type Auxiliaries

Type	Equation
aux unit	SPSQ_LHDWC_t1 = Epi_LHDWC/LHD_on_care_r SPSQ_LHDWC_t1 = Months
aux unit	SPSQ_LHDWC_t2 = Epi_LHDWC/LHD_sym_w_care_r SPSQ_LHDWC_t2 = Months
aux unit	SPSQ_LHU_t = Epi_LHU/Late_HIV_sym_undia_r SPSQ_LHU_t = Months
aux unit	SPSQ_MHD_t1 = Epi_MHD/Early_test_pos_r SPSQ_MHD_t1 = Months
aux unit	SPSQ_MHD_t2 = Epi_MHD/MHD_off_care_r SPSQ_MHD_t2 = Months
aux unit	SPSQ_MHDWC_t = Epi_MHDWC/MHD_on_care_r SPSQ_MHDWC_t = Months
aux unit	SPSQ_MHU_t = Epi_MHU/Mid_HIV_sym_undia_r SPSQ_MHU_t = Months
aux unit	SPSQ_NI_t = Epi_NI/Infect_r SPSQ_NI_t = Months
aux unit	SPSQ_on_SCA_EHU_m = GRAPH(SPSQ_EHU,0,10,[2,1.93,1.81,1.65,1.37,0.61,0.35,0.18,0.07,0.02,0"Min:0;Max:2; Zoom"]) SPSQ_on_SCA_EHU_m = Dimensionless
aux unit	SPSQ_on_SCA_LHD_m = GRAPH(SPSQ_LHD,0,10,[1.5,1.47,1.42,1.35,1.32,1.25,1.18,1.14,1.07,1.05,1"Min:0;Max: 2;Zoom"]) SPSQ_on_SCA_LHD_m = Dimensionless
aux unit	SPSQ_on_SCA_LHDWC_m = GRAPH(SPSQ_LHDWC,0,10,[2,1.93,1.81,1.65,1.37,0.61,0.35,0.18,0.07,0.02,0"Min:0;Ma x:2;Zoom"]) SPSQ_on_SCA_LHDWC_m = Dimensionless
aux unit	SPSQ_on_SCA_LHU_m = GRAPH(SPSQ_LHU,0,10,[2,1.93,1.81,1.65,1.37,0.61,0.35,0.18,0.07,0.02,0"Min:0;Max:2; Zoom"]) SPSQ_on_SCA_LHU_m = Dimensionless
aux unit	SPSQ_on_SCA_MHD_m = GRAPH(SPSQ_MHD,0,10,[2,1.91,1.79,1.63,1.54,1.4,1.3,1.26,1.21,1.14,1"Min:0;Max:2;Z oom"]) SPSQ_on_SCA_MHD_m = Dimensionless
aux unit	SPSQ_on_SCA_MHDWC_m = GRAPH(SPSQ_MHDWC,0,10,[2,1.93,1.81,1.65,1.37,0.61,0.35,0.18,0.07,0.02,0"Min:0;M ax:2;Zoom"]) SPSQ_on_SCA_MHDWC_m = Dimensionless
aux unit	SPSQ_on_SCA_MHU_m = GRAPH(SPSQ_MHU,0,10,[2,1.93,1.81,1.65,1.37,0.61,0.35,0.18,0.07,0.02,0"Min:0;Max:2; Zoom"]) SPSQ_on_SCA_MHU_m = Dimensionless

APPENDIX H (continued)

Base Case Model Equations by Variable Type

Auxiliaries

[illegible]

[illegible]

APPENDIX H (continued)

Base Case Model Equations by Variable Type

Auxiliaries

[illegible]

APPENDIX H (continued)

Base Case Model Equations by Variable Type

Auxiliaries

[illegible]

APPENDIX H (continued)

Base Case Model Equations by Variable Type Auxiliaries

Type	Equation
aux unit	Total_AIDS_deaths = Epi_ADD+Epi_ADDWC+Epi_ADU Total_AIDS_deaths = Persons/Month
aux unit	Total_current_AIDS_death_r = AIDS_death_undia_r+AIDS_death_w_care_r+AIDS_death_wo_care_r Total_current_AIDS_death_r = Persons/Month
aux unit	Total_diag_p = Epi_MHD+Epi_LHD+Epi_MHDWC+Epi_LHDWC Total_diag_p = Persons
aux unit	Total_diag_rec_care_p = Epi_MHDWC+Epi_LHDWC Total_diag_rec_care_p = Persons
aux unit	Total_HIV_AIDS_cases = Total_diag_p+Total_undiag_p Total_HIV_AIDS_cases = Persons
aux unit	Total_HIV_pos_p = Total_diag_p+Total_undiag_p Total_HIV_pos_p = Persons
aux unit	Total_undiag_p = Epi_NI+Epi_EHU+Epi_MHU+Epi_LHU Total_undiag_p = Persons

APPENDIX H (continued)

Base Case Model Equations by Variable Type Constants

Type	Equation
const	AD_diag_t = 12
unit	AD_diag_t = Months
const	AD_undiag_t = 12
unit	AD_undiag_t = Months
const	ADD_p_init = 0
unit	ADD_p_init = Persons
const	ADDWC_p_init = 0
unit	ADDWC_p_init = Persons
const	ADU_p_init = 5
unit	ADU_p_init = Persons
const	AIDS_death_w_care_t = 42
unit	AIDS_death_w_care_t = Months
const	CC_LHD_adj_t1 = 24
unit	CC_LHD_adj_t1 = Months
const	CC_LHD_adj_t2 = 24
unit	CC_LHD_adj_t2 = Months
const	CC_LHDWC_adj_t1 = 48
unit	CC_LHDWC_adj_t1 = Months
const	CC_LHDWC_adj_t2 = 48
unit	CC_LHDWC_adj_t2 = Months
const	CC_MHD_adj_t1 = 24
unit	CC_MHD_adj_t1 = Months
const	CC_MHD_adj_t2 = 24
unit	CC_MHD_adj_t2 = Months
const	CC_MHDWC_adj_t1 = 6
unit	CC_MHDWC_adj_t1 = Months
const	CC_MHDWC_adj_t2 = 12
unit	CC_MHDWC_adj_t2 = Months
const	CR_drain_t = 48
unit	CR_drain_t = Months
const	CR_production_t = 12
unit	CR_production_t = Months
const	CSQ_base_compound_frac = .04
unit	CSQ_base_compound_frac = System quality units/System quality units/Months
const	EHU_p_init = 500
unit	EHU_p_init = Persons
const	Epi_LHD_care_complacency_goal = 50
unit	Epi_LHD_care_complacency_goal = Care complacency units/Person
const	Epi_MHD_care_complacency_goal = 50
unit	Epi_MHD_care_complacency_goal = Care complacency units/Person
const	LHD_off_care_t = 12
unit	LHD_off_care_t = Months
const	LHD_on_care_t = 2
unit	LHD_on_care_t = Months

APPENDIX H (continued)

Base Case Model Equations by Variable Type Constants

Type	Equation
const	LHD_p_init = 2
unit	LHD_p_init = Persons
const	LHD_w_care_t = 54
unit	LHD_w_care_t = Months
const	LHDWC_p_init = 1
unit	LHDWC_p_init = Persons
const	LHS_diag_t = 36
unit	LHS_diag_t = Months
const	LHS_diag_wo_care_t = 48
unit	LHS_diag_wo_care_t = Months
const	LHS_undiag_t = 48
unit	LHS_undiag_t = Months
const	LHU_p_init = 45
unit	LHU_p_init = Persons
const	MHD_off_care_t = 24
unit	MHD_off_care_t = Months
const	MHD_on_care_t = 2
unit	MHD_on_care_t = Months
const	MHD_p_init = 2
unit	MHD_p_init = Persons
const	MHDWC_p_init = 1
unit	MHDWC_p_init = Persons
const	MHS_diag_t = 12
unit	MHS_diag_t = Months
const	MHS_undiag_t = 12
unit	MHS_undiag_t = Months
const	MHU_p_init = 1000
unit	MHU_p_init = Persons
const	MI_pop_1970 = 8881826
unit	MI_pop_1970 = Persons
const	NI_p_init = 500
unit	NI_p_init = Persons
const	PC_EHU_adj_t2 = 24
unit	PC_EHU_adj_t2 = Months
const	PC_LHD_adj_t1 = 6
unit	PC_LHD_adj_t1 = Months
const	PC_LHD_adj_t2 = 12
unit	PC_LHD_adj_t2 = Months
const	PC_LHDWC_adj_t1 = 6
unit	PC_LHDWC_adj_t1 = Months
const	PC_LHDWC_adj_t2 = 6
unit	PC_LHDWC_adj_t2 = Months
const	PC_LHU_adj_t1 = 48
unit	PC_LHU_adj_t1 = Months

APPENDIX H (continued)

Base Case Model Equations by Variable Type Constants

Type	Equation
const unit	PC_LHU_adj_t2 = 6 PC_LHU_adj_t2 = Months
const unit	PC_MHD_adj_t1 = 24 PC_MHD_adj_t1 = Months
const unit	PC_MHD_adj_t2 = 12 PC_MHD_adj_t2 = Months
const unit	PC_MHDWC_adj_t1 = 48 PC_MHDWC_adj_t1 = Months
const unit	PC_MHDWC_adj_t2 = 6 PC_MHDWC_adj_t2 = Months
const unit	PC_MHU_adj_t1 = 24 PC_MHU_adj_t1 = Months
const unit	PC_MHU_adj_t2 = 24 PC_MHU_adj_t2 = Months
const unit	PC_NI_adj_t1 = 3 PC_NI_adj_t1 = Months
const unit	PC_NI_adj_t1_1 = 3 PC_NI_adj_t1_1 = Months
const unit	PC_NI_adj_t2 = 24 PC_NI_adj_t2 = Months
const unit	Perceived_HIV_related_Stigma_goal = 70 Perceived_HIV_related_Stigma_goal = Perceived HIV related stigma units/Person
const unit	Perceived_Treatment_Efficacy_goal = 60 Perceived_Treatment_Efficacy_goal = Perceived treatment efficacy units/Person
const unit	Percent_high_risk_p = .1 Percent_high_risk_p = Dimensionless
const unit	PHS_EHU_adj_t1 = 1 PHS_EHU_adj_t1 = Months
const unit	PHS_EHU_adj_t2 = 2 PHS_EHU_adj_t2 = Months
const unit	PHS_LHD_adj_t1 = 72 PHS_LHD_adj_t1 = Months
const unit	PHS_LHD_adj_t2 = 2 PHS_LHD_adj_t2 = Months
const unit	PHS_LHDWC_adj_t1 = 12 PHS_LHDWC_adj_t1 = Months
const unit	PHS_LHDWC_adj_t2 = 6 PHS_LHDWC_adj_t2 = Months
const unit	PHS_LHU_adj_t1 = 24 PHS_LHU_adj_t1 = Months
const unit	PHS_LHU_adj_t2 = 6 PHS_LHU_adj_t2 = Months
const unit	PHS_MHD_adj_t1 = 12 PHS_MHD_adj_t1 = Months

APPENDIX H (continued)

Base Case Model Equations by Variable Type Constants

Type	Equation
const	PHS_MHD_adj_t2 = 2
unit	PHS_MHD_adj_t2 = Months
const	PHS_MHDWC_adj_t1 = 24
unit	PHS_MHDWC_adj_t1 = Months
const	PHS_MHDWC_adj_t2 = 6
unit	PHS_MHDWC_adj_t2 = Months
const	PHS_MHU_adj_t1 = 12
unit	PHS_MHU_adj_t1 = Months
const	PHS_MHU_adj_t2 = 6
unit	PHS_MHU_adj_t2 = Months
const	PHS_NI_adj_t1 = 1
unit	PHS_NI_adj_t1 = Months
const	PHS_NI_adj_t2 = 1
unit	PHS_NI_adj_t2 = Months
const	PHS_on_SC_EHU_adj_t1 = 12
unit	PHS_on_SC_EHU_adj_t1 = Months
const	PHS_on_SC_LHD_adj_t1 = 12
unit	PHS_on_SC_LHD_adj_t1 = Months
const	PHS_on_SC_LHDWC_adj_t1 = 12
unit	PHS_on_SC_LHDWC_adj_t1 = Months
const	PHS_on_SC_LHU_adj_t1 = 12
unit	PHS_on_SC_LHU_adj_t1 = Months
const	PHS_on_SC_MHD_adj_t1 = 12
unit	PHS_on_SC_MHD_adj_t1 = Months
const	PHS_on_SC_MHDWC_adj_t1 = 12
unit	PHS_on_SC_MHDWC_adj_t1 = Months
const	PHS_on_SC_MHU_adj_t1 = 12
unit	PHS_on_SC_MHU_adj_t1 = Months
const	PHS_on_SC_NI_adj_t1 = 72
unit	PHS_on_SC_NI_adj_t1 = Months
const	PR_drain_t = 48
unit	PR_drain_t = Months
const	PR_production_t = 12
unit	PR_production_t = Months
const	Prevention_complacency_goal = 50
unit	Prevention_complacency_goal = Prevention complacency units/Person
const	PSQ_base_compound_frac = .08
unit	PSQ_base_compound_frac = System quality units/System quality units/Months
const	PTE_EHU_adj_t1 = 24
unit	PTE_EHU_adj_t1 = Months
const	PTE_LHD_adj_t1 = 48
unit	PTE_LHD_adj_t1 = Months
const	PTE_LHDWC_adj_t1 = 84
unit	PTE_LHDWC_adj_t1 = Months

APPENDIX H (continued)

Base Case Model Equations by Variable Type Constants

Type	Equation
const	PTE_LHU_adj_t1 = 48
unit	PTE_LHU_adj_t1 = Months
const	PTE_MHD_adj_t1 = 48
unit	PTE_MHD_adj_t1 = Months
const	PTE_MHDWC_adj_t1 = 60
unit	PTE_MHDWC_adj_t1 = Months
const	PTE_MHU_adj_t1 = 36
unit	PTE_MHU_adj_t1 = Months
const	PTE_NI_adj_t1 = 12
unit	PTE_NI_adj_t1 = Months
const	SA_on_SC_LHD_adj_t2 = 12
unit	SA_on_SC_LHD_adj_t2 = Months
const	SA_on_SC_LHDWC_adj_t2 = 12
unit	SA_on_SC_LHDWC_adj_t2 = Months
const	SA_on_SC_LHU_adj_t2 = 12
unit	SA_on_SC_LHU_adj_t2 = Months
const	SA_on_SC_MHD_adj_t2 = 12
unit	SA_on_SC_MHD_adj_t2 = Months
const	SA_on_SC_MHDWC_adj_t2 = 12
unit	SA_on_SC_MHDWC_adj_t2 = Months
const	SA_SC_EHU_adj_t2 = 12
unit	SA_SC_EHU_adj_t2 = Months
const	SA_SC_MHU_adj_t2 = 12
unit	SA_SC_MHU_adj_t2 = Months
const	SA_SC_NI_adj_t2 = 12
unit	SA_SC_NI_adj_t2 = Months
const	Satisfaction_with_Care_System_Quality_goal = 80
unit	Satisfaction_with_Care_System_Quality_goal = Satisfaction units/Person
const	Satisfaction_with_Prevention_System_Quality_goal = 40
unit	Satisfaction_with_Prevention_System_Quality_goal = Satisfaction units/Person
const	SC_on_SA_EHU_adj_t1 = 48
unit	SC_on_SA_EHU_adj_t1 = Months
const	SC_on_SA_LHD_adj_t1 = 48
unit	SC_on_SA_LHD_adj_t1 = Months
const	SC_on_SA_LHDWC_adj_t1 = 48
unit	SC_on_SA_LHDWC_adj_t1 = Months
const	SC_on_SA_LHU_adj_t1 = 48
unit	SC_on_SA_LHU_adj_t1 = Months
const	SC_on_SA_MHD_adj_t1 = 48
unit	SC_on_SA_MHD_adj_t1 = Months
const	SC_on_SA_MHDWC_adj_t1 = 48
unit	SC_on_SA_MHDWC_adj_t1 = Months
const	SC_on_SA_MHU_adj_t1 = 48
unit	SC_on_SA_MHU_adj_t1 = Months

APPENDIX H (continued)

Base Case Model Equations by Variable Type Constants

Type	Equation
const	SC_on_SA_NI_adj_t1 = 48
unit	SC on SA NI adj t1 = Months
const	SC_t = 6
unit	SC t = Months
const	SCA_EHU_adj_t1 = 4
unit	SCA EHU adj t1 = Months
const	SCA_LHD_adj_t1 = 4
unit	SCA LHD adj t1 = Months
const	SCA_LHDWC_adj_t1 = 48
unit	SCA LHDWC adj t1 = Months
const	SCA_LHU_adj_t1 = 48
unit	SCA LHU adj t1 = Months
const	SCA_MHD_adj_t1 = 4
unit	SCA MHD adj t1 = Months
const	SCA_MHDWC_adj_t1 = 48
unit	SCA MHDWC adj t1 = Months
const	SCA_MHU_adj_t1 = 4
unit	SCA MHU adj t1 = Months
const	SCA_NI_adj_t1 = 2
unit	SCA NI adj t1 = Months
const	SCA_on_SC_EHU_adj_t3 = 12
unit	SCA on SC EHU adj t3 = Months
const	SCA_on_SC_LHD_adj_t3 = 12
unit	SCA on SC LHD adj t3 = Months
const	SCA_on_SC_LHDWC_adj_t3 = 12
unit	SCA on SC LHDWC adj t3 = Months
const	SCA_on_SC_LHU_adj_t3 = 12
unit	SCA on SC LHU adj t3 = Months
const	SCA_on_SC_MHD_adj_t3 = 12
unit	SCA on SC MHD adj t3 = Months
const	SCA_on_SC_MHDWC_adj_t3 = 12
unit	SCA on SC MHDWC adj t3 = Months
const	SCA_on_SC_MHU_adj_t3 = 12
unit	SCA on SC MHU adj t3 = Months
const	SCA_on_SC_NI_adj_t3 = 12
unit	SCA on SC NI adj t3 = Months
const	SCA_SA_EHU_adj_t2 = 6
unit	SCA SA EHU adj t2 = Months
const	SCA_SA_LHD_adj_t2 = 3
unit	SCA SA LHD adj t2 = Months
const	SCA_SA_LHDWC_adj_t2 = 3
unit	SCA SA LHDWC adj t2 = Months
const	SCA_SA_LHU_adj_t2 = 3
unit	SCA SA LHU adj t2 = Months

APPENDIX H (continued)

Base Case Model Equations by Variable Type Constants

Type	Equation
const	SCA_SA_MHD_adj_t2 = 3
unit	SCA_SA_MHD_adj_t2 = Months
const	SCA_SA_MHDWC_adj_t2 = 3
unit	SCA_SA_MHDWC_adj_t2 = Months
const	SCA_SA_MHU_adj_t2 = 6
unit	SCA_SA_MHU_adj_t2 = Months
const	SCA_SA_NI_adj_t2 = 48
unit	SCA_SA_NI_adj_t2 = Months
const	SCSQ_EHU_adj_t1 = 12
unit	SCSQ_EHU_adj_t1 = Months
const	SCSQ_LHD_adj_t1 = 12
unit	SCSQ_LHD_adj_t1 = Months
const	SCSQ_LHDWC_adj_t1 = 12
unit	SCSQ_LHDWC_adj_t1 = Months
const	SCSQ_LHU_adj_t1 = 12
unit	SCSQ_LHU_adj_t1 = Months
const	SCSQ_MHD_adj_t1 = 12
unit	SCSQ_MHD_adj_t1 = Months
const	SCSQ_MHDWC_adj_t1 = 12
unit	SCSQ_MHDWC_adj_t1 = Months
const	SCSQ_MHU_adj_t1 = 12
unit	SCSQ_MHU_adj_t1 = Months
const	SCSQ_NI_adj_t1 = 6
unit	SCSQ_NI_adj_t1 = Months
const	Self_Concept_goal = 60
unit	Self_Concept_goal = Self concept units/Person
const	SPSQ_EHU_adj_t1 = 12
unit	SPSQ_EHU_adj_t1 = Months
const	SPSQ_LHD_adj_t1 = 12
unit	SPSQ_LHD_adj_t1 = Months
const	SPSQ_LHDWC_adj_t1 = 6
unit	SPSQ_LHDWC_adj_t1 = Months
const	SPSQ_LHU_adj_t1 = 12
unit	SPSQ_LHU_adj_t1 = Months
const	SPSQ_MHD_adj_t1 = 12
unit	SPSQ_MHD_adj_t1 = Months
const	SPSQ_MHDWC_adj_t1 = 12
unit	SPSQ_MHDWC_adj_t1 = Months
const	SPSQ_MHU_adj_t1 = 12
unit	SPSQ_MHU_adj_t1 = Months
const	SPSQ_NI_adj_t1 = 12
unit	SPSQ_NI_adj_t1 = Months
const	Sympt_EHU_drain_t = 3
unit	Sympt_EHU_drain_t = Months

APPENDIX H (continued)

Base Case Model Equations by Variable Type Constants

Type	Equation
const	Sympt_EHU_intensity_fraction = 6
unit	Sympt_EHU_intensity_fraction = Symptoms/Person
const	Sympt_LHD_adj_t1 = 12
unit	Sympt_LHD_adj_t1 = Months
const	Sympt_LHD_drain_t = 6
unit	Sympt_LHD_drain_t = Months
const	Sympt_LHD_intensity_fraction = 8
unit	Sympt_LHD_intensity_fraction = Symptoms/Person
const	Sympt_LHDWC_drain_t = 6
unit	Sympt_LHDWC_drain_t = Months
const	Sympt_LHDWC_intensity_fraction = 6
unit	Sympt_LHDWC_intensity_fraction = Symptoms/Person
const	Sympt_LHU_drain_t = 12
unit	Sympt_LHU_drain_t = Months
const	Sympt_LHU_intensity_fraction = 12
unit	Sympt_LHU_intensity_fraction = Symptoms/Person
const	Sympt_MHD_adj_t1 = 12
unit	Sympt_MHD_adj_t1 = Months
const	Sympt_MHD_drain_t = 6
unit	Sympt_MHD_drain_t = Months
const	Sympt_MHD_intensity_fraction = 6
unit	Sympt_MHD_intensity_fraction = Symptoms/Person
const	Sympt_MHDWC_adj_t1 = 12
unit	Sympt_MHDWC_adj_t1 = Months
const	Sympt_MHDWC_adj_t1_1 = 12
unit	Sympt_MHDWC_adj_t1_1 = Months
const	Sympt_MHDWC_drain_t = 6
unit	Sympt_MHDWC_drain_t = Months
const	Sympt_MHDWC_intensity_fraction = 2
unit	Sympt_MHDWC_intensity_fraction = Symptoms/Person
const	Sympt_MHU_drain_t = 12
unit	Sympt_MHU_drain_t = Months
const	Sympt_MHU_intensity_fraction = 12
unit	Sympt_MHU_intensity_fraction = Symptoms/Person
const	Sympt_NI_drain_t = 1
unit	Sympt_NI_drain_t = Months
const	Sympt_NI_intensity_fraction = 1
unit	Sympt_NI_intensity_fraction = Symptoms/Person
const	System_Awareness_goal = 30
unit	System_Awareness_goal = System awareness units/Person
const	System_Change_Action_goal = 20
unit	System_Change_Action_goal = System change action units/Person

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