A Mental Health Allocation and Planning Simulation Model:

A Mental Health Planner's Perspective

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Introduction: Type of Operations Research Models Used in Behavioral Health

Operations research (OR) is a scientific extension of mathematics that attempts to explain the behavior of systems based on an understanding or knowledge about the behavior of the system's components (Sacolick 1980). It utilizes diverse methods such as mathematical modeling, statistics, and algorithms to arrive at optimal (or near optimal) solutions to intricate problems. It is typically concerned with maximizing or minimizing some goal stated as an "objective function."

> Operations research as a paradigm has the potential for aiding decision-makers in improving the planning, management, and operations of the mental health service system and its interactions with other systems. Problems and issues are approached by understanding the system being studied, that is, defining the objectives or goals of concern, the flows of people, the facilities and processes within and outside the system, the inputs to and outputs from the system, and the data needed to develop OR models of the system. (Pierskalla 1981).

Operations research models - conceptual frameworks and mathematical formulations of systems - have been used for capacity planning, resource allocation, and systems management in general health and in mental health (Pierskalla 1981). Applied in a planning process, operations research models can be used to project[1] the consequences of particular courses of action which suggest how to improve the plan (Nutt 1984). As used in health systems planning, OR employs

[1] Note that "a *projection* specifically allows for significant changes in the set of 'boundary conditions' that might influence [a] prediction, creating "if this, then that" types of statements. Thus, a *projection is … statement that it is possible that something will happen in the future if certain conditions develop.* The set of boundary conditions that is used in conjunction with making a projection is often called a scenario, and each scenario is based on assumptions about how the future will develop...For a decision maker, a projection is an indication of a possibility, and normally of one that could be influenced by the actions of the decision maker" (MacCracken 2001).

interdisciplinary methods and expertise—such as that from mathematics, statistics, psychology, sociology, and economics.

There is a great need for quantitative planning models in mental health. Since the beginning of "deinstitutionalization" – the move to treat persons with serious mental illness in community programs rather than large state institutions - mental health system planning has been governed by overly optimistic and simplistic plans with respect to amounts of services and resources required (Foley and Sharfstein 1983; Frank and Glied 2006; Grob and Goldman 2006; Rochefort 1997; Levin and Roberts 1976). As a result, flawed plans have resulted in persons with serious mental illness failing to progress in their recovery, and in the worst instances, becoming homeless or incarcerated (Rochefort 1997). In many cases careful modeling of system functioning could have foreseen these unintended consequences (Levin 1977). However, more typically, systems planning, has been in the form of repeated commissions at the federal and state levels designed to enlist public opinion rather than specify needed amounts of services and resources (Frank and Glied 2006; Grob and Goldman 2006; Lippmann 2004)..

Certain aspects of operations research models make them particularly useful in mental health planning, such as:

1. Most mental health problems are complex and require knowledge from multiple disciplines for their solution. Operations research models lend themselves to development by multidisciplinary teams (Pierskalla 1981).
2. By manipulation of model variables, operations research models can project the performance of innovative systems that differ substantially from existing ones (Pierskalla 1981).

3. Operations research models can be used to make system projections “just in time.” Evaluation and applied research studiesgenerally take extended periods of time. As Levin et al. (1976) note:

> If many studies ranging over a long period of time are needed to build a good scientific account of some social phenomenon, the social practitioner will probably not have time to wait (p.7).

A variety of different types of models have been described as operations research models. These include: linear programming models, network flow models, integer programming models, nonlinear programming models, dynamic programming models, stochastic programming models, combinatorial optimization models, stochastic process models, discrete time Markov chain models, continuous time Markov chain models, queuing models, and simulation models (Sainfort, Brandeau, and Pierskalla 2004; Jensen and Bard 2003). It is beyond the scope of this chapter to describe these various models; howeverthe texts cited above are good examples of the many that do so.

The Human Services Research Institute mental health allocation and planning simulation (HSRI MHAPS) model, discussed here, is a deterministic first order Markov simulation model. This model is an off-shoot of a mental health allocation and planning linear programming model (HSRI MHAPLP) developed by Leff and Graves (Leff 1985; Leff 1981; Leff 1986).

Planning models generally, and simulation models in particular, require specific steps we describe below (Levin and Roberts 1976; Pierskalla 1981; Hargreaves 1986).

1. Development of a conceptual framework or theory describing key elements of the system to be modeled.
2. Mathematical formulation of the model.
3. Collection of data necessary to populate model variables.
4. Scenario review and selection.
5. Presentation of "user-friendly" results to different audiences.

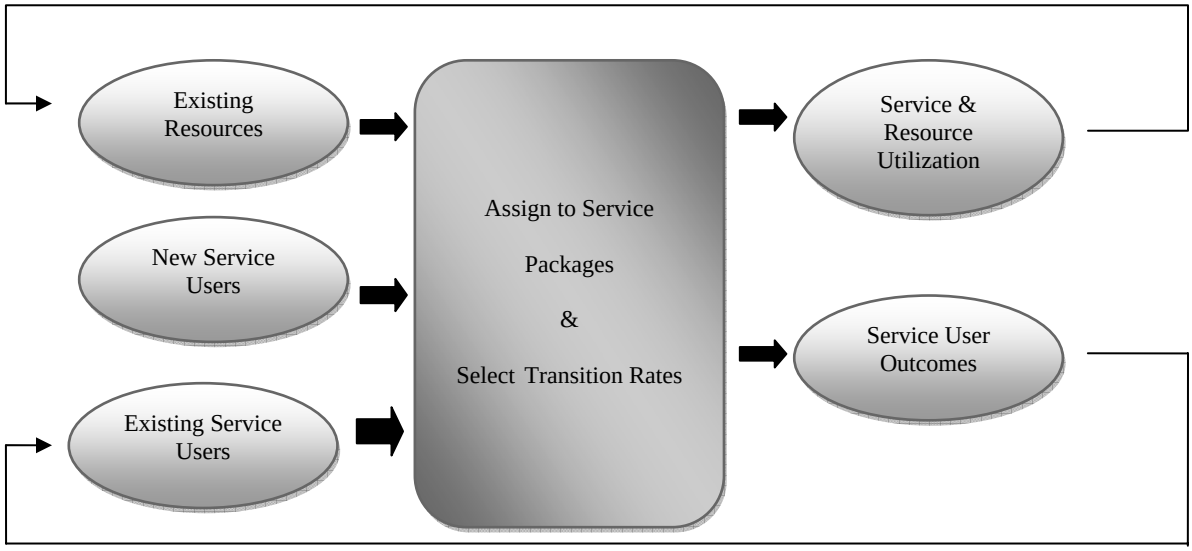
1.1 The HSRI Mental health Allocation and Planning Simulation

1.2 Theoretical and Conceptual Framework

Figure 1, below, depicts the framework we developed for both HSRI MHAPS and MHAPLP. At regular intervals mental health systems take into consideration current service users that continue in care as well as recent arrivals from outside the system. Arrivals occur under a number of circumstances. They may be persons who have just been diagnosed or evaluated for a serious mental illness (treated incidence) They may also be persons who have had a serious mental illness for some time but who are participating in services for the first time, either under the prevailing service system or due to service system changes (latent demand becoming expressed). Arrivals may also be previously served persons who have left the system but are returning for service. Persons are assigned to combinations of different services (service packages) based on their service needs, judgments as to the effectiveness of candidate service packages, and on the availability of new and existing resources to meet service package resource requirements. During the delivery of services, resources are consumed. Following the delivery of service packages service recipients either improve, worsen, or remain the same in terms of one or more system objective(s). They may also disappear from the system or die. The number of persons still in need of service and continuing in a system influence the future number of persons to be served.

The amount of resources consumed influences the future resources supply, and so on (Leff 1985; Leff 1986).

Figure 1. HSRI MHAPS Conceptual Framework



Given this conceptual framework, we postulated that, with respect to the need for services, the most salient characteristics of persons with serious mental illness would be reflected in their overall level of functioning. Level of functioning is not a fixed trait but a state that changes with the natural course of mental disorder and the receipt of services. For that reason when discussing functioning we will typically speak of persons in terms of "when they are at specific functional levels". We further postulated that persons in need of service would require different types and amounts (packages) of services depending on their level of functioning. Finally, we postulated that service recipient outcomes could be most relevantly measured in terms of functional level changes. System level outcomes would be most meaningfully expressed as aggregate changes in

levels of functioning and system performance would be best articulated as some ratio of outcomes to total resources expended.

We selected one month as the planning unit of time for our model based on the rates at which persons with a serious mental illness who were very low and mid-range functioning transition. Persons when they are very low functioning typically are suffering from acute psychiatric symptoms. In many instances, these symptoms can be ameliorated fairly rapidly by psychoactive medications. Hence, persons when they are low functioning often improve in functioning in days or weeks. Persons with a serious mental illness when they are mid-range functioning typically are engaged in learning community living skills, such as how to find and retain employment or how to deal with the stresses of everyday life. It can take periods of one year or more to learn skills like these. Given a range of transition times - from days and weeks to years - we chose one month as a plausible unit of time for our model. We do note that since persons when they are low functioning may transition in days or weeks, our use of a month period may overestimate service needs for these groups. However, we believe this bias is somewhat mitigated by the fact that service systems probably lag to some degree in responding to rapid functional level changes.

At this point, it is instructive to note why we went from using MHAPLP to HSRI MHAPS. In its initial formulation, for each month in the planning time frame, MHAPLP was allowed to assign monthly service packages differing in types and amounts of service to functional level groups (functional level groups and service packages are discussed further below). Planning time frames typically ranged from 12 to 60 months. As we experimented with MHAPLP we found that it made a number of decisions that would not be acceptable in real systems. For example, it

made different service package assignments within functional level groups with no justification other than optimizing long-term system outcomes, given resource constraints. As another example, MHAPLP would change service packages from month to month, sometimes substituting “poorer” service packages for “richer” ones, again to maximize long-term system outcomes. As a final example, towards the end of a planning period, MHAPLP would myopically tend to assign “poorer” service packages to some groups because there was insufficient time for favorable outcomes and associated cost savings to occur. These decisions would have the appearance of inequities and arbitrary rationing to providers, service users and other stakeholders in mental health systems. While real systems may engage in such behaviors as unintended consequences of resource constraints (Levin 1977; Levin and Roberts 1976) more often than we would like to admit, we found that systems planners could not choose plans that had these characteristics. As a result we increasingly constrained MHAPLP so that it would not make these decisions. Eventually, it seemed more straightforward to employ a simulation model than a severely constrained MHAPLP that, in many ways, was functioning like a simulator.

1.3 Mathematical Formulation

As noted above, we mathematically formulated HSRI MHAPS as a deterministic first order Markov simulation model. Markov models have been and are being used in mental health planning (Bala and Mauskopf 2006; Hargreaves 1986; Heeg et al. 2008; James et al. 2006; Korte 1990; Chui-Yu Liu, Teh-Wei Hu, and Jeanette Jerrell 1992; Miller et al. 2009; Norton et al. 2006; Patten 2005; Perry, Lavori, and Hoke 1987; Shumway, Chouljian, and Hargreaves 1994; Sweillam and Tardiff 1978). Markov transitions have been proposed as a useful way to think about mental health outcomes for mental health evaluation and planning (Hargreaves 1986; Pierskalla 1981). These outcomes can be the number of individuals who enter, remain or leave a mental health service system. Markov transitions for most health settings have been calculated to describe the progression of phases of from the onset of illness to recovery. Two great attractions of Markov models for planning are (1) their basis in states for which services can be planned and (2), their ability, given that even the most effective services do not have favorable outcomes for all persons at all times, to describe backwards as well as forwards movement or change.

In the HSRI MHAPS model, planners assign service packages to functional level groups. Functional level groups describe states through which persons pass (although not necessarily linearly) in the course of mental illness. Service packages start as menus of multiple services. For each functional level planners "prescribe" the *services* that persons in the functional level group should receive, the *percents of persons* in the functional group who should receive the services, and the *average amounts of service* that persons in need should receive. The percent of persons prescribed a service multiplied by the average amount of service prescribed is the utilization rate for that service. Each service is associated with a unit cost (or any other resource requirement, e.g., staffing) and can also be associated with revenues realized.

Additionally, for each service package, planners estimate a set of monthly Markov transition probabilities reflecting the effectiveness of the service package in improving service recipients' level of functioning (discussed below). Simply put, for each month in the planning time frame, the model multiplies the number of new and arriving persons in each functional level group by the service utilization rates and uses these numbers to estimate service costs and revenues. It also uses the Markov transition probabilities to distribute persons to functional levels to set the stage for the next month.

1.4 Functional Level Groups and Estimating Persons in Need of Service

Given our theory that functional level is the most useful way to think about persons with serious mental illness for system planning purposes, we developed a functional level framework for use with MHAPLP that we also use with HSRI MAHPS. To develop this functional level framework, the first author interviewed psychiatric case managers specializing in treatment planning and care management for persons with serious mental illness (Leff 1986). These case managers typically placed persons into 3-6 groups. The first author also observed that many multi-item and multi-scale measures often were reduced for planning and evaluation purposes to only one score consisting of no more than ten levels (Weissman 1975). Given these observations and the need for a framework that could be translated into minimally burdensome measures for assessing functional levels repeatedly and system-wide, a global and resource associated level of functioning framework with seven levels was developed.

This framework is described in Table 1. The framework is "global" because the levels are meant to describe functional areas such as activities of daily living and community living skills, rather

than individual skills. Other frameworks breakdown functioning into multiple individual skills, although, as stated above, they often combine them into a global measure (The Evaluation Center@HSRI 2004). The framework is "resource associated" because the functional areas it focuses on have implications for service needs In fact, planners using these levels prescribe service packages that focus on services that control symptoms of persons at the lower functional levels, and prescribe services packages that focus on rehabilitation and community integration for persons at the higher levels. Resource requirements decrease as functional level increases (Leff 1985).

Following this, we developed a functional level scale to measure functioning according to this framework, the Resource Associated Functional Level Scale (RAFLS). The RAFLS is a global measure of functioning with seven levels paralleling the levels in the global, resource associated functional level framework. This scale has proved to have acceptable reliability (Leff et al. 2004). Other scales are available for measuring level of functioning (Goldman, Skodol, and Lave 1992). One scale that is typical of others, and for which data is frequently available, is the Global Assessment of Functioning (GAF) Scale used to measure Axis V in the Diagnostic and Statistical Manual of Mental Disorders (DSM) (Goldman, Skodol, and Lave 1992). We have been able to cross-walk scores on the GAF (and on a number of other scales) to our functional level framework, although without some collapsing of items and re-arrangement of resulting levels these scales may not be ideal for planning services (Moos, Nichol, and Moos 2002).

HSRI MHAPS requires information on the number and functional level distribution of persons in the mental health system at the start of a planning period (snapshot data) and the average number and functional levels of persons arriving monthly (arrival rates). We can estimate the numbers of

persons in, and arriving, to systems either through the use of administrative data or sample surveys. However, estimating functional level distributions is more difficult when using administrative data. Administrative data systems do not necessarily measure level of functioning. Those that do, do not measure it monthly. Instead, information systems that measure functional level take varied approaches: some measure it at the initiation of service, and some at initiation and termination. Others measure it at the time of service changes, and others quarterly. Additionally, management information systems do not tend to use functional level measures designed to relate directly to service need. Therefore, although it is possible to estimate functional level changes from management information system data, we prefer to measure it using sample surveys and a functional level measure.

It is possible for persons to vary in functioning within months. Since we use monthly planning periods, some error is unavoidable. Our rule for these situations is to "code to or take the lowest." For clinical and safety reasons we believe it is better to over-estimate system needs than to under-estimate them.

Table 1. Resource Associated Functional Level Scale (RAFLS)

Level	Level Name	Level Description
1	At-risk	At-risk to self or others, or to property of value. Unable or unwilling to participate in one's own care or to cooperate in control of violent or aggressive behavior. May require continuous (24-hour) supervision, high staff/consumer ratio.
2	Unable to Function, Current, Acute Psychiatric Symptoms	Acute symptoms may result in behavior that is seriously disruptive or at-risk to self or others, but if so, is able/willing to control impulses with assistance and willing to participate in own care. Alternatively, acute symptoms seriously impair role functioning. Examples of acute symptoms: lack of reality testing, hallucinations or delusions, impaired judgment, impaired communication, or manic behavior. Nonetheless, may be able to carry out *some* activities of daily living. May require continuous supervision, or moderate staff/consumer ratio.
3	Lacks ADL/Personal Care Skills	Lacks ADL due to active symptoms that do not result in behavior that is seriously disruptive or dangerous. Unable or unwilling to make use of sufficient ADL and/or personal care skills to carry out basic role functions. May require continuous (24-hour) prompting, skill training, and encouragement.
4	Lacks Community Living Skills	Able to carry out ADL personal care skills. Role functioning impaired by lack of community living skills or motivation to perform. Community living skills include: money management, ability to engage in competitive employment, maintaining interpersonal contacts. May require regular and substantial but not necessarily continuous training, prompting, and encouragement.
5	Community Living Skills but Vulnerable to Stresses of Everyday Life	Can perform role functions, at least minimally, in familiar settings and with frequent support to deal with the ordinary stresses of everyday life; although may need the regular assistance of a roommate, homemaker-aide, etc., or can work outside of sheltered situations with on-site support or counseling. Requires support under the stresses associated with the frustrations of everyday life and novel situations. May require frequent (e.g., weekly) information, encouragement, and instrumental assistance.
6	Community Living Skills and Only Needs Support/Treatment to Cope with Extreme Stress or Seeks Treatment to Maintain or Enhance Personal Development	Can perform role functions adequately except under extreme or unusual stress. At these times, the support of natural or generic helpers such as: family, friends, or clergy is not sufficient. Mental health services are required for the duration of stress; or performs role functions adequately, but seeks mental health services because of feelings of persistent dissatisfaction with self or personal relationships. Intensity and duration of treatment can vary.
7	System Independent	Can obtain support from natural helpers or generic services. Does not require or seek mental health services.

1.5 Planning Service Packages

A population of persons with serious mental illness can require between twenty and forty services in the service domains of medical inpatient and outpatient treatment, mental health inpatient and outpatient treatment, case management, housing, rehabilitation and social support (Leff et al. 2004). Table 2 contains an illustrative list of services and their definitions. Depending on level of functioning and other considerations (e.g., family supports) individuals with serious mental illness typically receive 4-6 services. For a desired service system, HSRI MHAPS planners prescribe the percentage of persons in each functional level group who are in need of a service and the average amount of service persons in need should receive. If the purpose of a plan is to change the service system, the services available and the percentages and amounts prescribed for the desired system will always differ from those available and utilized in the current system. In some cases services will be added or increased.

However, an important part of service planning is removing or reducing ineffective or inefficient services, a process Frank and Glied (2006) have described as exnovation. We refer to the resultant multi-service prescriptions for each functional group as “service packages.” The group process by which these prescriptions are made is described in a later section.

Table 2. Service Variables, Component Services, and Service Definitions

Service Domain	Component Services	Definition
Inpatient	Specialty Inpatient	Provides continuous treatment that includes general psychiatric care, medical detoxification, and/or forensic services in a general hospital, a general hospital with a distinct part or a freestanding psychiatric facility.
Emergency	Crisis Intervention Services	Crisis intervention services for the purpose of stabilizing or preventing a sudden episode or behavior.
	Crisis respite	24-hr services for individuals in crisis in homelike settings
Residential Treatment	Short-Term and Long-Term Residential	Residential services that are provided by a behavioral health agency. These agencies provide a structured treatment setting with 24-hour supervision and counseling or other therapeutic activities for persons who do not require on-site medical.
Community Treatment	Assessment	Evaluation for the purposes of intake, treatment planning, eligibility determination
	Individual counseling	Scheduled outpatient mental health services provided on an individual basis in a clinic or similar facility
	Group Counseling	Psychotherapy to multiple clients in same session
	Family counseling	Psychotherapy to a family or couples to improve insight, decision-making, reduce stress.
	Medication evaluation/ management	Services provided by physician or other qualified medical provider to evaluate, prescribe, and monitor psychiatric medications
	Substance Abuse Treatment	Programs for persons with both mental illness and substance abuse
	Assertive Community Treatment	ACT is a multi-disciplinary approach to providing an inclusive array of community-based rehabilitation services following SAMHSA EBP guidelines.
Rehabilitation	Supported Employment	Job finding and retention services following SAMHSA EBP guidelines.
	Skills Training	Individual or group training in activities of daily and community living skills
Support	Case management	Assistance in accessing services and making choices about opportunities and services in the community
	Peer Support	Self-help/peer services are provided by persons or family members who are or have been consumers of the behavioral health system. This may involve assistance with more effectively utilizing the service delivery system or understanding and coping with the stressors coaching, role modeling and mentoring.
	Supported Housing	Supported housing services are provided to assist individuals or families to obtain and maintain housing in an independent community setting including the person's own home or apartments and homes that are owned or leased by a subcontracted provider

Initially, we developed service packages (and estimated outcomes) by convening diverse mental health system stakeholders from the locales for which we were planning. We would then engage them in a consensus process for assigning services to functional groups (Leff 1985). Recently we have modified this approach, although we still convene planning workgroups of diverse mental health system stakeholders. These stakeholders include service users, service providers, advocates, policy-makers and planners. However, given findings from social-psychological research, we no longer have the workgroups reach consensus. Bringing together groups to plan services is based on the idea that individuals, by virtue of their unique life experiences and expertise, make more informed decisions than single individuals (Reuter and Gustafson 1981; Sunstein 2006; Gustafson et al. 1973). However, social-psychological research has shown that when groups are asked to seek consensus they can be heavily influenced by factors such as the dominance of a few individuals, or the predisposition of others to withhold their ideas because they are shy or concerned about alienating other group members (Sunstein 2006). Consequently, we now use an evidence-based method described by Reuter and Gustafson (1981) as "estimate-talk-estimate." In this approach individuals first make service recommendations privately. These recommendations are averaged and fed back to the workgroup. If the members' recommendations vary widely, we may transform the estimates to minimize the influence of extreme ratings (Charemza 2002). The workgroup then talks about the recommendations. Prior to the discussion, workgroup members are asked to discuss general principles for making recommendations and not the specific percents and amounts they prescribed. They then privately re-recommend services. The second round of service recommendations becomes the primary service prescriptions for the modeling effort.

When we first began modeling mental health systems in the late 1970s administrative data sets with monthly data on service utilization were rarely available. When they were available, they were expensive to access. Monthly service utilization data that could be organized by level of functioning was even more rare. Consequently, we either used sample surveys to collect data on utilization and functioning, or planned without current system information. However service utilization data that can be organized by month and by functional level has become much more accessible in administrative data sets. Consequently, we are usually able to present our planning workgroups with data for their systems showing current service packages for functional groups. The planning task then becomes modifying the current service packages to make them more effective or efficient.

1.6 Assigning Unit Costs and Revenues

We also assign a unit cost and revenue generated to each service. Units differ as a function of service. For example, hospital units of service are typically days and outpatient therapy units of treatment are typically hours. Unit cost and revenue data for existing services are usually available from system financial divisions. It should be noted that the unit cost data available is more accurately unit price data. If new services are being planned, unit cost data may have to be obtained from outside the system. In some cases it may have to be estimated based on staffing and other resource requirements.

1.7 Estimating Outcomes

MHAPLP and HSRI MHAPS are unique among mental health planning approaches in the way that they incorporate outcomes. Under our theory, persons with serious mental illness improve or regress in functioning depending on their current level of functioning and the service packages

they receive. Our models assume that a Markov property applies to these transitions. More specifically, we assume that a person in FL *i*, depending on the service package received, makes a transition (improves, regresses, or does not change) to FL *j* within a certain period of time. For HSRI MHAPS this is one month. Additionally, for planning purposes, we assume that these transitions occur exactly at their expected value despite the probabilistic nature of individual service recipient movements. For example, suppose the probability of improvement is 0.3 for each person in FL *i* that receives service package *k*. If there are 100 persons in FL *i* receiving service package *k*, exactly 30 of these persons will improve in the immediate time period. As noted in Leff et al. (1986), we believe that ignoring transition randomness is appropriate for, and consistent with, the development of an aggregate resource-planning model. A number of studies demonstrate how Markov transitions can be used to estimate forward and backward transition of mental health clients (Hargreaves 1986; Pierskalla 1981; Bala and Mauskopf 2006; Chui-Yu Liu, Teh-Wei Hu, and Jeanette Jerrell 1992; Miller et al. 2009; Sonnenberg and Beck 1993; Norton et al. 2006).

Given our 7 level of functioning conceptual framework, in model applications we develop a 6-by-9 transition probability matrix to represent outcomes for functional groups given defined service packages. Table 3 presents an example of such a matrix. There are only six rows for initial functional groups since persons at functional level 7 are, by definition, not in need of service. There are 9 outcome states, one for each functional group, one for persons transitioning to death, and one for persons transitioning to disappearance. Many persons with serious mental illness leave the mental health system in unplanned ways. Under these circumstances little is known about their levels of functioning at the time (Olfson et al. 2009). Some may have become system independent (i.e., reached functional level 7). Others may have regressed and become

involved with the criminal justice system, homeless, or hospitalized on some other system (Rochefort 1997).

Table 3. Transition Probability Matrix for Functional Levels

		Destination								
Initial Functional Level	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Death**	**Disap-pearance**	**Total**
1	FL *11*	FL *12*	FL *13*	FL *14*	FL *15*	FL *16*	FL *17*	1 De	1 Dis	1.00
2	FL *21*	FL *22*	FL *23*	FL *24*	FL *25*	FL *26*	FL *27*	2 De	2 Dis	1.00
3	FL *31*	FL 3*2*	FL 3*3*	FL 3*4*	FL 3*5*	FL 3*6*	FL 3*7*	3 De	3 Dis	1.00
4	FL *41*	FL *42*	FL *43*	FL *44*	FL *45*	FL *46*	FL *47*	4 De	4 Dis	1.00
5	FL *51*	FL *52*	FL *53*	FL *54*	FL *55*	FL *56*	FL *57*	5 De	5 Dis	1.00
6	FL *61*	FL *62*	FL *63*	FL *64*	FL *65*	FL *66*	FL *67*	6 De	6 Dis	1.00

After we complete the service planning process, as described above, we use the planning workgroups to estimate Markov transition probabilities for the planned service packages. Once again, because administrative data sets with functional level data have become more available we are able to provide planning workgroups with matrices showing transition probabilities for their systems given current service packages. However, since the functional level data available to us are not monthly we have to make assumptions about functional level changes occurring between measurements. This allows us to translate the differing time intervals between functional level measures we have into monthly functional level ratings and monthly changes. For this reason, we still prefer to collect level of functioning data using sample surveys that ask for functional level ratings for the current and the previous month. These ratings allow us to estimate transitions based on monthly data.

We also follow an estimate-talk-estimate approach for transition probabilities. After presenting the planning workgroup with current transition rates we have members privately estimate what

they think transition probabilities will be under the planned system. We then average the members' estimates (making some modifications, if necessary, to make the row totals equal to 1.00), enter them into HSRI MHAPS, and implement a simulation with the new plan's data elements. Next we present the simulation results to the planning workgroup and allow them to discuss the findings. As in the service planning component, workgroup members are asked to discuss general principles and not their specific estimates. After a discussion period, we ask the workgroup members to re-estimate transition probabilities for the new service packages. The averages of these estimates (again modified to sum to 1.00) becomes the transition probabilities for the new plan.

1.8 Web-Based Implementation of HSRI MHAPS

Following the development of our simulator we have spent over two decades using the model to assist states, counties, and local entities to explore mental health system options. During this time, we identified several barriers to widespread model use. The first was the lack of "desktop" model accessibility to state planners. Another was a lack of experience among state planners with model-based planning. A third was our desire to be constantly enhancing and improving our model. A fourth was the relative isolation of state mental health planners from other planners and scientists working on planning problems. Last but not least, was the lack of empirical data for the model.

Motivated by these practical experiences, we decided to develop a web-implemented version of the model. This version has screens and instructions for entering all the model inputs described above. It is programmed in…and located on a server operated by HSRI (**a wee bit more on technical details of web version programming language.) The enhancement enables us to make

the model accessible to local planners and to provide technical assistance on appropriate uses of the model. Further, web dissemination of our model allows us to fix model problems and disseminate new model versions. Finally, a version of the model, situated on a web site along with community building and information sharing mechanisms such as shared databases, bulletin boards, and list serves, seemed to us a way to overcome the isolation of state planners and of increasing the available data for modeling efforts.

The second enhancement we made to the current model also addressed the lack of empirical data for model inputs. This enhancement involved developing a model component for generating different inputs for the model in a particularly important and data-sparse area (estimates of treatment outcomes) to be used in sensitivity analysis.

2.1 Case Study: *Arnold V Sarn* Service Capacity Plan

2.2 Background

Arnold v Sarn is a class action suit that was brought by advocates on behalf of persons with mental illness in 1981, alleging that the Division of Behavioral Health Services of the state of Arizona (ADBHS) was not providing adequate or comprehensive mental health services in Maricopa County. In 1986, the court found that the mental health system was in violation of state statutes. To provide support in the resolution of this suit, the plaintiffs, representatives of the Court, and the ADBHS retained HSRI in1991 to conduct a study to develop a mental health system plan for Maricopa County that would be acceptable to all parties. (In 1996, the parties negotiated an exit stipulation to the suit to determine when the state had sufficiently implemented a system that satisfied these criteria. The exit stipulation included requirements on the Arizona State Hospital, service planning and quality improvement efforts, and obligations to case management, rehabilitation, and housing services. In 1998 a supplemental agreement was

reached between the parties to avoid further litigation against the ADHAS for not being in compliance with the exit stipulation. There has been continuing action taken in regard to the suit, with the Court's Office of the Monitor conducting independent assessments of progress to determine compliance. HSRI completed the service capacity plan for ADBHAS in 1999.

2.3 Steps in and Results of the Planning Process

To develop the plan, a planning workgroup representing all parties to the suit was formed. The steps taken in the planning process and the findings of those steps are presented below.

2.3.1 Estimate Functional Level Distribution

We used ADBHS Colorado Client Assessment Record (CCAR) (Ellis, Wilson, and Foster 1984) data for 1998 to estimate the functional levels of persons in the planning population. Several algorithms were developed for cross-walking CCAR data to the MHAPS functional level framework. Representatives of parties to the suit acted as a planning committee and agreed on a cross-walk that yielded the distribution shown in Table 4. Distributions were developed for service users who received assessments prior to 1998 (the "snapshot population") and for persons who received intakes in 1998 (the "arrival population"). Note that arriving service users are at a lower level of functioning than persons who have been in the system, indicating some degree of improvement associated with the current system in Arizona.

Table 4. Estimated Snapshot and Arrival Functional Level Distribution: Numbers and Percents in Planning Population

	Snapshot		Monthly Arrivals	
MAHPS LEVEL	**Number**	**%**	**Number**	**%**
1 At Risk.	840	7	224	9
2 Acute Symptoms	1428	12	527	21
3 Lacks ADL/Personal Care Skills	3516	29	734	30
4 Lacks Community Living Skills	1536	13	389	16
5 Needs Role Support and Training	2124	18	347	14
6 Needs Support/Treatment to Cope with Extreme Stress	2556	21	239	10
Total	12000	100	2463	100

2.3.2 Determine and Define Services

In consultation with the planning participants, we developed a list of services and service definitions judged necessary for persons in the planning population. These services were suggested by reviews of services provided in Arizona and other states, consideration of the scientific literature on evidenced-based mental health services, and the literature on service user and family preferences. The service domains covered included: residential, emergency services, hospital and crisis services, treatment, outpatient treatment, rehabilitation and support. Services were selected that were consistent with the scientific evidence and the clinical principles cited above, which are that services should ensure service user and community safety, be least restrictive, respond flexibly to changes in need, promote functioning, empowerment, and recovery, and be cost-effective. The final list of 35 services, organized by domain, is presented below in Table 5.

2.3.3 Estimate service unit costs based on data from Arizona and other states

Unit service costs for 18 states were examined. For data prior to 1998, an inflation rate equation was utilized to provide updated costs. This equation was based on data from the Bureau of Labor Statistics' Consumer Price Index for Medical Care Services. For some services, unit costs were calculated using information provided and reviewed by the planning process participants relating to staffing patterns and assumptions about amounts of service to be delivered. In addition, whenever possible, unit cost estimates were compared with unit cost estimates in the published literature on services for persons with severe mental illness. Table 6 also shows the final service unit costs estimated by HSRI and the planning participants - organized by service domains.

Table 5. Unit Costs Estimated for Services in Needs Assessment

Service	Unit	Cost
Hospital and Crisis		
1 Inpatient - Specialty/State	Days	$285.00
2. Inpatient – General	Days	$440.00
3. Inpatient – Forensic	Days	$285.00
4. Inpatient – Detoxification	Days	$150.00
5. Crisis Outreach	Hours	$115.00
6. Crisis Residential	Days	$285.00
Emergency		
7. Respite Care	Days	$132.00
8. Crisis Emergency Walk-In	Hours	$166.00
Residential		
9. Intensive Staff/ Supervision	Days	$250.00
10. Moderate Staff/ Supervision	Days	$200.00
11. Minimum Staff/ Supervision	Days	$90.00
12. Independent Living w/ Housing Subsidy	Days	$11.51
13. Independent Living w/o Housing Subsidy*	Days	
14. Specialized Residential	Days	$275.00
Treatment		
15. Evaluation (Diagnosis)	Hours	$110.00
16. Court Ordered Evaluation	Hours	$110.00
17. Medication Management	Hours	$64.00
18. Intensive Clinical Services	Hours	$90.00
19. Individual Psychotherapy	Hours	$85.00
20. Group Psychotherapy	Hours	$20.00
21. Family Psychotherapy	Hours	$80.00
22. Therapeutic Supervision	Hours	$25.00
23. Outpatient Detoxification	Hours	$75.00
24. Substance Abuse Counseling	Hours	$75.00
25. Methadone Maintenance Clinic	Week	$75.00
Rehabilitation		
26. Psychosocial Rehabilitation	Hours	$11.00
27. Consumer Operated Services	Hours	$5.00
28. Vocational Assessment	Hours	$60.00
Support		
29. Assertive Community Treatment	Hours	$123.00
30. Supported Employment	Hours	$60.00
31. Supported Education & Other Educational Services	Hours	$30.00
32. Protection & Advocacy	Hours	$22.50
33. Client Transportation	Hours	$10.00
34. Family Psycho-education	Hours	$60.00
35. Friend Advocacy	Per person	$83.00

* Independent Living w/o Housing Subsidy does not have an associated cost because the assumption is that housing costs are paid by other sources.

2.3.4 Prescribe percents and amounts of services for persons with serious mental illnesses at different functional levels

For each functional group, the planning workgroup generated service prescriptions (percentages of persons to receive a service and average amount of service per recipient) for each of the services in Table 5. These prescriptions were based on prescriptions from a previous Arizona study, other state prescriptions from earlier studies, expert judgment, information about the current Arizona system, and the scientific literature.

Table 7 below shows service package costs by service domain and functional level. Patterns of costs indicate that the planning workgroup prescribed services according to the logic of the functional level framework. Total service package costs and all but two costs per domain decreased as level of functioning increased. The only exceptions to this were the treatment and rehabilitation domains. Treatment costs did not vary, but types of treatment did. Treatments for persons who were at lower functional levels were primarily intensive clinical services and medication, treatments for persons at higher functional levels included individual and group psychotherapy. Rehabilitation costs increased as functional level increased. Rehabilitation costs were highest for functional levels 3 and 4, but decreased for functional levels 5 and 6. This reflects the fact that many persons at functional level 1 may have symptoms that are too severe to benefit from intensive rehabilitation, while many at functional levels 5 and 6 do not need it. Persons at functional levels 2 through 4 are typically both in need of rehabilitation and in a position to take advantage of it.

Table 6. Service Package Option Costs by Domain, Functional Level and Total

	Functional Levels					
Service Domains	**1**	**2**	**3**	**4**	**5**	**6**
Hospital and Crisis	$2,087	$647	$71	$156	$20	$0
Emergency	$880	$467	$208	$165	$82	$27
Residential	$8,556	$8,122	$6,753	$6,204	$5,573	$4,791
Treatment	$175	$222	$219	$245	$246	$156
Rehabilitation	$2,040	$2,924	$3,038	$2,155	$1,349	$733
Support	$1,650	$1,454	$568	$732	$276	$75
Total	$15,388	$13,835	$10,856	$9,657	$7,546	$5,782

2.3.5 Estimate Transition Probabilities

After service packages were planned, the planning workgroup was presented with monthly transition probabilities from various other planning or evaluation efforts including ones in Arizona (Hargreaves 1986; Leff 1985; Leff et al. 1996). The planning workgroup discussed these estimates and recommended modifications based on differences between the newly planned service packages and the ones used in previous studies. These monthly transition rates are shown in Table 7, below.

Table 7-Revised Arizona Transition Probability Matrix

	Destinations									
Initial Functional Level	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Disap-pearance**	**Death**	**Total**
1	**0.624**	0.118	0.050	0.154	0.007	0.005	0.000	0.037	0.005	1.000
2	0.099	**0.624**	0.129	0.037	0.068	0.002	0.000	0.037	0.004	1.000
3	0.006	0.031	**0.716**	0.184	0.022	0.001	0.000	0.037	0.003	1.000
4	0.014	0.019	0.069	**0.734**	0.111	0.013	0.000	0.037	0.003	1.000
5	0.004	0.007	0.015	0.073	**0.747**	0.103	0.013	0.036	0.002	1.000
6	0.000	0.008	0.000	0.008	0.050	**0.879**	0.017	0.037	0.001	1.000

One important aspect of this table is that most persons at each of the functional levels stay at the same functional from month to month. Another important aspect is that even under the newly

planned services, estimated to be more effective than current services, the planning workgroup estimated some regression (or backwards transitions) for all levels of functioning. Additionally, , consistent with our theory that persons at lower levels of functioning tend to progress in shorter periods of time, persons at functional levels 1 and 2 are estimated to progress more in one month than persons at other functional levels. Persons at functional level 3 are also estimated to change somewhat rapidly, but a part of that change is estimated to be regression. Finally, note that although some persons from functional levels 5 and 6 transition to functional level 7, the proportions that do are very small.

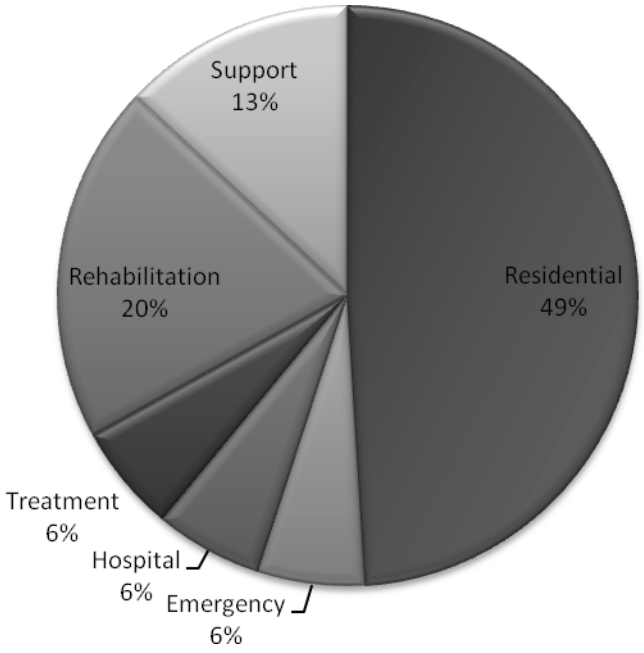
2.36 Estimate annual service system costs, taking into account estimated service needs, unit costs, and service user outcomes.

After the workgroup had estimated the information described above, HSRI entered this information into HSRI MHAPS and explored a variety of planning options with the planning workgroup. The final model selected estimated service system costs for a fully funded and implemented plan serving 14, 258 persons with serious mental illness at $435,943,267, yielding a per person cost of $30,576. The cost estimate estimated administrative costs and costs of medication separately. These estimates were expected to apply to the system for the year 2002.

Figure 2 shows the projected distribution of year 1 expenditures for the fully implemented simulation by major service domains. This figure shows that the bulk of expenditures are directed at housing, rehabilitation, and support. This expenditure distribution is reflective of the clinical principles that informed the planning process. These principles emphasized service user and community safety, least restrictive environment, flexible services, and service user recovery

and independence. Note that residential care was a substantial portion of estimated service costs and that rehabilitation cost exceeded treatment costs.

FIGURE 2. Year 1 Distribution of Expenditures by Service Domains



2.4 Case Study Discussion

This plan for a comprehensive, full capacity mental health system for Arizona was based on the best information and planning technology currently available. The plan was very explicit about the types of persons to be served, the types and amounts of services needed, the outcomes to be expected, and the probable costs of the services.

The Department of Health Services (the umbrella agency for the ADBHS) presented this plan to the Judge in *Arnold vs. Sarn* (Arnold vs. Sarn 1999). The presentation described the planning methods used and the plan in all its detail. The scientific underpinnings of the planning process and the detailed plan allowed the Arizona Department of Health to orally testify to the Judge:

> In particular, the Department of Health Services is, I think, pleased with the Arizona Service Capacity Planning Project…The project represents many months of work analyzing data, developing program models and costs and refining a cost-efficient approach for developing a comprehensive mental health system for seriously mentally ill people in Maricopa County.. The Department concurs with the client movement model presented by HSRI, the contractor, and believes that its conclusion represents a reliable estimate of what is required in order to have an opportunity to meet the State's requirements in this case. (Arnold vs. Sarn 1999)

Although the Judge expressed that he lacked the expertise to fully evaluate the plan, he recognized the work that had gone into the planning process, and accepted it as a basis for going forward, illustrating the usefulness of HSRI MHAPS in the setting of mental health policy:

> I feel optimistic by the fact that the parties have worked together diligently over many months to develop the remedial strategic plans, including service gap analysis…Consequently, it is my belief that the Department should go forward… (Arnold vs. Sarn 1999)

The ADBHS has been implementing the plan since 1999. The specificity of model estimates allows for testing of the model's accuracy as the plan is implemented. Recently we received system cost and number of persons for the served information on the performance of the Maricopa County mental health system for the years 1999-2008 (Franczak 2009). We had estimated that 2001 would be the earliest the Maricopa County mental health system might approach full implementation of the plan developed. Our HSRI MHAPS estimate for the number of persons to be served in the first full year of system implementation was 14,257

persons. Our estimate of system costs for that year was $435,943,267 or $30,844 per person. The number of persons served in 2002 was 13,407 and the total system cost was $413,523,978, or $30,843 per person. These observed data points are satisfyingly close to our projections. However, it is not clear that more detailed data would be equally consistent with model projections. More detailed findings are not available to us. However, they could be very useful. To the extent that there are variances from our projections, the plan could be revised using the new information.

The total system cost was substantially more than the ADBHS was currently spending. The court suit caused the ADBHS to receive more dollars to meet the models requirements. This will not be the case in most localities and simulations in these settings will have to be used to "back into" available dollars. However, one bright spot is that simulations for more extended periods of time suggest system costs might level off or even decrease as persons improve in functioning and some reach the point that they no longer need regular services from the public mental health system. One danger in backing into affordable system changes is that planners will dilute service packages without correspondingly making transition probabilities less positive and ignoring the fact that this will increase backwards transitions. Probably the best options for reducing system costs involve maintaining service package integrity, but implementing plans only incrementally in selected geographic localities. However, this is a difficult option for public officials because it results in inequalities.

It is important to note that the projections presented assumed a "frictionless" system in which services could be changed rapidly in response to changes in service user needs. Real systems experience friction and should be expected to change more slowly than our model projects and

Arizona exhibited, particularly when a judge and court monitor are overseeing the system's changes.

Additionally, the Arizona plan addressed only the monetary resources required by the new and expanded services. It is also important to note that implementing the plan required well-trained and skilled "front-line" staff to deliver the planned services with fidelity to the service models identifiedin Arizona's service definitions. The Arizona data we were recently given suggest ADBHS so far has been able to recruit, train, and retain staff for the services planned. If service fidelity drifts away from desired models, refresher training will be necessary. Other states planning new service systems need to attend to staff recruitment, training, and retention issues as well.

3.1 Summary and Conclusions

Above, we describe a simulation model for mental health system planning and we provide an illustrative case study of an actual implementation. We have implemented the model in over two dozen States and counties. The model conceptual framework has been accepted as a plausible and useful theory of how mental health systems function. The model has been mathematically formulated and a computer-implemented, web-based version of the model has also been developed. Over time, more administrative data have become available to estimate model parameters; nevertheless, in the absence of survey data, estimating monthly service needs by functional level and estimating functional level changes continues to be a challenge. However, we have developed evidence-based methods methods for using groups comprised of mental health system stakeholders for estimating these data.

Currently we are continuing to implement our model in additional states. We hope that in some of these states we will obtain data to further assess the accuracy of our model. We are also attempting to extend our modeling in two ways.

3.2 Criminal justice

One goal identified for additional model development identifed by The Ad Hoc Advisory Group on Operations Research and the Mental Health System was building models that can represent the flow or transfers between mental health and other systems (Pierskalla 1981). Given concerns about the flow of persons with mental illness into criminal justice systems, we have developed and are continuing to extend versions of HSRI MHAPS to describe how this flow occurrs and to plan and evaluate service options to divert persons into mental health systems (Norton et al. 2006). The HSRI MHAPS Mental Health / Jail Diversion Cost Simulation was developed to

help communities as they plan and budget for programs that divert persons from the criminal justice system into community-based mental health services. The model projects the costs, effectiveness, and potential cost offsets of implementing a jail diversion program for persons with mental illness. The model is a strategic planning tool intended to provide program stakeholder groups with information for planning resource allocation strategies and prioritizing and choosing options for jail diversion programs.

This model compares the service utilization, consumer outcomes and costs for a group of individuals who are diverted into community-based services and supports to the costs for the same group of individuals in the absence of a jail diversion program. Program planners can use the model to explore the fiscal and outcome implications of implementing different jail diversion strategies, providing different services, and choosing different target populations. The model has been tested in two counties and is currently being used by one state.

3.3 Quebec Planning Study

It is our theory, and the theory of others, that the use of planning models like HSRI MHAPS should result in plans that meet service needs more adequately and efficiently than planning not based on models (Pierskalla 1981). However, this theory remains to be empirically verified by comparing planning efforts with and without models. We are currently engaged in a project to do this with colleagues in Quebec, Canada including McGill University, the Quebec Mental Health Directorate and the Quebec Health and Social Service Centers. We will compare a simple approach to planning (systematic enumeration of anticipated costs and benefits associated with each option) with the dynamic modeling approach to system and services planning described above.

References

Bala, M. V., and J. A. Mauskopf. 2006. Optimal Assignment of Treatments to Health States Using a Markov Decision Model: An Introduction to Basic Concepts. *PharmacoEconomics* 24 (4):345-354.

Charemza, W. W. 2002. Guesstimation. *Journal of Forecasting* 21 (6):417-433.

Charles L. Arnold et al., Plaintiffs vs. James Sarn et al., Defendents. 1999. In *Fredrick Gaio III*: Superior Court of the State of Arizona in and for the County of Maricopa.

Chui-Yu Liu, Teh-Wei Hu, and Jeanette Jerrell. 1992. A Markov Analysis of the Service System for Severe Mental Illness. *Biometrical Journal* 34 (4):443-457.

Ellis, R., N. Wilson, and F. Foster. 1984. Statewide treatment outcome assessment in Colorado: the Colorado Client Assessment Record (CCAR). *Community Mental Health Journal* 20 (1):72-89.

Foley, H. A., and S. S. Sharfstein. 1983. *Madness and government : who cares for the mentally ill?* Washington, D.C.: American Psychiatric Press.

Franczak, M. 2009. Phoenix.

Frank, R. G., and S. Glied. 2006. *Better but not well : mental health policy in the United States since 1950*. Baltimore: Johns Hopkins University Press.

Goldman, H. H., A. E. Skodol, and T. R. Lave. 1992. Revising Axis V for DSM-IV: A review of measures of social functioning. *American Journal of Psychiatry* 149 (9):1148-1156.

Grob, G. N., and H. H. Goldman. 2006. *The dilemma of federal mental health policy : radical reform or incremental change?, Critical issues in health and medicine*. New Brunswick, N.J.: Rutgers University Press.

Gustafson, D. H., R. K. Shukla, A. Delbecq, and G. W. Walster. 1973. A comparative study of differences in subjective likelihood estimates made by individuals, interacting groups, Delphi groups, and nominal groups. *Organizational Behavior & Human Performance* 9 (2):280-291.

Hargreaves, W. A. 1986. Theory of psychiatric treatment systems. An approach. *Arch Gen Psychiatry* 43 (7):701-5.

Heeg, B. M. S., J. Damen, E. Buskens, S. Caleo, F. De Charro, and B. A. Van Hout. 2008. Modelling approaches: The case of schizophrenia. *PharmacoEconomics* 26 (8):633-648.

James, G. M., C. A. Sugar, R. Desai, and R. A. Rosenheck. 2006. A comparison of outcomes among patients with schizophrenia in two mental health systems: A health state approach. *Schizophrenia Research* 86 (1):309-320.

Jensen, P. A., and J. F. Bard. 2003. *Operations research : models and methods*. Hoboken, N.J. [Great Britain]: Wiley.

Korte, A. O. 1990. A first order Markov model for use in the human services. *Computers in Human Services* 6 (4):299-312.

Leff, H., Dada, M, Graves, S. 1986. An LP planning model for a mental health community support system. *Management Science* 32 (2(Feb)):139-155.

Leff, H. S. 1981. Apartments or Houses in Community Support Systems: A Computer Modeling Approach. In *American Psychological Association Convention*. Los Angeles, CA.

Leff, H. S., Graves Sc, Natkins J, Bryan J. 1985. A system for allocating mental health resources. *Administration in Mental Health* 13 (1(Fall))::43-68.

Leff, H. S., M. Lieberman, V. Mulkern, and B. Raab. 1996. Outcome trends for severely mentally ill persons in capitated and case managed mental health programs. *Administration and Policy in Mental Health* 24 (1):3-11.

Leff, H. S., J. C. Mcpartland, S. Banks, B. Dembling, W. Fisher, and I. E. Allen. 2004. Service quality as measured by service fit and mortality among public mental health system service recipients. *Ment Health Serv Res* 6 (2):93-107.

Levin, G. 1977. Point of view: poor quality is the solution, not the problem. *Health Care Manage Rev* 2 (3):69-72.

Levin, G., and E. B. Roberts. 1976. *The dynamics of human service delivery*. Cambridge, Mass.: Ballinger Pub. Co.

Lippmann, W. 2004. *Public opinion*. Mineola, N.Y.: Dover Publications.

Maccracken, M. 2009. *Prediction versus Projection - Forecast versus Possibility* 2001 [cited June 22 2009].

Miller, L., T. Brown, D. Pilon, R. Scheffler, and M. Davis. 2009. Measuring Recovery from Severe Mental Illness: A Pilot Study Estimating the Outcomes Possible from California's 2004 Mental Health Services Act.

———. 2009. Patterns of Recovery from Severe Mental Illness: A Pilot Study of Outcomes. *Community Mental Health Journal*.

Moos, R. H., A. C. Nichol, and B. S. Moos. 2002. Global Assessment of Functioning ratings and the allocation and outcomes of mental health services. *Psychiatr Serv* 53 (6):730-7.

Norton, E. C., J. Yoon, M. E. Domino, and J. P. Morrissey. 2006. Transitions between the public mental health system and jail for persons with severe mental illness: A Markov analysis. *Health Economics* 15 (7):719-733.

Nutt, P. A. 1984. *Planning Methods for Health and Related Organizations*. New York: John Wiley & Sons.

Olfson, M., R. Mojtabai, N. A. Sampson, I. Hwang, B. Druss, P. S. Wang, K. B. Wells, H. A. Pincus, and R. C. Kessler. 2009. Dropout From Outpatient Mental Health Care in the United States. *Psychiatr Serv* 60 (7):898-907.

Patten, S. 2005. Markov models of major depression for linking psychiatric epidemiology to clinical practice. *Clinical Practice and Epidemiology in Mental Health* 1 (1):2.

Perry, J. C., P. W. Lavori, and L. Hoke. 1987. A Markov model for predicting levels of psychiatric service use in borderline and antisocial personality disorders and bipolar type II affective disorder. *Journal of Psychiatric Research* 21 (3):215-232.

Pierskalla, W., P. 1981. Operations Research and the Mental Health Service System. Washington, D.C.: National Institute of Mental Health.

Reuter, J., and D. H. Gustafson. 1981. Need, Demand, and Utilization Models for the Mental Health System. In *Operations Research and the Mental Health Service System, Volume 1: Report of Ad Hoc Advisory Group*, edited by L. G. Kessler. Washington, D.C.: Superintendent of Documents, U.S. Government Printing Office.

Rochefort, D. A. 1997. *From poorhouses to homelessness : policy analysis and mental health care*. 2nd ed. Westport, Conn.: Auburn House.

Sacolick, J. 1980. The Role of Operations Research in Systems Analysis. *Interfaces* 10 (5):49-54.

Sainfort, F., M. L. Brandeau, and W. P. Pierskalla. 2004. *Operations research and health care : a handbook of methods and applications, International series in operations research & management science 70*. Boston, Mass.: Kluwer Academic.

Shumway, M., T. L. Chouljian, and W. A. Hargreaves. 1994. Patterns of substance use in schizophrenia: A Markov modeling approach. *Journal of Psychiatric Research* 28 (3):277-287.

Sonnenberg, F. A., and J. R. Beck. 1993. Markov Models in Medical Decision Making: A Practical Guide. *Med Decis Making* 13 (4):322-338.

Sunstein, C. R. 2006. *Infotopia : how many minds produce knowledge*. New York: Oxford University Press.

Sweillam, A., and K. Tardiff. 1978. Prediction of psychiatric inpatient utilization: A Markov chain model. *Administration in Mental Health* 6 (2):161-173.

The Evaluation Center@Hsri. 2004. Level of Care Instruments. Cambridge: The Evaluation Center@HSRI.

Weissman, M. M. 1975. The Assessment of Social Adjustment: A Review of Techniques. *Arch Gen Psychiatry* 32 (3):357-365.