An Agent-Based Explanation for 20th Century Living Situation Changes in America's Severely and Persistently Mentally Ill Population

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Abstract

The largest public mental health facility in the United States is not a hospital; it is the Los Angeles County Jail.[1] This paper describes an agent-based approach to explaining why prisons and jails house so many of America's most seriously mentally ill. It traces this fact to the differing ways in which various housing situations react to mental illness and to legislation passed in the 1960's, which allocated public funding away from state mental hospitals.

Introduction

Agent-based models generally to fall into two broad categories:

1. Those that seek to resemble very closely the real and complex world. Accuracy is the key metric, and the AnyLogic Conference 2014 was full of such examples, including rail network simulations and forecasts of the efficiencies brought to a warehouse by a robotic merchandise retrieval system.

2. Those that purposefully abstract with minimal detail in order to give a clear, overarching picture of underlying system mechanisms. Understanding is the key metric here, following Picasso's mantra that "Art is a lie that helps us see the truth."[2] The agent-based modeling literature contains many such examples, most famously including the Schelling Segregation Model[3] and Epstein's Artificial Anasazi Society[4]

In a previous research publication, we used category one modeling to simulate the mental health environment of a major US city.[5] As is so often the case when building such models, the process of gathering the category one model's detailed requirements gave our team insight into a powerful yet subtle mechanism that controls the living situation of much of America's Severely and Persistently Mentally Ill (SPMI) population. This paper describes that mechanism with a category two simulation

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[1] Crazy: A Father's Search Through America's Mental Health Madness", 2007, Pg. 3
[2] Espstein, Joshua M. "Why Model?" 2008, Journal of Artificial Societies and Social Simulation, Vol. 11 No. 4 Pg. 12
[3] Schelling, Thomas C. 1971. "Dynamic Models of Segregation." Journal of Mathematical Sociology 1: Pg.143-186
[4] Epstein, Joshua, 2006, "Generative Social Science: Studies in Agent-Based Computational Modeling". Pg.90-116
[5] Kalton, Falconer, Docherty, Alevras, Brann and Johnson, 2014, Autonomous Agents and Multi-Agent Systems Conference, Mutli-Agent Systems for Healthcare Workshop, http://aamas2014.lip6.fr/workshops.php. Additional publications pending.

model. Our hope is to give the reader an intuitive understanding of the major shifts in the types of housing situations most commonly utilized by America's SPMI population over the past 60 years.

A SPMI patient is generally defined as someone with a diagnosis of Schizophrenia, Bipolar Disorder or Major Depressive Disorder, and the group constitutes about 1.7% of the US population.[6] The housing environment of the SPMI population in the United States has changed drastically over the past 60 years, most notably in the percentage of the population living in jail/prison versus the percentage living in community based care and private residences.[7]

SPMI Housing Situation Changes from 1950-2000						
	1950	1960	1970	1980	1990	2000
Jail or Prison	1%	1%	1%	2%	3%	5%
Long Term Hospital	23%	20%	15%	10%	4%	2%
Homeless	1%	1%	1%	1%	3%	2%
Assisted Living Facility	1%	1%	2%	2%	3%	3%
Private or Subsidized Residence	65%	65%	73%	79%	83%	84%
Community Hospital	5%	5%	5%	3%	2%	2%
Shelter or Transitional Housing	4%	7%	3%	2%	2%	2%
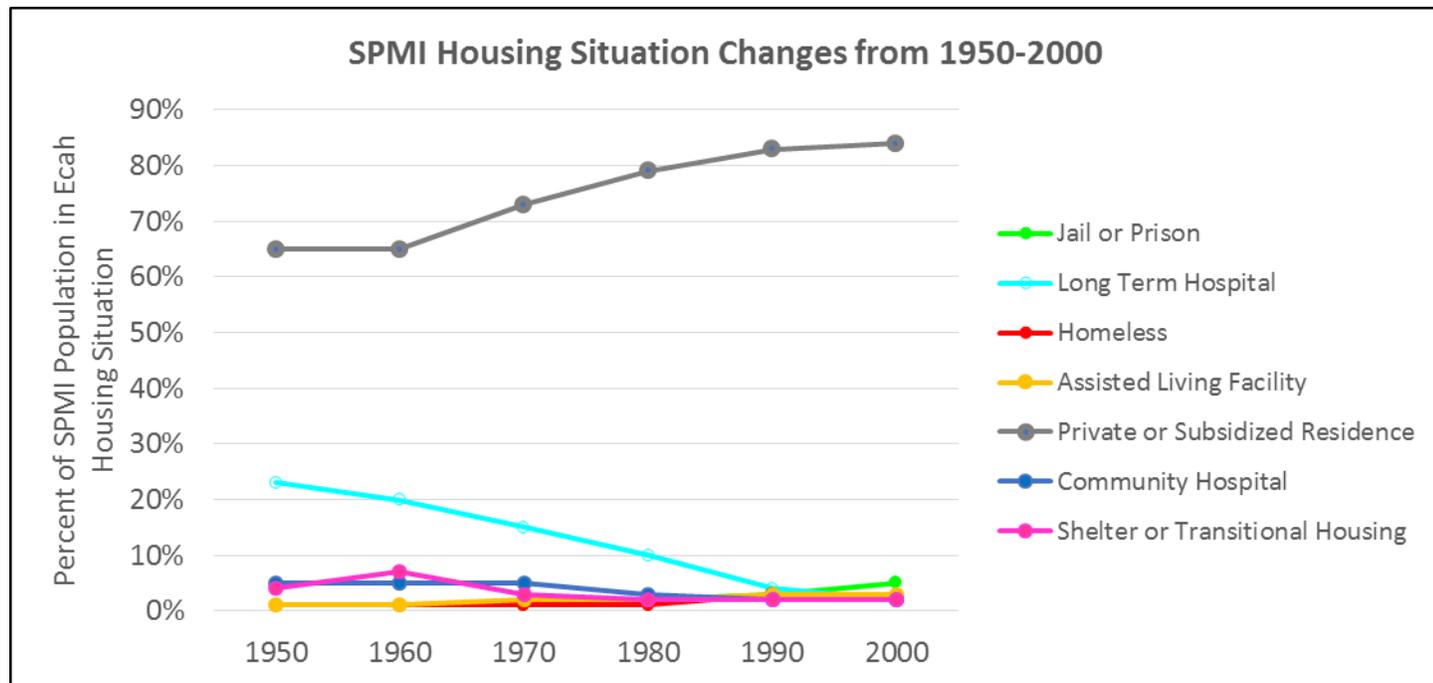
Mental healthcare in the United States has a long and complicated history that is more completely described in other accounts, but a summary of the three key phases provides an adequate background explanation for the drastic SPMI housing changes visualized in the above chart.

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[6] Frank, Richard G. and Glied, Sherry A. 2006, "Better But Not Well: Mental Health Policy in the United States since 1950". Pg. 24
[7]"Better But Not Well: Mental Health Policy in the United States since 1950". Pg. 123-128

Phase 1 (nation's founding to late 1800s): The US Justice System sees little distinction between mental illness and criminal intent. The most severely mentally ill are housed in prisons, while the healthiest live independently as best they are able.

Phase 2 (late 1800s to mid-1900s): Social worker Dorothea Dix raises public awareness of the frequency with which the mentally ill were housed in American jails and prison. Her work in the late 19th century inspired the U.S. Congress to create the first generation of mental asylums. For the next 100 years, the housing situation of America's SPMI population was largely unchanged. As a 2014 released by the Treatment Advocacy Center states:[8]

> From the 1870s until the 1970s, it was widely assumed in the United States that mentally ill individuals did not belong in prisons and jails but rather in mental hospitals, where they could receive asylum and treatment. Most studies during that period reported comparatively low prevalence rates of mentally ill persons in prisons and jails. For example, a 1930 study of almost 10,000 arrestees reported that just 1.5 percent of them were psychotic at the time of arrest. Thus, for approximately 100 years, the problem of mentally ill persons in prisons and jails appeared to have been solved. These individuals were treated as patients, not as criminals, and were sent to mental hospitals for treatment.

Phase 3: (Mid-1900s to present): A variety of factors cause long-term hospitals to lose prominence.

1) **Medical:** In 1951, Chlorpromazine is the first of many anti-psychotic medications released on the US market.[9] Medications change the paradigm from custodial, long term hospital living to a hope that SPMI patients can return to healthy and productive lives in the community.

2) **Political:** In 1963, President John F. Kennedy signs into law the Community Mental Health Act which financially incentivizes states to shift SPMI health funding to community based treatment programs and away from state residential hospitals.[10]

3) **Academic:** In 1973, Stanford University Professor David Rosenhan releases his landmark study criticizing the validity of psychiatric diagnoses and the state hospital system.[11]

4) **Popular Press:** In 1962, Ken Kesey releases his famous book, *One Flew Over the Cuckoo's Nest*.

5) **Insurance:** The passage of Medicaid and Medicare changes the financial strategy of the US fight against mental illness from one that funds institutions (mostly state hospitals) to one that gives money directly to individuals (Medicaid and Medicare). SPMI patients have much more individual choice than in years past.[12]

From a housing perspective, the changes have been largely successful. For the first time, SPMI patients and their families have community-based treatment alternatives beyond state hospitals. The

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[8] Treatment Advocacy Center, The Treatment of Persons with Mental Illness in Prisons and Jails. A State Survey", April 8, 2014. Pg. 11
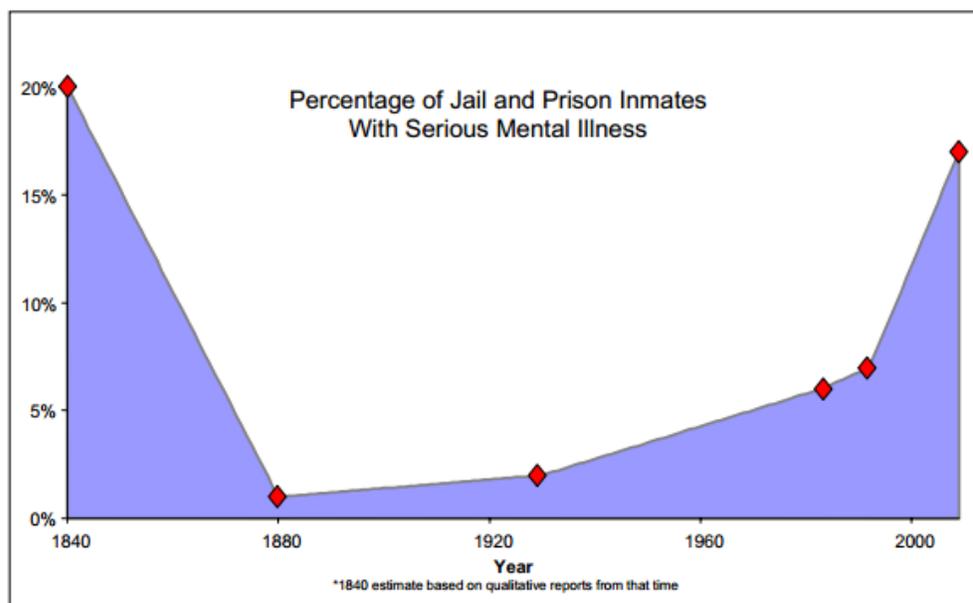[9] "Better But Not Well: Mental Health Policy in the United States since 1950". Pg. 29
[10] Torrey, Fuller E. "American Psychosis: How the Federal Government Destroyed the Mental Health Treatment System" 2014, Pg. 30
[11] Rosenhan, David L. "On Being Sane in Insane Places", 1973. Science
[12] "Better But Not Well: Mental Health Policy in the United States since 1950". Pg. 54

number of SPMI patients living in the community increased by about 30% from 1960 to 2000, and although SPMI patients can still be institutionalized against their will,[13] the likelihood of this happening is much lower than in the past. However, these changes have not been universally beneficial. Harvard public health professors Glied and Frank write that "For most people with severe mental illness, living conditions have improved over time. Most live in the community and have entitlements to a range of public benefits. Yet a small but growing minority of people with severe illness are worse off because they are homeless or incarcerated."[14] See the above charts for a more precise quantification of the changing percentages.

Glied and Frank are not the only ones to notice the growing rates of SPMI homelessness and incarceration. Former Time magazine journalist Peter Earley writes, "The largest public mental health institution in America is not a hospital. It's the Los Angeles County Jail. On any given day, it houses an estimated 3,000 mentally disturbed inmates."[15] A recent Treatment Advocacy Center (TAC) report concurs, saying that the treatment gains won by Dorothea Dix at the end of the 19th century have been largely reversed.[16] A second report by the TAC group quantifies the recent changes to SPMI incarnation rates, visualized in the chart below:[17]

Percentage of Jail and Prison Inmates With Serious Mental Illness

*1840 estimate based on qualitative reports from that time

In the tradition of Epstein's "Generative Social Science," this paper uses an agent-based, generative approach to modeling these remarkable swings in SPMI living situations over the second half of the 20th century. The above mentioned journalist Peter Earley provides a fitting anecdote to illustrate the fundamental rule underlying our approach to building this bottom-up model. Earley writes in his Pulitzer Prize Finalist book *Crazy: A Father's Search Through America's Mental Health Madness* of

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[13] Florida's "Baker Act" is just one of many examples:
http://www.leg.state.fl.us/Statutes/index.cfm?App_mode=Display_Statute&Search_String=&URL=0300-0399/0394/0394PARTIContentsIndex.html
[14] "Better But Not Well: Mental Health Policy in the United States since 1950". Pg. xiii
[15] "Crazy: A Father's Search Through America's Mental Health Madness", 2007, Pg. 3
[16] Treatment Advocacy Center, "The Treatment of Persons with Mental Illness in Prisons and Jails: A State Survey", April 8, 2014. Pg. 11
[17] Treatment Advocacy Center, "More Mentally Ill Persons Are in Jails and Prisons than Hospitals: A Survey of the States", May, 2010. Pg. 13

how SPMI patients often fight with each other and with prison guards. In the event that a SPMI patient attacks a prison guard, the inmate is typically moved to solitary confinement,[18] prosecuted and punished with an extended prison sentence.[19] In sharp contrast to prison, "Living in the community has special challenges and hazards for people with severe mental disorders. Their disorder may be associated with disturbed and disturbing behavior that can result in incarceration and eviction from stable housing arrangements. The combination of poverty, limited access to housing, and severe mental illness can lead to increased vulnerability to crime and abuse."[20] The important contrast is that some types of housing situations (Jails, Prisons and Long-term hospitals) keep SPMI patients longer when they have mental health relapses, while the majority of housing situations seek to evict patients who misbehave in this same way. This fundamental difference is the key rule that our model seeks to demonstrate as a major influencing force on the dramatic housing situation changes undergone by SPMIs over the second half of the 20th century.

The Model

Our SPMI housing agent-based model contains five main components, each based upon a feature of the SPMI population's real world housing environment.

1) **The housing cycle**: When SPMIs leave one housing situation, they are faced with a decision about where to live next. SPMI housing choices are thus a continuous cycle. Upon a patient's arrival at the housing decision point, the patient is randomly placed into one of the seven housing choices with the following probabilities:

Housing Type	Decision Point Probability
Jail/Prison	1%
Long Term Hospital/State Hospital	5%
Homeless	4%
Assisted Living Facility	5%
Private/Subsidized Residence	70%
Community Hospital	10%
Shelter or Transitional Housing	5%

Housing Situation SPMI Patient Flow
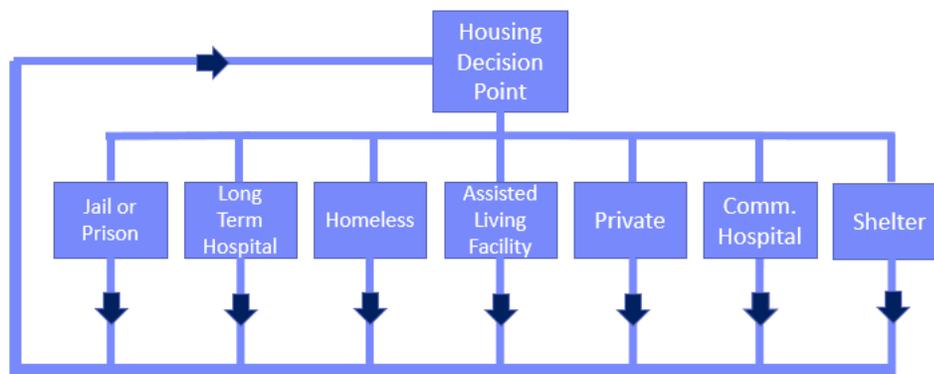
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2) **The seven housing types:** The seven types of housing have baseline lengths of stay for SPMI patients. Long term hospitals tend to keep SPMI patients for longer than Community Hospital Emergency Rooms, etc. SPMI agent time in each housing situation is modeled in AnyLogic with rate functions as 1 / (Baseline Length of Stay). Upon leaving a housing type, SPMI agents return to the Housing Decision Point. If a patient stays in any housing type for over 20 years without returning to the Housing Decision Point, the agent will instantly be returned to the Housing Decision Point. This last point is to make sure all patients are cycling through the Decision Point at least once every 20 years.

Housing Type	Length of Stay Baseline
Jail/Prison	60 days
Long Term Hospital/State Hospital	180 days
Homeless	90 days
Assisted Living Facility	180 days
Private/Subsidized Residence	365 days
Community Hospital	5 days
Shelter or Transitional Housing	90 days

3) **The SPMI Patient Agent:** Patient agents cycle between the Decision Point and actually residing in the location decided upon at the Decision Point. Each patient has a "time to mental health crisis" variable. The model is populated with 1,000 such SPMI Patient Agents.

SPMI patient time to mental health crisis is the model's way of representing the various severity levels of mental illness. Time to crisis is uniformly distributed between 5 and 250 days for each SPMI agent in the model and is static for each patient for the entire model run. For the sake of this model, a mental health crisis is defined as a symptom flare-up that would make it clear to people interacting with the agent that the agent is not mentally stable. Examples include a psychotic episode, hallucinations, deep depression, etc. Finally, in the model UI agents are closer to the color pure red as their time to crisis is closer to the minimum of 5 and closer to the color pure green as their time to crisis is closer to the maximum of 250. Agent coloring has no functional effect and is merely for a visual display of time to crisis.

4) **Different responses to identical crises:** As highlighted by Earley, the seven housing types respond heterogeneously to a SPMI patient's mental health crisis. While a long-term hospital typically extends length of stay for a patient having a crisis, most other types of housing would seek to evict or discharge such patients. These differing responses to a crisis are modeled with updates to the rate variable in the following manner:

For Jail/Prison and Long Term Hospital:
1 / (Baseline Length of Stay + exponential()*(Baseline Length of Stay))

For all other housing types:
1 / (Baseline Length of Stay - exponential()*(Baseline Length of Stay))

5) U.S. Legislation placed a ceiling on the percentage of patients who can possibly live in long term hospitals: The ceiling is quantified by Glied and Frank's estimates for the percentage of SPMIs living in long term hospitals for each decade in the second half of the 20th century.
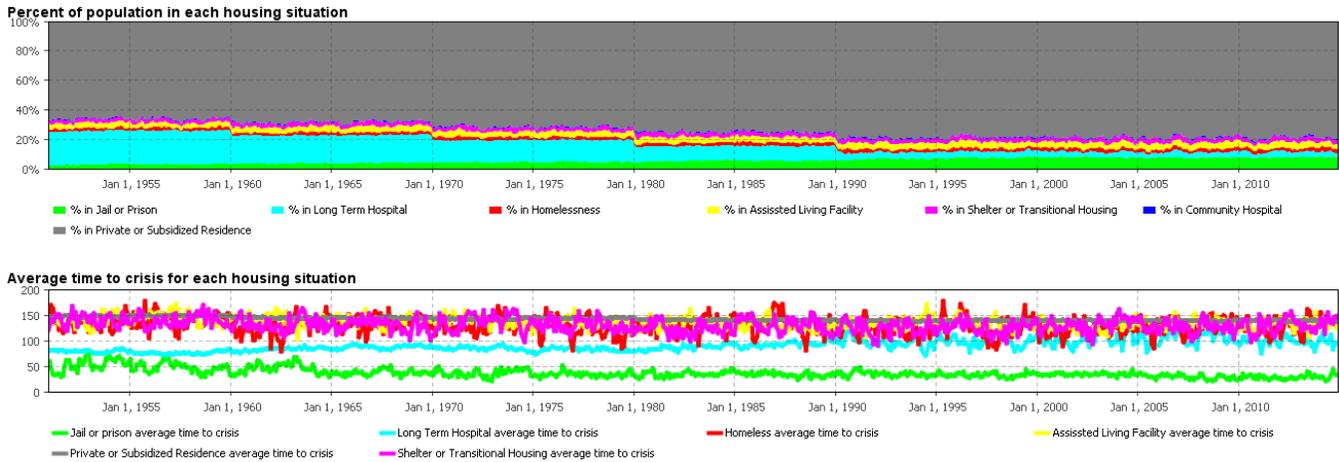
Year	Cap for % of SPMI population able to live in a Long Term Hospital
1950-1960	23%
1960-1970	19%
1970-1980	15%
1980-1990	10%
1990-2000	4%
2000-2014	2%

Results

The model user interface is below, with metrics showing the baseline lengths of stay and likelihood of going to each housing type upon reaching the Housing Decision Point (Decision % N). Included are the date (Year, Month, Day), percentage of the total population currently living in each housing situation and the average time to crisis for the group currently living in each of the seven types of housing.
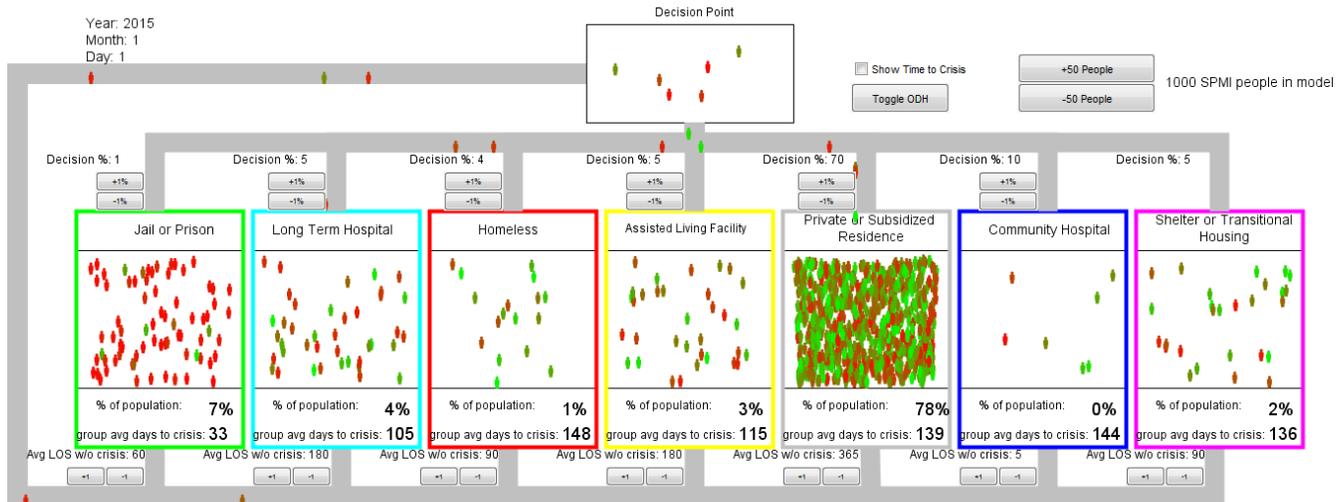
The UI also includes two charts. The first displays the percentage of the total population living in each housing situation for each year of the model's runtime. The second displays the average time to crisis for the group living in each housing situation and how those averages changed over the years of the model's runtime.

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Percent of population in each housing situation

Legend: % in Jail or Prison, % in Long Term Hospital, % in Homelessness, % in Assissted Living Facility, % in Shelter or Transitional Housing, % in Community Hospital, % in Private or Subsidized Residence

Average time to crisis for each housing situation

Legend: Jail or prison average time to crisis, Long Term Hospital average time to crisis, Homeless average time to crisis, Assisted Living Facility average time to crisis, Private or Subsidized Residence average time to crisis, Shelter or Transitional Housing average time to crisis

The bottom-up agent-based model does an excellent job matching Glied and Frank's estimates for SPMI housing situation changes over the second half of the 20th century. With each subsequent lower ceiling on the percentage of agents capable of being housed in Long Term Hospitals, Private Housing adds the majority of the formerly hospitalized agents with a small increase to the Jail and Prison populations.

The second chart also closely matches real world evidence about the health of SPMI people living in each of the seven major housing categories. As cited in Glied and Frank, Earley and the TAC Report, the least healthy SPMI patients tend to pool in long-term hospitals and prisons. As long-term hospitals lose capacity, the worst-off SPMI agents increasingly move into jails and prisons.

The reason for this phenomenon of the lowest time to crisis agents pooling in long term hospitals and jails/prison has to do with the unique way in which these two housing types treat patients who have a crisis while housed in their custody. This reinforcing effect is increasingly strong as a SPMI patient has more crises at the given housing entity. In other words, the less healthy the person, the stronger the reinforcing effect to stay in Long Term Hospital and Jail/Prison and to leave all the other housing options. The ethical problem arises when legislation places a limit on the number of SPMI patients who can live in Long Term Hospital, resulting in Jail/Prison being the only housing environment which both has capacity and a response of increased length of stay upon mental health crisis event.

Conclusion

This simple agent-based model improves our understanding of Severely and Persistently Mentally Ill housing dynamics in multiple important ways. First, the model shows that even a weak length of stay alteration due to SPMI crises produces a very strong effect. In the same way that H_2O molecules constantly flow through the Water Cycle until freezing in place, the lives of America's worst-off SPMI patients are in a state of flux until landing in a place that will not let them leave. Second, increasing patient time to crisis has a significant positive impact on the population's housing makeup. In a second model run, we increased patient time to crisis by 45 days in the year 2000 and examined what would happen by 2030. The results of that model run are illustrated in the chart below.

Percent of population in each housing situation

Average time to crisis for each housing situation
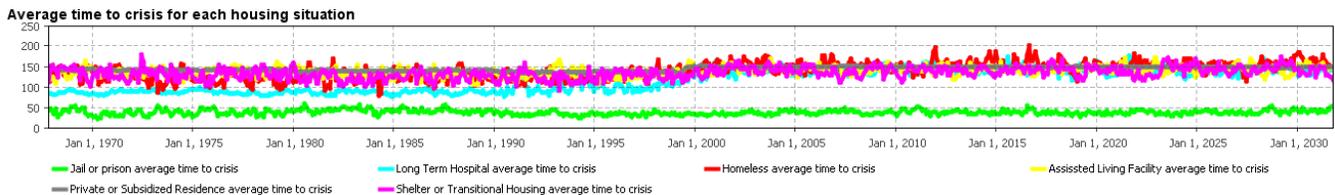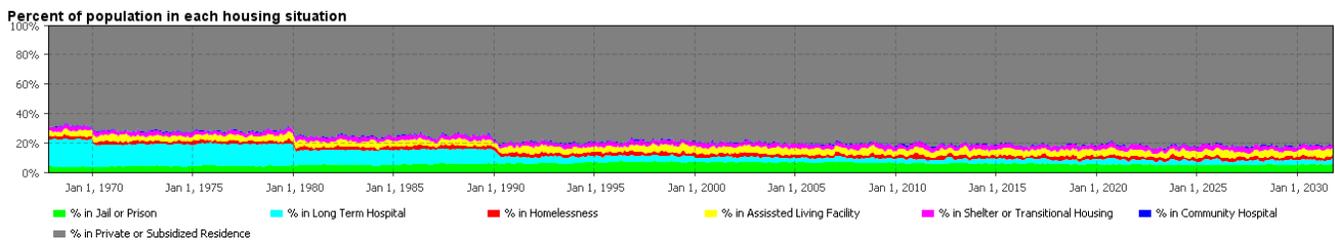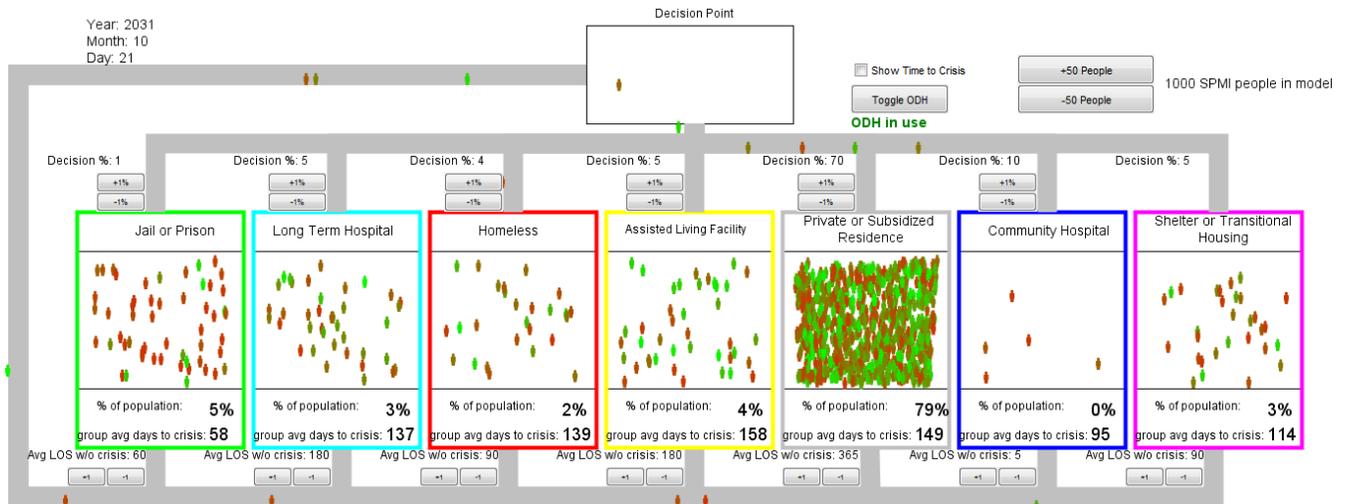
As expected, a healthier population (a population with higher time to crisis values) has weaker length of stay reinforcing effects and thus returns to population housing rates more in line with the percentages dictated at the Housing Decision Point[21]. This insight has implications for policy makers looking to evaluate the return on investment of projects designed to improve the lives of the mentally ill. Through this agent-based simulation, we find evidence that proactive governments can indeed lower prison rates by improving mental health in a geographic area.

Finally, the model raises ethical concerns for future mental health policy in the United States. Policy and medical advancements over the last 60 years have certainly been a net-benefit to America's mentally ill, but those changes have left behind our most needy. We are thus left with three choices.

1) The status quo

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[21] Rather than the first model run which saw an increase in Long Term Hospital and Jail/Prison residency rates above and beyond what the housing decision point percentages allocated.

2) Re-increase long term hospital capacity. Not to 19th century levels, but enough to ethically care for the SPMI people currently housed in our criminal justice systems.

3) Find a way to increase patient time to crisis. Anti-psychotic medication advances over the past 50 years have largely been in the reduction of side-effects, rather than in drug efficacy improvements. While psychiatrists and pharmaceutical companies continue to iterate upon and to refine these medications, other vested interests must do what they can to improve the health of America's SPMI population.

One such effort to improve SPMI patient health in the information technology realm is currently underway with a partnership between Otsuka Pharmaceuticals and IBM. This project seeks to use care coordination information technology to help a geographic area's many health care providers work together to efficiently treat SPMI patients. The effort is quickly gaining traction and has even received the attention of the United States House of Representatives.[22]

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[22] Statement of Judge Steve Leifman. Chair, Supreme Court of Florida Task Force on Substance Abuse and Mental Health Issues in the Courts before the Subcommittee on Oversight and Investigations of the Energy and Commerce Committee of the United States House of Representatives. March 16,2014 http://democrats.energycommerce.house.gov/sites/default/files/documents/Testimony-Leifman-OI-Psychiatric-Patient-Beds-2014-3-26.pdf