Impact of State Psychiatric Hospital Waitlists on Monthly Admissions

Online Supplement

Hypotheses

With regard to the effects of the waitlist policy on the number and case mix of monthly admissions, two distinct scenarios were possible. One might be called the "miniaturization" hypothesis whereby restrictions on admission intake lead to a down-sizing in the absolute number of patients served on a monthly basis but the relative composition or case mix of admissions remains as before. The other might be called the "transformation" hypothesis where the waitlist not only leads to overall reductions in the absolute number of monthly patient admissions but also to relative changes in the case mix or diagnostic composition of monthly admissions as reductions in certain subgroups of patients may have outpaced reductions in other subgroups. The latter situation might arise, for example, if waitlists functioned as a filter to screen in patients with the most serious illness and to screen out less serious patients who are relatively easier to care for in alternative settings. The net result would be fewer admissions but, case mix-wise, those admissions would consist of a greater proportion of patients with serious illness. This study aimed to determine which of these two scenarios or others best characterized the effects of waitlist policies implemented in 2007 on the number and case mix of admissions to the four state psychiatric hospitals (SPHs) in North Carolina (NC).

Data Sources

Data from NC's Healthcare Enterprise Accounts Receivable Tracking System (HEARTS) were used to determine the monthly number and case mix of admissions at

each hospital. HEARTS is an administrative database maintained by NC's Division of State Operated Healthcare Facilities and contains information on all persons admitted to SPHs, regardless of payer status. Data were obtained between January 2004 and November 2010 because NC had four SPHs during this period, with regional boundaries that remained relatively unchanged. In December 2010, the state consolidated from four to three SPHs (1); the data collected post-consolidation were excluded because the changes in counties from a SPH's catchment area could influence the number and/or case mix of admissions.

In addition to the HEARTS data and SPH waitlist data, other data sources were used to control for time-varying regional characteristics that may have affected SPH admissions. Data on the demographic composition of the four SPH service regions were obtained from the US Census Bureau (2); data on monthly local area unemployment rates were obtained from the Bureau of Labor Statistics (3); and annual data on alternative treatment availability in each region were obtained from NC's Health Professions Data System and the NC Division of Health Service Regulation (4,5).

Measures

Diagnoses were categorized based on the presence of a severe mental illness diagnosis or substance abuse diagnosis anywhere in the SPH visit record. Following prior work (6), severe mental illness diagnoses were identified using International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes corresponding to schizophrenia, bipolar disorder, major depression, or other nonorganic psychoses,. Patient diagnoses were further classified into five mutually exclusive categories (severe mental illness/no substance abuse, severe mental illness/substance

abuse, no severe mental illness/no substance abuse, no severe mental

illness/substance abuse, and substance abuse/no mental health diagnosis).

Results

In addition to the subgroups listed in Table 1, changes in mean age, insurance

status, criminal involvement, and commitment status of monthly admissions were also

examined (Table S1). Here, criminal involvement was flagged based on whether

patients had (1) any known current or pending legal charges or (2) a referral/arrival

source or discharge destination related to the court system, law enforcement, or a

correctional facility. Involuntary commitment was flagged based on whether patients had

an involuntary mental health or substance abuse commitment status associated with

their admission. Mean age of monthly admissions increased from 36.5 years pre-waitlist

to 37.4 years post-waitlist (2.5% change, *p*<.001). Consistent with other findings, the

numbers of monthly admissions with and without criminal involvement and the numbers

of admissions that were involuntary and voluntary commitments all decreased post-

waitlist (with criminal involvement: 27.0 pre- vs. 15.4 post-waitlist, *p*<.001; without

criminal involvement: 254.0 pre- vs. 135.2 post-waitlist, *p*<.001; involuntary

commitment: 257.2 pre- vs. 131.3 post-waitlist, *p*<.001; voluntary commitment: 23.8 pre-

vs. 19.3 post-waitlist, *p*=.02). The relative percentage of monthly admissions with

criminal involvement increased from 9.8% pre-waitlist to 11.4% post-waitlist (*p*=.03) and

the relative percentage of monthly admissions that were involuntary commitments

decreased from 91.5% pre-waitlist to 85.7% post-waitlist (*p*<.001).

In both the pre- and post-waitlist periods, the majority of monthly SPH

admissions were for patients who were male, white, self-pay or uninsured, without

criminal involvement, and involuntarily committed. Consistent with the miniaturization hypothesis, the unadjusted relative percentage distribution of demographic and legal admission characteristics pre-waitlist remained essentially unchanged post-waitlist. The major exceptions to this pattern occurred with regard to insurance status, in particular, increases in the proportion of Medicaid enrollees and decreases in the proportion of uninsured patients (see discussion below) and the case mix or diagnostic composition of monthly admissions. Post-waitlist, there was a 17% relative increase in the percentage of patients with a severe mental illness diagnosis (severe mental illness with and without substance abuse combined at 59.7% pre-waitlist vs. 69.9% post-waitlist, $p<.001$), a 24% relative decrease in patients without severe mental illness or substance abuse (10% pre-waitlist vs. 7.6% post-waitlist, $p<.001$), a 10% relative decrease in non-severe mental illness patients with substance abuse (17.1% pre-waitlist vs. 15.5% post-waitlist, $p<.003$), and a 47% relative decrease in patients with substance abuse without a mental health diagnosis (13.2% pre-waitlist vs. 7% post-waitlist, $p<.001$).

Full regression results are presented in Table S2.

Post-waitlist Changes in Insurance Status

In unadjusted results, the percentage of SPH admissions by individuals who were self-pay/uninsured decreased from 57.6% pre-waitlist to 47.3% post-waitlist ($p<.001$). This shift was mostly offset by increases in the percentage of admissions by individuals with Medicaid only (16.8% pre-waitlist vs. 23.0% post-waitlist, $p<.001$) or dual Medicaid/Medicare (11.8% pre-waitlist vs. 13.9% post-waitlist, $p<.001$). However, these changes may, at least partially, reflect general trends over the full study period. Between 2004 and 2010, the percentage of NC residents with public insurance

4

increased from 28.8% to 34.3% (7). Regression models formally tested whether the waitlists were associated with changes in the number and case mix of admissions by insurance status. Results from these models (not shown) indicated that waitlist implementation was associated with an average 27.9 fewer monthly admissions by individuals who were uninsured or self-pay across all post-waitlist months ($p<.001$) but no incremental effect over the estimated effect from each prior month. Waitlist implementation was also associated with an average 3.3% *increase* in the percentage of monthly admissions by individuals who were uninsured or self-pay across all post-waitlist months ($p=.007$) but no incremental effect in each additional month post-waitlist. In contrast, the model's linear time trend was associated with a 0.3% decrease in the percentage of admissions by individuals who were uninsured or self-pay in each month over the full study period ($p<.001$).

Regression Results Including SPH Interaction Effects

As shown in results from models including individual hospital × post-waitlist interactions, waitlist effects differed to a certain extent by hospital, particularly for models of the absolute number of monthly admissions (Table S3). For example, post-waitlist changes in the total number of monthly admissions ranged from no significant change in the north-central region to 92.1 fewer admissions in the eastern region across all months post-waitlist (main and interaction effects jointly significant at $p<.001$). The incremental effects of each additional month post-waitlist implementation on the absolute number of admissions also differed by hospital ($p<.001$). Although we had no apriori hypotheses to account for these differences, the variations indicate that each hospital was being used differently by the referral sources in their respective regions.

This may be due to social and economic differences in regional populations as well as differences in community mental health resources that could serve as alternatives to SPH inpatient care. Clearly, additional research is needed to further understand these between hospital differences.

Table S1. Number and percentage of monthly admissions pre-waitlist and post-waitlist to SPHs in NC (January 2004-November 2010)

Subgroup	Number of monthly admissions					Percentage of monthly admissions				
	Pre-waitlist		Post-waitlist		p-value	Pre-waitlist		Post-waitlist		p-value
	n	SD	n	SD		%	SD	%	SD	
Insurance status										
Private	18.1	6.4	11.9	7.3	p<.001	6.5	2.2	7.8	2.9	p<.001
Public/no private										
Medicaid	46.9	10.4	32.8	11.7	p<.001	16.8	3.4	23.0	5.5	p<.001
Medicare	20.7	6.5	11.6	5.4	p<.001	7.4	2.1	8.0	3.0	p=.02
Dual Medicaid/Medicare	32.9	8.5	20.1	7.9	p<.001	11.8	3.0	13.9	3.5	p<.001
Self-pay/uninsured	162.5	32.8	74.2	40.1	p<.001	57.6	5.8	47.3	7.6	p<.001
Criminal involvement										
Yes	27.0	17.5	15.4	9.8	p<.001	9.8	6.3	11.4	7.2	p=.03
No	254.0	44.7	135.2	64.7	p<.001	90.2	6.3	88.6	7.2	p=.03
Commitment status										
Involuntary commitment	257.2	45.4	131.3	65.0	p<.001	91.5	7.6	85.7	9.8	p<.001
Voluntary commitment	23.8	21.7	19.3	14.2	p=.02	8.5	7.6	14.3	9.8	p<.001

SD=standard deviation.

Table S2. Hospital-level fixed effects regression estimates of the effect of the waitlist policy on the number and case mix of monthly admissions to state psychiatric hospitals in North Carolina (January 2004-November 2010)

Variable[a]	Overall	Severe mental illness		Substance abuse		Five categories				
		Yes	No	Yes	No	Severe mental illness/no substance abuse	Severe mental illness/substance abuse	No severe mental illness/no substance abuse	No severe mental illness/substance abuse	Substance abuse with no mental health diagnosis
Models of the absolute number of monthly admissions overall and with specific diagnoses										
Post-waitlist (reference: pre-waitlist)	-53.1**	-31.8**	-21.3**	-43.7**	-9.4*	-6.0	-25.9**	-3.4	-10.1**	-7.8**
Time trend * post-waitlist	-1.6*	-1.4**	-0.2	-0.8	-0.8*	-0.7**	-0.7*	-0.1	-0.3	0.2
Models of the relative percentage of monthly admissions with specific diagnoses										
Post-waitlist (reference: pre-waitlist)	--	-0.4	0.4	-4.2**	4.2**	3.7**	-4.1**	0.6	0.1	-0.2
Time trend * post-waitlist	--	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0

OLS=ordinary least squares; SPH = state psychiatric hospital.

* *p*<.05

** *p*<.01

[a] The post-waitlist period was defined based on SPH-specific policy implementation; SPHs continued operating on waitlists for all months following policy implementation. Other independent variables included in each of the OLS models controlled for time trends (linear time trend and calendar month), demographic composition of the population (sex: proportion male/female; age: proportion aged 20-29, 30-64, and 65 years and older; and race: proportions black and other minority race), regional unemployment rate, and mental health services within regions (number of licensed psychiatrists per 100,000 population and number of licensed adult psychiatric beds in general hospital psychiatric units or private psychiatric hospitals per 100,000 population). Results from sensitivity analyses examining different model specifications are also provided in online supplement. None of the models produced any out of range predictions (i.e., negative numbers of admissions or proportions outside of the 0-1 range).

Table S3. Hospital-level fixed effects regression estimates of the effect of the waitlist policy on the number and case mix of monthly admissions to state psychiatric hospitals in North Carolina, including hospital interaction effects (January 2004-November 2010)

Variable[a]	Overall	Severe mental illness		Substance abuse		Five categories of diagnoses				
		Yes	No	Yes	No	Severe mental illness/no substance abuse	Severe mental illness/ substance abuse	No severe mental illness/no substance abuse	No severe mental illness/ substance abuse	Substance abuse with no mental health diagnosis
Models of the absolute number of monthly admissions overall and with specific diagnoses										
Post-waitlist (reference: pre-waitlist)	-12.1	-2.5	-9.6	-22.0*	9.9	13.2**	-15.8*	-3.4	-1.4	-4.8
Time trend * post-waitlist	-3.1**	-2.2**	-0.9	-1.8**	-1.3**	-1.1**	-1.1**	-0.2	-0.5	-0.2
Post-waitlist interaction effects										
Post-waitlist * hospital										
Post-waitlist * western region hospital	-37.5**	-30.2**	-7.3	-12.9	-24.6**	-23.5**	-6.8	-1.2	-6.7	0.6
Post-waitlist * eastern region hospital	-80.0**	-54.5**	-25.5	-45.3*	-34.7**	-34.0**	-20.5*	-0.7	-14.8*	-9.9
Post-waitlist * south-central region hospital	-18.2	-15.1	-3.2	0.6	-18.8*	-22.2**	7.2	3.4	-2.8	-3.8
Time trend * post-waitlist * hospital										
Time trend * post-waitlist * western region hospital	1.6**	0.6	1.0**	1.7**	-0.1	-0.2	0.9**	0.1	0.3	0.5**
Time trend * post-waitlist * eastern region hospital	6.4**	3.5**	3.0**	5.2**	1.2*	0.8	2.6**	0.3	1.3**	1.3**
Time trend * post-waitlist * south-central region hospital	0.3	0.0	0.3	-0.4	0.7	0.5	-0.5	0.2	-0.4	0.5
Models of the relative percentage of monthly admissions with specific diagnoses										

Post-waitlist (reference: pre-waitlist)	--	-0.2	0.2	-3.4	3.4	4.2*	-4.4	-0.7	1.8	-0.9
Time trend * post-waitlist	--	0.1	-0.1	-0.4**	0.4*	0.3*	-0.2	0.1	0.0	-0.1
Post-waitlist interaction effects										
Post-waitlist * hospital										
Post-waitlist * western region hospital	--	-0.3	0.3	-0.3	0.3	0.0	-0.3	0.3	-1.5	1.4
Post-waitlist * eastern region hospital	--	1.2	-1.2	-4.9	4.9	1.8	-0.6	3.1*	-4.3	0.0
Post-waitlist * south-central region hospital	--	0.4	-0.4	1.1	-1.1	-3.2	3.6	2.1	-1.6	-0.9
Time trend * post-waitlist * hospital										
Time trend * post-waitlist * western region hospital	--	-0.2	0.2	0.4**	-0.4**	-0.4**	0.2*	0.0	0.0	0.1*
Time trend * post-waitlist * eastern region hospital	--	0.0	0.0	1.1**	-1.1**	-0.8*	0.8**	-0.3*	0.0	0.3*
Time trend * post-waitlist * south-central region hospital	--	-0.2	0.2	0.7**	-0.7**	-0.6**	0.5*	-0.1	0.1	0.3**

OLS=ordinary least squares.

* *p*<.05

** *p*<.01

[a] The post-waitlist period was defined based on SPH-specific policy implementation; SPHs continued operating on waitlists for all months following policy implementation. Other independent variables included in each of the OLS models controlled for time trends (linear time trend and calendar month), demographic composition of the population (sex: proportion male/female; age: proportion aged 20-29, 30-64, and 65 years and older; and race: proportions black and other minority race), regional unemployment rate, and mental health services within regions (number of licensed psychiatrists per 100,000 population and number of licensed adult psychiatric beds in general hospital psychiatric units or private psychiatric hospitals per 100,000 population). None of the models produced any out of range predictions (i.e., negative numbers of admissions or proportions outside of the 0-1 range).

Sensitivity Analyses

In addition to the study's main analyses, three sensitivity analyses examined whether results were robust to various model specifications. The first two of these analyses included control variables for SPH capacity (statewide and by SPH region). Here, data on SPH bed capacity were obtained from the American Hospital Association's Guides to the Health Care Field, the Centers for Medicare and Medicaid Services' Hospital Cost Reports, and NC's Division of State Operated Healthcare Facilities (8-10). All three sources were used to estimate capacity because of incomplete or erroneous data in any single source. The questionable reliability of estimates also contributed to the decision to use these data only in sensitivity analyses, as opposed to the study's main analyses. For example, the AHA Guides relied on the previous year's estimates when SPHs did not respond to the annual survey, resulting in closed hospitals still appearing to have staffed capacity. Data from certain hospitals in CMS' Cost reports were similarly incorrect. A single measure of regional SPH capacity was derived from the AHA Guides and Cost Reports using the source that provided the most reasonable estimate for each hospital in each year, based on author expectations. Finally, the estimates from NC's Division of State Operated Healthcare Facilities were only available statewide and not separately by SPH. Linear interpolation was used to smooth capacity changes within a given year since all measures of SPH capacity were reported annually at the end of each fiscal year.

The third sensitivity analysis excluded rarely changing control variables since fixed effects models are inefficient at estimating the effects of near time-invariant variables (11). Using a between/within variation ratio threshold of 2.8 for excluding

variables (11), the model excluded most regional demographic composition variables, with the exception of the proportion of the SPH region's full population that is classified as other minority. The model also excluded the number of licensed psychiatrists per 100,000 population as a rarely changing variable.

Results from sensitivity analyses were generally consistent with those from the main analysis (subset of results shown in Table S4). Across all sensitivity analyses, waitlists were associated with decreases in the number of admissions overall, by individuals with severe mental illness, and by individuals with substance abuse diagnoses, although the magnitude of these effects varied to some extent across analyses. Waitlists were also consistently associated with a decrease in the percentage of admissions by individuals with substance abuse diagnoses.

Table S4. Sensitivity analysis state hospital-level fixed effects regression results estimating the effects of the waitlist policy on the number and case mix of monthly admissions

Analysis scenario and key variable[a]	Total number of admissions	Number of admissions with severe mental illness	Percentage of admissions with severe mental illness	Number of admissions with substance abuse	Percentage of admissions with substance abuse
Sensitivity analysis 1: including statewide psychiatric beds in SPHs per 100,000 population as control variable					
Post-waitlist (reference: pre-waitlist)	-35.5**	-21.0**	-0.3	-32.9**	-4.1*
Time trend * post-waitlist	-1.6**	-1.4**	0.0	-0.8	0.0
Sensitivity analysis 2: including regional psychiatric beds in SPHs per 100,000 population as control variable					
Post-waitlist (reference: pre-waitlist)	-51.1**	-31.0**	-0.7	-43.9**	-4.3**
Time trend * post-waitlist	-1.6*	-1.4**	0.0	-0.8	0.0
Sensitivity analysis 3: excluding rarely changing control variables					
Post-waitlist (reference: pre-waitlist)	-35.1**	-23.5**	-1.1	-22.9**	-3.6**
Time trend * post-waitlist	-2.1**	-1.6**	0.0	-1.5**	0.0

OLS=ordinary least squares; SPH=state psychiatric hospital.
* $p < .05$
** $p < .01$
[a] The post-waitlist period was defined based on SPH-specific policy implementation; SPHs continued operating on waitlists for all months following policy implementation. Unless otherwise noted, additional independent variables included in each of the OLS models controlled for time trends (number of months in the full data period and calendar month), demographic composition of the population (sex: proportion male/female; age: proportion aged 20-29, 30-64, and 65 years and older; and race: proportions black and other minority race), regional unemployment rate, and mental health services within regions (number of licensed psychiatrists per 100,000 population and number of licensed adult psychiatric beds in general hospital psychiatric units or private psychiatric hospitals per 100,000 population). None of the models produced any out of range predictions (i.e., negative numbers of admissions or proportions outside of the 0-1 range).

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