

Informing the Design and Evaluation of Superuser Care Management Initiatives

Accounting for Regression-to-the-Mean

Sujoy Chakravarty, PhD and Joel C. Cantor, ScD

Background: Health care spending is concentrated among a small number of high-cost patients, and the popularity of initiatives to improve care and reduce cost among such “superusers” (SUs) is growing. However, SU costs decline naturally over time, even without intervention, a statistical phenomenon known as regression-to-the-mean (RTM).

Objectives: We assess the magnitude of RTM in hospital costs for cohorts of hospital SUs identified on the basis of high inpatient (IP) or emergency department (ED) utilization. We further examine how cost and RTM are associated with patient characteristics including behavioral health (BH) problems, multiple chronic conditions, and indicators of vulnerability.

Study Design: Using longitudinally linked all-payer hospital billing data, we selected patient cohorts with ≥ 2 IP stays (IP SUs) or ≥ 6 ED visits (ED SUs) during a 6-month baseline period, and additional subgroups defined by combinations of IP and ED superuse.

Population Studied: A total of 289,060 NJ hospital IP and treat-and-release ED patients over 2009–2011.

Results: Hospital costs among IP and ED SUs declined 70% and 38%, respectively, over 8 quarters following the baseline period. The decrease occurs more quickly for IP SUs compared with ED SUs. Presence of BH problems was positively associated with costs among patients overall, but the relationship varied by SU cohort.

Conclusions: Understanding patterns of RTM among SU populations is important for designing intervention strategies, as there is greater potential for savings among patients with more persistent costs (less RTM). Further, as many SU initiatives lack resources for

rigorous evaluation, quantifying the extent of RTM is vital for interpreting program outcomes.

Key Words: hospital superuser, regression-to-the-mean, program evaluation, behavioral health, severe mental illness, hospital costs

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The high concentration of health care spending, with the 5% most costly patients accounting for nearly 50% of health care expenditures,¹ suggests that improving quality and efficiency of care for such patients could yield savings. These high-cost patients, commonly known as “superusers” (SUs), may suffer from inadequate access to high-quality ambulatory care, poor continuity of care during transitions across treatment settings, and health-related sequelae of complex social factors such as homelessness, pointing to opportunities for better care, better health, and lower cost.

The concentration of costs alongside the complex social circumstances and often poor medical care experienced by high-cost individuals have brought into increased focus the potential for SU-targeted care management programs to reduce overall costs,² and numerous efforts are currently underway to identify effective SU care management strategies.^{3–6} Despite considerable focus on intervention development, systematic evaluations have revealed mixed findings. Disease management and care coordination programs directed at Medicare patients with high hospitalization risk have often been found to have limited or no effectiveness on hospital utilization or costs.^{7,8} In contrast, a few recent initiatives aimed at Medicaid high-utilizing patients have demonstrated significant net savings in costs.⁶ In all of the systematic assessments, it is actively recognized that while programs may generate observed decreases in costs over time, evaluations should take into account the tendency for high costs to naturally decline over time independent of interventions,⁹ a statistical phenomenon known as regression-to-the-mean (RTM).^{10–12} Controlling for RTM can be achieved by randomized controlled trials or by using quasi-experimental methods examining costs trends among patients participating in SU initiatives compared with groups of matched patients. The latter method of benchmarking enables evaluations to measure program-attributable changes in costs when randomized clinical trials are infeasible because they are too expensive or time consuming.

From the Center for State Health Policy, Rutgers, The State University of New Jersey, New Brunswick, NJ.

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Reprints: Sujoy Chakravarty, PhD, Center for State Health Policy, Rutgers, The State University of New Jersey, 112 Paterson St, Room 548, New Brunswick, NJ 08901. E-mail: schakravarty@ifh.rutgers.edu.

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For programs without comparison patients, understanding of the magnitude of RTM may help program managers assess any observed pre-post change in costs. One recent study, by Johnson et al,¹² found average costs of SUs identified on the basis of high inpatient (IP) utilization decreased by around 60% over 2 years. More generally, studies of cost persistence have shown that only a limited fraction of high-cost patients (eg, top decile) remain high cost over time.^{1,13–15} Although not documenting its magnitude, these studies are consistent with substantial RTM.

Our study contributes to the literature on high-cost patients by examining in detail the effect of RTM in synthetic cohorts of New Jersey hospital SUs selected on the basis of high IP or emergency department (ED) utilization over a 6-month baseline period (details on utilization thresholds are provided in the Methods section). We examined quarterly changes in average costs of patients in each cohort over 2 years, comparing rates of RTM and the rapidity with which it occurs across patients having high IP or ED utilization. This analysis builds on previous work by Johnson and colleagues by focusing on, in addition to those with high IP use, SUs characterized by high ED use, and subgroups of IP and ED SUs which demonstrates just one, or both types of high use. We find substantial differences in levels and trends of costs between IP SUs and ED SUs, and additional variations by patient demographics, clinical characteristics, and source of insurance.

METHODS

We used statewide New Jersey uniform billing hospital discharge data as the source for IP hospitalizations and treat-and-release ED visits during our study period of 2009–2011. Under a special arrangement with the New Jersey Department of Health, LinkKing software¹⁶ was used to link patients' hospital records over time. Further, data from the New Jersey charity care program¹⁷ and mortality files, based on the death certificate database maintained by the New Jersey Department of Health (that included information on out-of-state deaths), were also linked to the uniform billing files to flag hospital encounters by low-income uninsured patients eligible for charity care reimbursement and to account for patients who died.

Each hospital record provides information on patient demographics, expected primary and secondary payer (that enabled classification of patients by source/availability of health insurance, namely Medicare-Medicaid dual eligibles, other Medicare, Medicaid only, private insurance, charity care, and self-pay/uninsured), clinical characteristics (primary and secondary diagnoses and procedures), patient residential zip code, and hospital charges associated with each discharge. We utilized hospital-specific cost-to-charge ratios from the Agency for Health Care Research and Quality (AHRQ), Healthcare Cost and Utilization Project,¹⁸ zip code level rates of individuals with incomes below the federal poverty level from the 2007–2011 5-year American Community Survey,¹⁹ and consumer price indices for medical care²⁰ from the Bureau of Labor Statistics, which is used to adjust for medical care inflation over our study period.

Study Population

Enrollment criteria of ongoing SU care demonstration projects^{6,21,22} guided our selection of utilization thresholds and related time periods for defining SU cohorts. We first selected 2 nonmutually exclusive cohorts of SUs based on their utilization over a 6-month “baseline” period July–December 2009: patients with ≥ 2 IP stays (denoted IP SUs) and those with ≥ 6 ED visits (ED SUs). Within these 2 groups, we further examined 3 mutually exclusive and exhaustive subsets of SU individuals. These are comprised of: (a) individuals who we denote as “IP SU only” (patients with 2+ IP stays but fewer than 6 ED visits); (b) those who we consider to be “ED SU only” (patients with 6+ ED visits but fewer than 2 IP stays); and (c) those who were “IP and ED SU” (patients with 2+ IP stays and 6+ ED visits). We further defined as non-SUs, the cohort of individuals who had 1 IP stay or 1 ED visit, the minimum utilization required to be included in this hospital database. Because many SU interventions serve adults with long-term health conditions, all of our cohorts are limited to patients over age 18 years with ≥ 2 diagnosed chronic conditions, that is, patients with zero or 1 chronic condition are excluded from the study. Further, as is typical of SU initiatives, we excluded patients who had a principal diagnosis of maternity or cancer, and also excluded from the analysis those who died during the baseline period. Our final analytic sample comprised 289,060 patients during the baseline period.

Study Outcome

Our outcome was average quarterly hospitalization costs for the baseline period (July–December 2009), and each of the 8 follow-up quarters over January 2010–December 2011. Hospital cost was calculated by applying hospital-specific cost-to-charge ratios to discharge-related charge amounts, and expressed in 2011 dollars.

Covariates

We examined the association of several patient-related factors with SU costs, adjusting for patient demographics, source/availability of health insurance, clinical factors, and poverty rates at zip codes where patients resided. We utilized algorithms based on the CMS Chronic Conditions Data Warehouse²³ to characterize patients based on whether they had 2, 3, or 4+ chronic conditions. The AHRQ Clinical Classification Software²⁴ was used to identify patients diagnosed with behavioral health (BH) conditions including a diagnosis of mental health or substance use disorder. We separately identified patients with a principal diagnosis of severe mental illness (SMI) based on the national comorbidity survey replication²⁵ and subsequent work by Coffey et al.²⁶ These patients experienced functional and social impairment that hampered their regular activities for at least 88 days out of the year and were most likely to have a diagnosis of psychoses, bipolar disorder, drug dependence, obsessive compulsive disorder, dysthymia (chronic depression), or related diagnoses.

Analytic Approach

We measured RTM as the percentage decrease in quarterly average IP and ED costs between baseline and each of 8 follow-up quarters. We investigated whether SU patients with SMI, other BH conditions, or greater numbers of chronic conditions have less RTM in costs over time, that is, more of cost persistence that is defined as $100\% - \text{RTM}$. We also considered additional indicators of patient vulnerability defined by zip code level poverty and source of health insurance. We conducted descriptive, bivariate, and also multivariate analysis of costs over baseline and 8 follow-up quarters utilizing the framework of generalized estimating equation (GEE) with a gamma distribution, logarithmic link.^{27,28} We assumed an exchangeable correlation structure as unobserved individual factors related to health status and behavior are expected to remain unchanged over our relatively short study period.

RESULTS

Table 1 shows demographic, clinical, and health insurance information relating to the 6 cohorts of patients during the baseline period and changes in average quarterly costs and cohort size over the subsequent 8 follow-up quarters. Eleven percent of the 289,060 patients at baseline died during the follow-up period. Compared with non-SU patients, the 5 types of SU patients are more likely to live in high-poverty zip codes, have higher prevalence of BH conditions, and, with the exception of ED SU-only individuals, have a higher burden of chronic conditions. ED SUs compared with IP SUs are much less likely to be elderly and more likely to be covered by Medicaid, charity care, or be uninsured. They are also more likely to have BH diagnoses, but less likely to have ≥ 4 chronic health conditions.

Figure 1 shows average quarterly costs at baseline and in each of the 8 follow-up quarters for each of 4 SU cohorts and all patients (the IP SU-only cohort and the non-SU cohort are not shown as their costs were almost identical to the IP SU cohort and all-patient cohort, respectively). The slope of the lines in Figure 1 reflects the magnitude of RTM in each cohort. The IP SU cohort experienced the greatest RTM by the end of the follow-up period (69.7%), whereas the ED SU-only cohort experienced the least RTM (8.4%). The ED SU cohort experienced a low RTM as well, at 38.3%. Although ED SUs had lower average cost during the baseline period, these differential trends resulted in their having an average cost at the end of the follow-up period that was 12% higher than IP SUs.

The lower baseline costs and RTM for ED SUs was driven by the ED SU-only subgroup, which had the lowest baseline cost (\$3889) and lowest RTM (8.4%) among all the SU cohorts. The remaining individuals among ED SUs, those who were both IP and ED SU, were distinctly different. They had the highest baseline costs among all SU groups and a RTM (46.4%) that was just above that of ED SUs (38.3%). The non-SU cohort (not shown here, but see Table 1) exhibited a level of costs that was slightly lower compared with all patients and also a declining trend in costs that reflects a

decreased likelihood of further hospitalizations in subsequent quarters.

We also replicated this analysis after dropping patients who died at any time during the follow-up period to account for the possibility that at least a part of the high costs at baseline or in the early follow-up quarters among SUs may be due to end-of-life costs, leading to the sharp decrease in average cohort costs after the death of such individuals. This exclusion had little impact on either the level of cost or RTM in any of the cohorts. The overall trend and quarterly changes in costs when analysis was restricted to only those patients who survived over the 8 quarters is similar to that in our original sample (see Fig., Supplemental Digital Content 1, <http://links.lww.com/MLR/B196>). In addition, though baseline costs are indeed slightly lower when only surviving patients are included, we see very similar rates of RTM (see Table, Supplemental Digital Content 2, <http://links.lww.com/MLR/B197>).

Table 2 reports findings from our adjusted analysis of hospitalization costs based on the GEE model and sheds further light on average cost levels and how quickly RTM occurs among SU cohorts. It reports the persistence percentage ($100\% - \text{RTM}$) and actual decrease in costs corresponding to each of the independent variables. The percentages relating to each of the 8 follow-up quarters thus equal average costs in that quarter expressed as a percentage of baseline costs. On the basis of the ratio of the corresponding RTM values (calculated as 100% minus coefficient estimates) at the end of the first and eighth quarters, we calculated that IP SUs experience the effects of RTM earlier, with 82.0% ($100\% - 45\%/100\% - 33\%$) of their overall decrease in costs occurring in the first quarter of follow-up. In contrast, the ED SU cohort experienced only 60.5% of their overall decrease in costs during the same period of time, and IP and ED SUs 65.9%. By the fourth quarter, all cohorts experienced at least 97% of their decrease in costs. Patients with BH conditions, 4+ chronic conditions, those who were dual eligible, or Medicaid beneficiaries faced higher levels of hospitalization costs, with the presence of 4+ chronic conditions making the greatest difference to costs.

Table 3 further illustrates the relationship of patient characteristics to cost levels and RTM across specific cohorts of SUs. Considering all patients, baseline and follow-up costs are greater when SMI, any BH, or 4+ chronic conditions are present, but the specific associations differ among SU groups. Consistent with the multivariate results reported above, though the presence of SMI increased the risk of being classified as an IP SU by 3 times and as ED SU by 16 times (data not shown), among SUs the incremental effect of SMI on costs is not evident. Presence of any BH diagnosis increases baseline costs among ED SUs, whereas having 4+ chronic conditions has a positive effect on costs for all categories of SUs. BH diagnosis was positively associated with RTM for ED SU, but negatively associated with RTM for IP SUs and when all patients were considered.

Finally, Figure 2 illustrates differences in levels of cost and RTM among subgroups of IP SUs and ED SUs distinguished by health and socioeconomic factors such as source/availability of insurance and residence in poor zip

TABLE 1. Characteristics of Adult Hospitalized Patients, by Patient Cohorts

Characteristics	Superuser Cohorts					Non-SUs	All Patients
	IP SU	IP SU Only	ED SU	ED SU Only	IP and ED SU		
Sex							
Female (%)	54.9	55.1	54.0	57.0	48.5	55.0	55.7
Age (y)							
Elderly (65 or older) (%)	56.5	58.5	10.2	9.3	11.7	60.0	57.2
Zip code poverty rate (%)							
Bottom quartile	43.1	42.4	57.9	56.8	59.8	34.4	36.8
Behavioral health diagnoses (%)							
SMI	4.9	3.9	20.7	16.7	28.0	0.7	1.6
BH without SMI	60.8	60.6	66.0	66.1	65.8	35.0	39.1
No. chronic conditions (%)							
2	9.8	9.3	36.6	45.0	21.6	36.3	33.9
3	11.4	11.0	22.7	24.7	19.0	25.3	23.8
≥ 4	78.8	79.7	40.7	30.3	59.3	38.4	42.3
Expected payer (%)							
Medicare and Medicaid dual	13.2	13.2	12.7	12.3	13.4	6.5	7.5
Medicare	50.9	52.3	17.9	17.0	19.5	51.2	49.5
Medicaid	6.5	5.9	18.5	17.7	19.9	2.9	3.9
Private or other	21.8	21.8	23.5	24.7	21.3	32.3	30.9
Self-pay	2.0	1.7	11.1	12.9	8.0	2.5	2.9
Charity care	5.7	5.1	16.3	15.5	17.9	4.7	5.3
Baseline							
N	27,106	25,955	3206	2055	1151	227,334	289,060
All Patients (%)	9.4	9.0	1.1	0.7	0.4	78.6	100
Mean costs	\$16,939	\$16,844	\$9346	\$3889	\$19,088	\$4121	\$5265
Follow-up period							
Quarter 1							
N	25,186	24,064	3165	2043	1122	223,951	283,042
Mean costs	\$7881	\$7611	\$7397	\$3950	\$13,672	\$1375	\$2124
Quarter 2							
N	23,947	22,851	3126	2030	1096	221,378	278,637
Mean costs	\$6616	\$6356	\$6467	\$3452	\$12,050	\$1124	\$1784
Quarter 3							
N	22,978	21,903	3089	2014	1075	219,082	274,825
Mean costs	\$6144	\$5866	\$6623	\$3858	\$11,803	\$1043	\$1653
Quarter 4							
N	22,033	20,985	3049	2001	1048	216,645	270,926
Mean costs	\$5791	\$5551	\$6008	\$3607	\$10,594	\$1046	\$1612
Quarter 5							
N	21,116	20,092	3017	1993	1024	214,121	266,874
Mean costs	\$6046	\$5862	\$5637	\$3576	\$9650	\$1079	\$1644
Quarter 6							
N	20,379	19,371	2990	1982	1008	212,068	263,614
Mean costs	\$5453	\$5243	\$5489	\$3456	\$9486	\$1013	\$1522
Quarter 7							
N	19,777	18,790	2955	1968	987	210,082	260,614
Mean costs	\$5020	\$4764	\$5755	\$3677	\$9898	\$939	\$1410
Quarter 8							
N	19,152	18,186	2919	1953	966	208,115	257,599
Mean costs	\$5141	\$4870	\$5770	\$3563	\$10,231	\$945	\$1421

Baseline period denotes July–December 2009. Follow-up period denotes January 2010–December 2011.

ED SU only indicates ED SU with 6+ ED and <2 IP; ED SU, ED SU with 6+ ED (no restrictions relating to IP use); ED, emergency department; IP and ED SU, individuals with 2+ IP and 6+ ED; IP SU only, IP SU with 2+ IP and <6 ED; IP SU, inpatient SU with 2+ IP (no restrictions relating to ED use); non-SUs, individuals with only 1 hospital encounter during baseline; SU, superuser.

codes. We define 3 mutually exclusive subgroups of SUs based on these characteristics. First, we define SUs as “more vulnerable” if they lived in a high-poverty zip code and were covered by Medicaid (including as Medicaid-Medicare dual eligibles) or classified as charity care eligible, did not have BH diagnoses, and had 2 or 3 chronic conditions. Next we classify SUs as “most vulnerable” if they differed in terms of having ≥ 1 non-SMI BH diagnoses and 4+ chronic con-

ditions. For contrast, SUs not living in a high-poverty area, without BH diagnoses, with only 2 or 3 chronic conditions, and covered by Medicare (but not Medicaid) or private insurance are classified as “less vulnerable.”

The most vulnerable IP SU group had the highest overall cost at baseline and experienced much less RTM compared with their less vulnerable counterparts. Consistent with previously described patterns, all ED SU

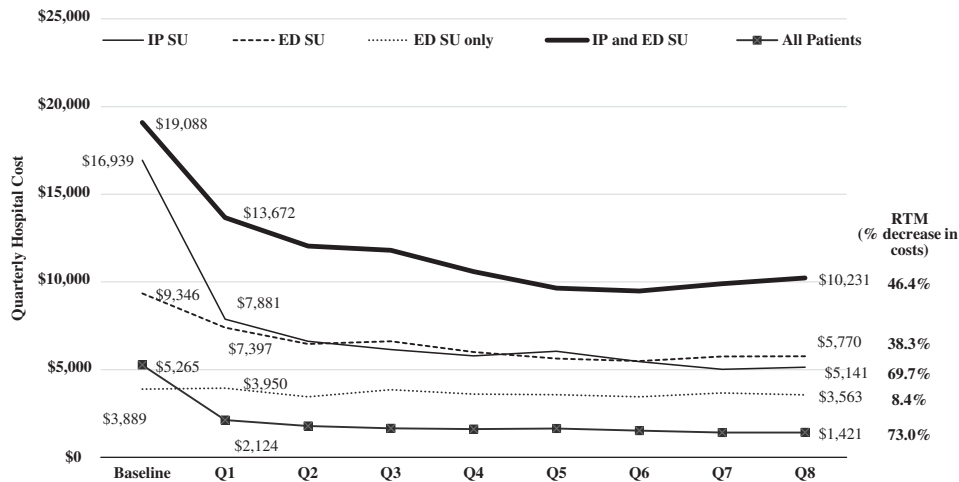


FIGURE 1. Quarterly hospital cost of cohorts of inpatient and emergency department superusers, 2009–2011. Author’s analysis of New Jersey hospital uniform billing data and linked mortality data. Baseline cost is the average of the last 2 quarters of 2009. IP SU = inpatient SU with 2+ IP (no restrictions relating to ED use); ED SU = ED SU with 6+ ED (no restrictions relating to IP use); ED SU only = ED SU with 6+ ED and <2 IP; IP and ED SU = individuals with 2+ IP and 6+ ED. ED indicates emergency department; IP, inpatient; Q, quarter of follow-up; SU, superutilizer.

TABLE 2. Multivariate Regression Analysis of Hospital Costs Across Patient Cohorts

	IP SU		ED SU		ED SU Only		IP and ED SU		All Patients	
	Effect	Persistence	Effect	Persistence	Effect	Persistence	Effect	Persistence	Effect	Persistence
Cost persistence (Ref.: baseline period)										
Quarter 1	\$6319	45%*	\$390	81%*	-\$6	100%	\$1868	70%*	\$1766	38%*
Quarter 2	\$7074	39%*	\$574	71%*	\$190	87%#	\$2318	63%*	\$1926	33%*
Quarter 3	\$7344	36%*	\$548	73%*	\$46	97%	\$2381	62%*	\$1967	31%*
Quarter 4	\$7504	35%*	\$649	68%*	\$131	91%	\$2754	56%*	\$1979	31%*
Quarter 5	\$7248	37%*	\$705	65%*	\$134	91%	\$3023	52%*	\$1935	32%*
Quarter 6	\$7579	34%*	\$727	64%*	\$178	88%#	\$3019	52%*	\$1977	31%*
Quarter 7	\$7854	32%*	\$633	69%*	\$67	95%	\$2887	54%*	\$2027	29%*
Quarter 8	\$7704	33%*	\$644	68%*	\$109	93%	\$2837	55%*	\$2006	30%*
Age (Ref.: nonelderly)										
Elderly (65 or older)	\$3473	70%*	\$197	90%	-\$160	111%	\$1175	81%	\$591	79%*
Sex (Ref.: male)										
Female	\$928	92%*	\$150	93%	\$14	99%	-\$42	101%	\$239	92%*
Zip code poverty rate (Ref.: not poorest quartile)										
Poorest quartile	-\$1110	110%*	-\$33	102%	\$17	99%	-\$138	102%	-\$580	120%*
No. chronic conditions (Ref.: 2 chronic conditions)										
3 chronic conditions	-\$1987	117%*	-\$551	127%*	-\$346	123% [^]	-\$321	105%	-\$1131	140%*
4+ chronic conditions	-\$8107	170%*	-\$2465	223%*	-\$876	159%*	-\$3241	152%*	-\$4169	246%*
Behavioral health (BH) diagnoses (Ref.: no BH diagnoses)										
Severe mental illness	\$1577	86%*	-\$538	127% [^]	-\$405	127% [^]	\$1764	72%#	-\$2052	172%*
BH without SMI	-\$457	104%#	-\$834	141%*	-\$302	120% [^]	-\$522	108%	-\$879	131%*
Expected payer (Ref.: Medicare)										
Charity care	\$2337	80%*	-\$66	103%	\$96	94%	\$63	99%	\$678	76%*
Medicare-Medicaid dual	-\$2482	122%*	-\$209	110%	\$36	98%	-\$1781	128%#	-\$974	134%*
Medicaid	-\$2187	119%*	-\$356	118%	\$125	92%	-\$2102	134% [^]	-\$471	116%*
Private and other	\$2382	79%*	\$184	91%	\$261	82%#	\$153	98%	\$1008	65%*
Self-pay	\$2309	80%*	\$461	77% [^]	\$340	77%#	\$700	89%*	\$985	66%*
Intercept		\$13,651*		\$4628*		\$3020*		\$14,178*		\$3482*
N		201,674		27,516		18,039		9477		2,445,191

Ref. indicates reference/omitted category.

Persistence = Persistence in costs relating to the independent variable as a percentage of reference categories. Effect denotes decrease in costs relating to the independent variable. Estimated from a generalized estimating equation with gamma distribution and log link. Unit of analysis is patient quarter.

#P < 0.05.

[^]P < 0.01.

*P < 0.001.

ED SU only indicates ED SU with 6+ ED and <2 IP; ED SU, ED SU with 6+ ED (no restrictions relating to IP use); ED, emergency department; IP and ED SU, individuals with 2+ IP and 6+ ED; IP SU, inpatient SU with 2+ IP (no restrictions relating to ED use); SU, superuser.

TABLE 3. Quarterly Average Cost Levels and RTM in Costs by Patient Diagnostic Characteristics and Superuser Cohort, 2009–2011

	All Patients	Severe Mental Illness		Any Behavioral Health Diagnosis		Number of Chronic Conditions	
		No	Yes	No	Yes	2-3	4 or More
IP superusers							
Baseline	\$16,939	\$17,079	\$14,235*	\$17,123	\$16,843	\$13,198	\$17,945*
Quarter 8	\$5141	\$5174	\$4621	\$4760	\$5339 [#]	\$3975	\$5547*
RTM (%)	70	70	68	72	68 [^]	70	69
ED superusers							
Baseline	\$9346	\$9140	\$10,132	\$5545	\$9927*	\$6358	\$13,698*
Quarter 8	\$5770	\$6019	\$4842 [#]	\$4752	\$5930	\$4082	\$8432*
RTM (%)	38	34	52*	14	40 [#]	36	38
IP and ED superusers							
Baseline	\$19,088	\$20,144	\$16,369*	\$18,306	\$19,140	\$15,097	\$21,823*
Quarter 8	\$10,231	\$11,954	\$6193*	\$12,067	\$10,111	\$7462	\$12,316*
RTM (%)	46	41	62*	34	47	51	44
All patients							
Baseline	\$5265	\$5249	\$6242*	\$4645	\$6168*	\$3431	\$7768*
Quarter 8	\$1421	\$1403	\$2449*	\$1177	\$1798*	\$1009	\$2060*
RTM (%)	73	73	61*	75	71*	71	73*

Authors' analysis of 2009–2011 New Jersey hospital uniform billing data. Characteristics assessed at baseline comprising second half of 2009.

[#]P < 0.05.

[^]P < 0.01.

*P < 0.001.

ED SU indicates ED SU with 6+ ED (no restrictions relating to IP use); ED, emergency department; IP and ED SU, SUs with 2+ IP and 6+ ED; IP SU, inpatient SU with 2+ IP (no restrictions relating to ED use); RTM, regression-to-the-mean; SU, superuser.

subgroups had lower baseline cost than the corresponding IP SUs, but less RTM. We also find that vulnerability, defined by insurance status and poverty, did not have a substantial effect on costs of IP or ED SUs, but poorer health had a much greater effect on the level of cost in relative terms on ED SUs than IP SUs.

DISCUSSION

Understanding patterns of RTM among SU populations is important for designing intervention strategies, as there is greater potential for savings among patients with more persistent costs (less RTM). Further, as many SU initiatives lack resources for rigorous evaluation, accounting for the effects

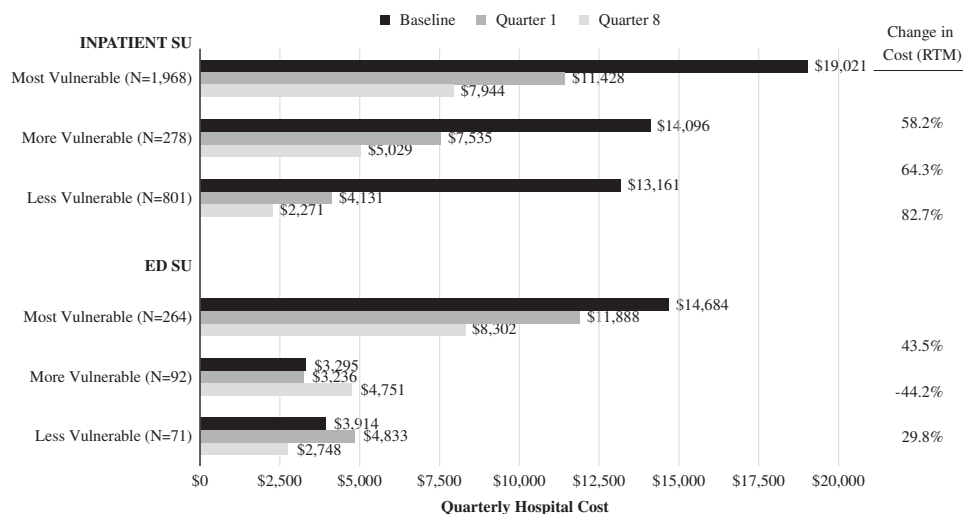


FIGURE 2. Quarterly hospital cost of selected groups of inpatient and emergency department superusers, 2009–2011. Author’s analysis of 2009–2011 New Jersey hospital uniform billing data linked to state charity care records, mortality data, and zip code level poverty rates. “More vulnerable”=lives in poor zip code, Medicaid (including dual eligible) or charity care. “Most vulnerable”=In addition to characteristics defining the “more vulnerable” category, individuals also have non-SMI behavioral health condition(s), and ≥ 4 chronic conditions. “Less vulnerable”=does not live in poor zip code, no behavioral health conditions, private insurance or Medicare (non-dual eligible), and 2 or 3 chronic conditions. IP SU=Inpatient SU with 2+ IP (no restrictions relating to ED use); ED SU=ED SU with 6+ ED (no restrictions relating to IP use). ED indicates emergency department; IP, inpatient; RTM, regression-to-the-mean; SMI, severe mental illness; SU, superutilizer.

of RTM is vital while interpreting program outcomes. Although the estimates from our study cannot substitute for an appropriate comparison group, they inform ongoing projects targeting patients based on high costs at a point in time on the need to adjust for such effects over time. Judging by their high baseline costs alone, IP SUs would seem to offer the greatest potential for savings, but their costs came down due to high RTM. However, mean cost in this cohort still remained elevated well above that of the average hospital patient, reflecting potential cost-saving opportunities, especially if some of their utilization can be prevented,²⁹ for instance, hospital use arising from ambulatory care sensitive conditions. RTM also occurred very quickly in this group suggesting that intervention projects without resources to establish rigorous comparison groups might effectively assess their impact by examining changes in cost beginning several months after program enrollment when the natural reduction in cost due to RTM has leveled off.¹⁰

Compared with IP SUs, ED SUs were characterized by lower burden of chronic physical conditions, higher prevalence of SMI, higher likelihood of residence in low-income areas, and higher likelihood of being Medicaid covered or charity care eligible. These findings point to the distinct nature of ED SUs and the need to address factors beyond chronic disease management, including integrating medical, behavioral, and social services and addressing sequelae of poverty such as housing instability. Among ED SUs there was substantial heterogeneity between those who were ED SU only compared with those who were IP and ED SU. IP and ED SUs had greater baseline costs compared with the overall group of IP SUs (\$19,088 vs. \$16,939), and the difference in costs at end of follow-up period was even higher (\$10,231 vs. \$5141). This greater differential was due to their low RTM at 46.4%, just above that of ED SUs. The higher cost as well as higher cost persistence in this group of individuals makes them the category of SUs with greatest potential for savings.

Our study also shows that risk factors for higher costs may differ between SUs and hospital patients overall. Although the presence of SMI diagnoses substantially increases the likelihood of being classified as SU, SUs with SMI do not have higher baseline cost or lower RTM. These patterns underscore the importance of incorporating information on SMI in predictive modeling intended to identify future high-cost patients and suggest that it may be efficient early-on to engage patients with SMI in strategies to prevent them from becoming SUs. Finally, our analysis of the effects of indicators of vulnerability shows varying patterns of RTM among IP and ED SUs.

This study has several limitations. New Jersey has high average income per capita, an ample supply of hospital beds, and historically generous Medicaid eligibility (including expanding Medicaid under the ACA). As a result, access to care may be better for SUs, limiting generalizability. That said, findings based on statewide analysis offer more generalizability than prior studies restricted to specific health care systems with distinct characteristics¹² and also ensures that all hospital utilization within the state is accounted for. However, being solely based on hospital discharges, we are

unable to assess total health care costs as there is no information on physician professional services, prescription drugs, and outpatient services. In addition diagnostic information in our study is based on hospital information only. Administrative billing data do not include important information on clinical acuity or the social situation of patients, for example, housing problems or a history of trauma over life course. Finally, we measure cost by adjusting charge data, not actual payments to hospitals. Actual savings will vary depending on payment source.

The popularity of SU care programs seems to be growing. Achieving success in such programs is dependent on effectively targeting patients who are likely to have persistently high costs and are likely to respond to interventions.^{3,7,8} Our study addressed the cost persistence question, but we could not address questions related to responsiveness to interventions. Nevertheless, understanding the natural tendency of cost among SU populations to moderate over time is critically important for designing and evaluating the impact of SU programs.

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