Cost-Effectiveness of Inpatient Substance Abuse Treatment

Paul G. Barnett and Ralph W. Swindle

Objective. To identify the characteristics of cost-effective inpatient substance abuse treatment programs.

Data Sources/Study Setting. A survey of program directors and cost and discharge data for study of 38,863 patients treated in 98 Veterans Affairs treatment programs.

Study Design. We used random-effects regression to find the effect of program and patient characteristics on cost and readmission rates. A treatment was defined as successful if the patient was not readmitted for psychiatric or substance abuse care within six months.

Principal Findings. Treatment was more expensive when the program was smaller, or had a longer intended length of stay (LOS) or a higher ratio of staff to patients. Readmission was less likely when the program was smaller or had longer intended LOS; the staff to patient ratio had no significant effect. The average treatment cost $3,754 with a 75.0% chance of being effective, a cost-effectiveness ratio of $5,007 per treatment success. A 28-day treatment program was $860 more costly and 3.3% more effective than a 21-day program, an incremental cost-effectiveness of $26,450 per treatment success. Patient characteristics did not affect readmission rates in the same way they affected costs. Patients with a history of prior treatment were more likely to be readmitted but their subsequent stays were less costly.

Conclusions. A 21-day limit on intended LOS would increase the cost-effectiveness of treatment programs. Consolidation of small programs would reduce cost, but would also reduce access to treatment. Reduction of the staff to patient ratio would increase the cost-effectiveness of the most intensively staffed programs.

Key Words. Substance abuse rehabilitation, cost-benefit analysis, economics of hospitalization, length of stay

During the 1980s, short-term hospital stays became an increasingly important treatment for substance abuse disorders (Gfroerer, Adams, and Moien 1988). Many states enacted laws requiring employers to include substance abuse treatment in their insurance plans, and the use of inpatient treatment increased sharply (Weisner, Greenfield, and Room 1995). Although the advent of managed care has curtailed the growth of the inpatient sector, hospital

and residential stays still account for nearly one-half of the funds spent on substance abuse treatment in the United States, or more than $2 billion a year (Barnett and Rodgers 1997).

This article analyzes the cost-effectiveness of inpatient substance abuse treatment, using readmission rates as the outcome measure. Our goal is to identify the characteristics of inpatient treatment programs that yield the most benefit at the least cost. Despite the widespread use of inpatient treatment, there has been a paucity of cost-effectiveness studies. The Institute of Medicine's review of drug abuse treatment literature found no studies of the cost-effectiveness of inpatient care (Gerstein and Harwood 1990). Two literature reviews found that the cost and effectiveness of different modes of alcoholism treatment are not correlated; however, the authors did not find the evidence persuasive enough to make recommendations about funding or treatment decisions (Finney and Monahan 1996; Holder et al. 1991).

The cost of inpatient treatment increases with its duration. There is conflicting evidence on how the length of treatment affects outcomes. Some observational studies have found that longer stays are associated with better outcomes in therapeutic communities (Bleiberg et al. 1994), halfway houses (Moos, Pettit, and Gruber 1995), and hospitals (Welte et al. 1981). Observational studies may suffer from selection bias, however. When the length of stay (LOS) is not randomly assigned, it is likely to be a function of the same patient characteristics that affect outcome.

Randomized clinical trials are designed to avoid this selection bias. Random assignment to a longer inpatient stay has not resulted in better outcomes for patients being treated for alcoholism (Mattick and Jarvis 1994) or drug abuse (McCusker, Vickers-Lahti, Stoddard, et al. 1995). This finding may not be definitive. Many LOS trials have few subjects and limited statistical power. Moreover, the results of trials may not apply to patients with the

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This research was supported by the Health Services Research and Development Service and the Mental Health and Behavioral Sciences Service of the U.S. Department of Veterans Affairs.

Paul G. Barnett, Ph.D. is a health economist with the HSR&D Center for Health Care Evaluation and the Program Evaluation and Resource Center, Veterans Affairs Palo Alto Health Care System, Menlo Park, California, and the Department of Health Research and Policy, Stanford University School of Medicine. Ralph W. Swindle, Ph.D. is a research health scientist with the HSR&D Service, Roudebush VAMC, Indianapolis, IN, and the Department of Medicine, Indiana University School of Medicine and the Regenstrief Institute for Health Care. Address correspondence and requests for reprints to Paul G. Barnett, Ph.D., Health Economist, Center for Health Care Evaluation, Veterans Affairs Palo Alto Health Care System, 795 Willow Rd. (152 MPD), Menlo Park, CA 94025. This article, submitted to *Health Services Research* on July 23, 1996, was revised and accepted for publication on February 28, 1997.

most severe disorders. Trials usually exclude these patients as it is regarded as unethical to enroll them in a protocol where they might be assigned a short LOS.

The cost of treatment also depends on the intensity of staffing. It is uncertain if intensively staffed programs yield better outcomes. A comparison of two inpatient alcohol treatment programs, one with 40 percent fewer staff, found no significant difference in effectiveness (Stinson et al. 1979). However, an evaluation of residential programs for adolescent drug abusers suggested that higher staffing levels were associated with better outcomes (Friedman and Glickman 1987).

There is little information on the effect of longer stays and more intensive levels of staffing on the cost of inpatient treatment. Also lacking is an analysis of whether the extra cost is justified by additional effectiveness.

The Department of Veterans Affairs (VA) relies heavily on inpatient programs to treat veterans with substance abuse disorders. In the 1994 fiscal year, VA provided 1.42 million days of inpatient substance abuse treatment (Piette, Baisden, and Moos 1995) at a cost of some $468 million. Until 1996, VA eligibility rules encouraged treatment in the inpatient setting. Most veterans qualify for care based on their income; low-income veterans were eligible for free outpatient care only if it was in preparation for a hospital stay or needed to prevent one.

VA's inpatient substance abuse programs have been studied using readmission as a measure of effectiveness (Peterson, Swindle, Phibbs, et al. 1994). Programs that performed better than expected had longer intended treatment duration, used assessment interviews involving family or friends, treated more patients on a compulsory basis, and had fewer early discharges and higher rates of participation in aftercare. The study used readmission after 180 days as the outcome. Only small changes resulted when the follow-up period was changed to 30, 60, 90, or 365 days.

We expand on this earlier study by considering costs and cost-effectiveness and by employing random effects regression.

DATA

Data on the design of treatment programs were obtained by mailed survey to all administrators of VA inpatient treatment programs in October 1990 (Peterson, Swindle, Phibbs, et al. 1994). The survey gathered information on the design of the program, such as the intended LOS and methods used in treatment, as well as a count of the number and type of direct treatment

staff. We obtained detailed cost and utilization data for the preceding year, the period October 1, 1989 to September 30, 1990. Information on patients was obtained from the Patient Treatment File, the VA database of hospital discharges. The VA discharge file includes a unique patient identifier, patient demographics, diagnoses, and LOS. We obtained data on program cost and staffing from the Cost Distribution Report, the cost-accounting system used by VA medical centers. We divided the total cost from this report by the total days of inpatient care from the discharge file to find the average cost per day of care for each program. The components of the average daily cost of treatment are presented in Table 1. Using the assumption that all patients incur costs at the program's mean daily rate, we multiplied each patient's LOS by daily cost to find the total cost of treatment. The VA cost report reported research costs of $10.01 per patient day and education costs that averaged $17.42 per day. These costs were excluded from our analysis.

The VA cost report may suffer from some inaccuracies (Swindle, Beattie, and Barnett 1996). We created an alternative estimate of the cost of treatment staff. The number of each type of staff reported in the program survey was multiplied by the national average salary and benefits cost obtained from the VA summary expense journal, the Computerized Accounting for Local Management. We substituted this estimate of the cost of each program's staff to create an alternative measure of treatment cost.

We studied treatment provided by 98 programs that could be matched to the discharge file and cost report. These programs treated 38,683 unique patients during the year ending September 30, 1990. We examined the cost and effectiveness of the first treatment received by each patient during the study year. When a patient received more than one treatment during the year, we included only this first treatment as the index treatment for our analysis.

We did not include 77 of the 175 VA inpatient programs. These were excluded because the VA databases did not always allow us to distinguish the cost and utilization of individual programs when several alternative programs operated in a single medical center. The excluded programs were larger, less intensively staffed, and had longer intended LOS (Peterson, Swindle, Phibbs, et al. 1994). There was no difference in patient characteristics, as measured by the severity of illness index developed for VA substance abuse patients (Phibbs, Swindle, and Recine 1997).

METHODS

Cost-effectiveness analysis requires a single measure of outcome. Our only information on patients came from the discharge database. Given this limita-

Table 1: Mean Cost per Day in Inpatient Substance Abuse Treatment Programs, VA Medical Centers, 1990 Fiscal Year

Physicians	14.58		
Social workers	6.54		
Nurses	48.38		
Psychologists, counselors, rehab and other staff	26.47		
Subtotal, treatment staff		95.96	45.3%
Dietary	17.14		
Sanitation	8.28		
Laundry and linen	2.42		
Recreation and libraries	3.62		
Other housing costs	38.01		
Subtotal, hotel costs		69.47	32.8%
Laboratory	5.69		
Pharmacy	5.24		
Diagnostic radiology	1.44		
Supplies	8.70		
Subtotal, ancillary costs		21.08	9.9%
Ward administrative staff	2.94		
Information services	1.93		
Security	2.31		
Fiscal and personnel	4.63		
Medical records	2.75		
Other administration	10.76		
Subtotal, administration		25.32	12.0%
Total treatment cost		211.82	100.0%
Range of costs	94.06–386.82		
Standard deviation	57.02		

tion, we defined a treatment as effective if the patient was not readmitted to any VA hospital within the United States for medical detoxification, substance abuse rehabilitation, or psychiatric care within 180 days of discharge from the index treatment. Using this definition, 75.0 percent of the treatments were effective. Data from non-VA programs were not available, so readmission to other facilities was not considered by our study.

Variables and their mean values are presented in Table 2. Medical and psychiatric conditions, and the substances abused by patients, are based on the diagnoses in the discharge file. Prior admissions represent the number of inpatient treatment episodes in the year before the index treatment. "High-

income" means an income of more than twice the upper limit established by the VA eligibility test; in 1990, a single veteran with income in excess of $34,480 would have been considered high-income, as would a veteran with two dependents and an income in excess of $48,276.

We wished to find the patient and program level characteristics that explain the cost of treatment and the probability of readmission for further treatment. If we had used the program as the unit of observation, patient characteristics would have entered our model as a mean value for each program, resulting in a substantial loss of statistical power. A patient-level analysis, however, cannot make the standard assumption that the error terms are independent. When the error terms of patients in the same program are correlated, then standard models overstate the statistical significance of the regression coefficients.

Random-effects models account for the correlation of patients within programs. We had a continuous dependent variable, *cost,* and a dichotomous dependent variable, an indicator of whether the patient was *readmitted within six months.* Random-effects models can be used in both linear (Laird and Ware 1982) and logistic regression (Wong and Mason 1985). We used simple random-effects regressions, treating the intercept as a random variable whose variation is explained by program characteristics. We did not estimate any program-by-patient interaction terms.

We were interested in discovering the program characteristics that affect readmission rates while controlling for patient characteristics. One important patient characteristic is the number of times the patient was hospitalized in the previous year. This depends on the characteristics of both patient and program, but we wished to control for only the patient's contribution. To keep program factors out of this measure of patient severity, we excluded previous admissions to the program that provided the index treatment.

We considered the program-level factors previously found to predict rates of readmission (Peterson, Swindle, Phibbs, et al. 1994). Because our focus was on cost-effectiveness, we added factors associated with resource use, including the intensity of staffing and program size.

We wished to consider the effect of program-level factors that influence the LOS. We used the intended length of a completed treatment, according to the program director. We did not use the actual LOS because it would reflect patient-level characteristics as well as the design of the program.

We did not include early discharge or participation in aftercare in our analysis. These variables were excluded because of our concern that they are endogenous, that is, that they are correlated with the error term. The

Table 2: Means of Variables in Inpatient Substance Abuse Treatment Programs, VA Medical Centers 1990 Fiscal Year

	Mean	*s.d.*
Program-Level Variables (n = 98)		
Intended length of stay (days)	24.44	4.16
Log intended length of stay (days)	3.181	0.183
Size of program (days of care)	9,244.240	5,365.240
Log of program size (days of care)	8.976	0.589
Wage index	0.992	0.150
Treatment staff (FTE/patient) (by cost report)	0.802	0.297
Treatment staff (FTE/patient) (by survey)	0.769	0.297
Compulsory admissions (fraction of patients)	0.139	0.181
> 50% family/friends assessment	0.306	0.463
Patient-Level Variables (n = 38,683)		
Cost of treatment (by cost report)	3,754.100	2,215.420
Cost of treatment (by survey)	3,633.600	2,146.160
1 prior admission (fraction of patients)	0.131	0.337
2 prior admissions (fraction of patients)	0.044	0.205
3 or more prior admissions (fraction of patients)	0.048	0.215
Age (years)	42.59	10.86
Age-squared (years)	1,931.800	1,021.100
Service-connected disability (fraction of patients)	0.292	0.455
High income (fraction of patients)	0.012	0.107
Non-veteran (fraction of patients)	0.007	0.082
Not married (fraction of patients)	0.746	0.435
African American (fraction of patients)	0.303	0.460
Opiate diagnosis (fraction of patients)	0.088	0.283
Marijuana (fraction of patients)	0.127	0.333
Nicotine (fraction of patients)	0.090	0.286
Amphetamine (fraction of patients)	0.018	0.133
Schizophrenia (fraction of patients)	0.029	0.168
Bipolar disorder (fraction of patients)	0.018	0.134
Post-traumatic stress disorder (fraction of patients)	0.043	0.202
Depression (fraction of patients)	0.069	0.253
Other personality disorder (fraction of patients)	0.079	0.270
Heart disease (fraction of patients)	0.055	0.228
Arthritis (fraction of patients)	0.057	0.232
Back problems (fraction of patients)	0.050	0.218
Cancer (fraction of patients)	0.014	0.116
Liver diagnoses (fraction of patients)	0.056	0.230
HIV (fraction of patients)	0.004	0.060
Alcohol withdrawal (fraction of patients)	0.142	0.349

unobserved patient attributes associated with retention in treatment are likely to be correlated with the likelihood that the patient avoided readmission. Inclusion of endogenous variables could bias our regression coefficients.

Table 3: Cost of Inpatient Substance Abuse Treatment VA Medical Centers, 1990 Fiscal Year; Random-Effects Regression ($N = 38,683$ patients, 98 programs)

	Coefficient	*p-Value*
Intercept	1,303.56	.512
Program-Level Factors		
Intended length of stay (days)	122.88	.000
Log program size	−524.66	.002
Wage index	1,977.58	.003
Treatment staff per patient (FTE)	2,228.64	.000
Percent compulsory admissions	966.85	.013
> 50% family/friends assessment	248.67	.270
Patient-Level Factors		
3 or more prior admissions	−496.71	.000
2 prior admissions	−229.79	.003
1 prior admission	−95.12	.048
Age	13.41	.177
Age-squared	−0.21	.036
Service-connected disability	−66.16	.024
High income	96.19	.542
Non-veteran	44.71	.845
Not married	148.42	.000
African American	410.47	.000
Opiate diagnosis	−281.21	.038
Marijuana	242.47	.003
Nicotine	384.87	.010
Amphetamine	26.60	.809
Schizophrenia	−328.20	.000
Bipolar disorder	124.03	.210
Post-traumatic stress disorder	390.15	.000
Depression	396.29	.000
Other personality disorder	410.69	.071
Heart disease	78.35	.188
Arthritis	416.34	.000
Back problems	281.18	.000
Cancer	737.65	.000
Liver diagnoses	334.76	.001
HIV	361.28	.240
Alcohol withdrawal	−637.47	.000

To control for the geographic variation in wages, we used the hospital wage index constructed by HCFA. The intensity of staffing was expressed as a ratio of staff to the average number of patients, obtained from discharge data.

RESULTS

We examined effects of program and patient characteristics on the cost of an inpatient treatment for substance abuse using random-effects regression (Table 3). A higher ratio of staff to patients was associated with higher costs. We modeled program size as the log of the total number of days of care provided by the program during the study year. This parameter was negative, demonstrating that larger programs had lower costs, that is, that there were economies of scale.

Each additional day of intended LOS added $123 to program costs. This marginal cost was less than the average daily cost because actual LOS is shorter than the intended LOS and because some costs are fixed and do not vary with LOS.

Many patients enter treatment as an alternative to jail. Our information about such compulsory admissions was available only at the program level. Programs with a higher percentage of patients with compulsory admissions had higher costs. Programs that conducted an assessment of the patient's family or friends in at least 50 percent of the treatments had no higher costs than those that did not.

We examined the effect of program and patient variables on readmission with a random-effects logistic regression (Table 4). Readmission rates were lower when the program had a longer intended LOS, was smaller, had more compulsory admissions, or assessed family or friends as part of treatment at least 50 percent of the time. Programs that had a greater intensity of staffing had no lower rates of readmission.

Patient characteristics did not affect readmission rates in the same way that they affected costs. We compared the parameters from the readmission regression with those of the cost regression. Some types of patients with high readmission rates, such as patients with a service-connected disability, schizophrenia, a diagnosis of alcohol withdrawal, or a history of prior treatment, were less costly to treat. Other types of patients with high readmission rates were more expensive to treat, including patients who were unmarried and those who suffered from post-traumatic stress disorder or depression. Some groups of patients had higher costs but were less likely to be readmitted, including African American patients and those with a diagnosis of cancer.

We tested the sensitivity of our results to possible biases in the VA cost report by reanalyzing the cost and effectiveness equations using our alternative, survey-based definition of staffing intensity and cost. Neither the sign nor the statistical significance of any parameter was changed. Our cost-

Table 4: Effectiveness of Inpatient Substance Abuse Treatment in VA Medical Centers, 1990 Fiscal Year; Random-Effects Logistic Regression of Readmission ($N = 38,683$ patients, 98 programs)

	Coefficient	*p-Value*
Intercept	−2.971	.033
Program-Level Factors		
Log intended length of stay	−0.678	.043
Log program size	0.301	.009
Wage index	−0.051	.888
Treatment staff per patient (FTE)	0.290	.131
Percent compulsory admissions	−1.072	.000
> 50% family/friend assessment	−0.296	.013
Patient-Level Factors		
3 or more prior admissions	2.008	.000
2 prior admissions	1.276	.000
1 prior admission	0.726	.000
Age	0.036	.000
Age-squared	0.000	.000
Service-connected disability	0.092	.009
High income	−0.329	.001
Non-veteran	−1.817	.000
Not married	0.310	.000
African American	−0.297	.000
Opiate diagnosis	0.138	.045
Marijuana	−0.236	.000
Nicotine	−0.342	.001
Amphetamine	−0.154	.081
Schizophrenia	0.516	.000
Bipolar disorder	0.322	.001
Post-traumatic stress disorder	0.473	.000
Depression	0.162	.013
Other personality disorder	0.046	.667
Heart disease	−0.106	.053
Arthritis	−0.152	.047
Back problems	−0.096	.107
Cancer	−0.485	.000
Liver diagnoses	0.011	.882
HIV	0.607	.016
Alcohol withdrawal	0.269	.006

effectiveness findings were not sensitive to the alternative source of cost data, as discussed further on.

We considered whether substitution of an externally validated case-mix measure would affect our results. We estimated the cost and readmission

models using an index of case-mix intensity that was developed from data on all VA substance abuse inpatients treated in the 1990 fiscal year (Phibbs, Swindle, and Racine 1997). When the severity-of-illness score from this index was used in lieu of patient characteristics, neither the sign nor the significance of any program level parameter was changed.

Cost-Effectiveness. The central focus of our study was to identify the impact of program characteristics on cost-effectiveness. An intervention is more cost-effective than another if it is more effective and does not cost more, or if it is as effective and costs less. This is the principle of strong dominance in cost-effectiveness analysis.

Additional staff per patient was associated with greater cost and no greater effectiveness. Under the principle of strong dominance, treatment with lower levels of staff is more cost-effective than treatment with higher levels of staff. Assessment of friends and family was an intervention associated with greater effectiveness and no greater costs. It may be regarded as a cost-effective strategy according to the principle of strong dominance.

The strong dominance principle does not provide any guidance in comparing interventions when one of them is both more costly and more effective. Mutually exclusive alternatives may be compared using the incremental cost-effectiveness ratio (Kamlet 1992). This ratio is the difference in the costs of the interventions divided by the difference in their effectiveness. A higher ratio represents a less efficient intervention, that is, one that requires a greater cost to achieve a given unit of outcome.

Efficiency must be gauged in terms of the value of the outcome. There is no objective standard for what constitutes an acceptably low cost-effectiveness ratio. The decision ultimately depends on the value that the policymaker assigns to the outcome. A common method of estimating this value is to consider what might be achieved by the alternative use of these resources, that is, the opportunity cost.

The average treatment cost $3,754 and had a 75.0 percent chance of being effective, a cost-effectiveness ratio of $5,007 per treatment "success" (with "success" defined as no hospitalization for psychiatric or substance abuse treatment within the next 180 days). This represents the average efficiency of inpatient substance abuse treatment and can be regarded as an standard for comparison, the opportunity cost. We may compare alternative interventions to this ratio because there is the alternative of treating some additional patients and, if they are typical, achieving at least this level of efficiency.

We estimated the incremental cost-effectiveness ratios for the program characteristics that management decisions can affect. We used our regression

models to simulate the effect of a policy change. We changed the values of a program characteristic and found the fitted values for cost and effectiveness while holding all other variables unchanged. We did not simulate any extreme changes to avoid extrapolating beyond the range of our models.

Intended LOS had an important impact on treatment costs, but only a small impact on effectiveness. Most programs had intended LOS of either 21 or 28 days. We compared these two strategies. An additional seven days of intended stay added $860 in cost and yielded an additional 3.3 percent in effectiveness. The incremental cost-effectiveness of the additional days was quite high, $26,450 per treatment "success."

We also considered the effect of program size, measured in terms of the average number of patients in treatment. We compared a smaller program (one providing 6,848 days per year of treatment, the 40th percentile among programs studied) to a larger one (a program operating at the 60th percentile, providing 9,275 days of care). The smaller program had $159 greater costs and was 1.5 percent more effective, an incremental cost-effectiveness of $10,922 per success.

Patients with a history of prior treatment were more likely to be readmitted. This suggests a high incremental cost-effectiveness for repeated treatments. On the other hand, the cost of repeated treatments was lower, suggesting a lower ratio. We examined the relative magnitude of these effects and determined the cost-effectiveness of additional treatments. The first treatment had a cost-effectiveness ratio of $4,747 per success. The second and third treatments within the year cost $5,570 and $6,617 per success, respectively. The fourth and additional treatments had an incremental cost-effectiveness of $8,985. Although there was diminishing marginal cost-effectiveness, the decrease in effectiveness was mitigated by the lower cost resulting from shorter stay during the additional treatments.

Our results did not depend on the source of cost and staffing data used. We recalculated the incremental cost-effectiveness ratios using our alternative, survey-based estimates of staffing intensity and cost and found that the incremental cost-effectiveness of a 28-day stay compared to a 21-day stay was $20,842 per treatment success (about 21 percent less than when the ratio is calculated using parameters estimated with the cost report data). The incremental cost-effectiveness of a smaller size program was $13,416 per treatment success (about 23 percent more than the ratios based on the cost report data).

DISCUSSION

The results from this study suggest that programs with the highest ratio of staff to patients could decrease this ratio, cutting the costs per treatment without compromising treatment effectiveness. The data in this study do not reveal the optimal staffing level, nor the optimal mix of different types of staff.

It is possible that intensively staffed programs treat patients who are sicker according to measures of case mix that were not available to us. This seems unlikely, however, because we found no correlation between staffing intensity and the available measures of patient severity.

Assessments of family and friends was also found to be a cost-effective treatment strategy. It is possible that these assessments had no actual effect and that this variable merely reflected the social support available to the patient.

We found that inpatient treatments that are longer than 21 days have a high incremental cost-effectiveness ratio. A policy limiting intended length of stay to a maximum of 21 days would affect 57 of the 98 programs we studied. It would reduce the amount of treatment provided by 153,556 days, resulting in 712 fewer treatment successes and saving $18.9 million. This is a conservative estimate of the cost savings that would result. Additional savings would be realized by a reduction in the length of readmission treatments. Although readmission costs would increase due to the return of these 712 patients, the cost of their treatment would be more than offset by the reduced length of stay of all other readmitted patients.

If the $18.9 million cost savings were used to provide inpatient treatments to different patients, with an intended stay of 21 days, 3,774 treatment successes could be achieved. On balance, this change would increase program effectiveness with no increase in cost, a strongly dominant strategy.

Cost could be reduced by consolidating small treatment programs, with some loss in effectiveness. This observation must be tempered by concern that program consolidation would increase the distance that patients would need to travel to enter a program, diminishing access to treatment.

This study uses readmission to inpatient treatment as its measure of outcome. A direct measure of subjects' use of chemical substances would have been a far better measure, but this information was not available. Readmission is only a proxy for what we care about, but it is a measure that we believe to be highly correlated with this outcome. Readmission is itself an endpoint of interest. Readmission to the hospital is costly, accounting for more than 25 percent of the cost of VA inpatient programs.

Managed care has reduced the number of admissions and the length of stay for the treatment of substance abuse and other psychiatric disorders (Mechanic, Schlesinger, and McAlpine 1995). Additional study is needed to better understand what constitutes cost-effective treatment of these conditions. Future research will need to identify the optimal length of inpatient stay, the relative cost-effectiveness of inpatient and outpatient treatment programs, and whether the strategy of matching patients to treatment is more cost-effective.

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