COST-BENEFIT ANALYSIS OF NARCOTIC ADDICTION TREATMENT PROGRAMS with Special Reference to Age

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Introduction

Efforts to deal with consequences of poverty, race, and other social problems have resulted in a proliferation of treatment and rehabilitation programs for criminals, addicts, and the mentally ill. These have included skills training, professional and nonprofessional psychotherapy, drug therapy, and incarceration and surveillance. Many such efforts are experimental or pilot projects. To date there has been little in the way of systematic efforts to evaluate, either publicly or privately, the success of these programs.

The amount of information in the public domain is growing, and public agencies providing funds are beginning to insist that evaluations take place. To attain comparability among such evaluations requires agreement on methodologies of general applicability. A "simplified" methodology which permits comparisons among divergent addiction rehabilitation and treatment methods is developed and illustrated here. It is believed that the techniques have applicability to many other programs.

A critical feature of rehabilitation efforts is that they tend to deal with very different groups. We would like to have cost-benefit information for each treatment applied to each population type. In lieu of this, we find it necessary to assume each treatment to be most appropriate to a particular population type. We examine costs and benefits for each group and then adjust for differences between groups in ease of treatment and in the value of benefits from successful treatment. In a related approach, the efficient choice of client group for a given program is considered.

There has been great concern over the growth in the drug problem among youth and its far-reaching implications for institutions such as schools and the military. There has been great concern over the lack of a consensus on any treatment method to effectively deal with the young. At the same time, there has been a proliferation of treatment programs attempting to deal with the young which require assessment. These efforts are critically bound up with discovery of the basic causes of addiction. Rather than develop a more general methodology for comparing programs dealing with divergent population groups, we focus here on the role of age in the success in treatment programs.

The Underlying Cost-Benefit Model

The benefit to society of having one less addict[2] depends on the number of years that an addict would have remained addicted without assistance. Because of a finite life expectancy and the possibility that many persons "mature out" of addiction as they grow older, the number of years of addiction remaining is greater for younger addicts. The number of remaining years of addiction is represented by ℓ.

The benefits of a reduction of a man-year of addiction (b_{ij}) are represented as a function of age (i) as well as the number of years (j) of addiction remaining.[3] Future benefits are discounted by an appropriate rate (r). The full expression for the benefits of $N = \sum_{i}^{a} N_i$ persons withdrawing from addiction is given by summarizing over individuals with different ages and numbers of years of addiction remaining:

$$B = \sum_{i=1}^{a} \sum_{j=1}^{\ell} \frac{N_{ij}\, \ell_j\, b_{ij}}{(1+r)^j} . \quad (1)$$

Equation 1 can be greatly simplified. First, we assume that the number of years of addiction remaining is solely a function of age. Therefore we can write

$$B = \sum_{j=1}^{\ell} \frac{N_j\, \ell_j\, b_j}{(1+r)^j} . \quad (2)$$

Now we examine the assumptions implicitly required to use simpler measures of success than the full expression in Equation 2. Most studies ignore differences among age groups in benefits per addict successfully treated. The effectiveness measure becomes

$$E = \sum_{j=1}^{\ell} \frac{N_j\, \ell_j}{(1+r)^j} , \quad (3)$$

where $B = bE$. The most commonly used measure of success is the proportion (σ) of persons admitted to treatment (A) who successfully withdraw. The reduction in the number of addicts is $N = A\sigma$. If we compared different programs treating the same types of people, b_1 would equal b_2 and ℓ_1 would equal ℓ_2, so that the probability of successful withdrawal would be sufficient to gauge success. Otherwise, use of this measure is equivalent to assumming that

$$\sum_{j=1}^{\ell} \frac{\ell_j}{(1+r)^j} = 1 \quad (4)$$

as well as ignoring age differences in benefits per man-year averted. It gauges success by the number of addicts successfully withdrawing without regard to length of time they would have been addicted. In doing so, it overemphasizes very immediate gains.

Reducing the average number of addicts over a number of years requires measuring success by the number of man-years of addiction averted, or $M = N \ell$. This can be derived from Equation 3 as

$$M = \sum_{j=1}^{\ell} N_j \quad \ell_j \qquad (5)$$

where $r = o$ and $B = b\ M$. This measure is particularly simple to use. However, it overemphasizes benefits which are deferred in time. If we wish to take into account that we value benefits today more than those which will not be received for many years, it is necessary to discount future benefits by an appropriate discount rate (r). The measure which does this is the discounted number of man-years of addiction averted, designated as E as defined in Equation 3.

Next we consider cost effectiveness. Where ℓ is used, a discounted ℓ could easily be substituted. Let individuals going through a program either be treated successfully at a cost c_s or unsuccessfully at a cost c_u. The average cost (c_t) of treating an addict in a program having a proportion successfully treated of σ is

$$c_t = \sigma\ c_s + (1-\sigma)\ c_u\ .^5 \qquad (6)$$

The cost of treating A addicts is $A\ c_t$, so that the cost per successfully treated is

$\frac{A\ c_t}{\sigma\ A} = \frac{c_t}{\sigma}$. Designating the cost per successfully treated addict as c,

$$c = c_s + \left(\frac{1-\sigma}{\sigma}\right) c_u\ . \qquad (7)$$

As the proportion successfully treated increases, cost per success falls because the costs of relatively fewer unsuccessful cases are included.

The ratio of costs of addicts admitted to treatment to man-years of addiction averted (cost-effectiveness ratio) is

$$\frac{c_t\ A}{M} = \frac{\sigma\ c_s + (1-\sigma)\ c_u}{\sigma\ \ell}\ . \qquad (8)$$

Assume that programs with a larger ℓ have a lower σ. If across programs σ is proportional to ℓ, the ratio of the cost-effectiveness ratios is the same as the ratio of the costs per person treated. If σ varies more than ℓ, the costs per person treated would have to be lower in the programs with the higher ℓ for them to compare favorably with the others. If c_u is small relative to c_s or σ is large

$$\frac{c_t\ A}{M} \simeq \frac{c_s}{\ell}\ . \qquad (9)$$

Empirical Evidence on Age Differences

We have examined the evidence on differences among age groups in the benefits of successful treatment and the chances for successful treatment. The analysis indicates (a) that differences in the prevalence of opiate use among age groups reflects some sort of maturation (and/or mortality) since without maturation they imply implausible patterns in the number of users over time, (b) derives the average number of years of addiction remaining by ethnic group based on age patterns under alternative assumptions about past rates of growth of addiction, and (c) compares the higher retention rates of the New York City Methadone Program for the youngest addicts with the lower derived maturation rates and suggests that the young may do the same or worse if "natural" maturation accounts for part of the dropping out of older persons. (This material is available upon request.)

A Cursory Look at Major Programs

Virtually any program will pay in terms of benefits to the nonaddict population. Even if we incarcerate persons at a cost of over $8,000 per year for several years, if crime of $10,000 to $20,000 per person per year is averted,[6] the program can be justified. However, this calculation does not consider that, even with a high payoff, funds for addiction services may be limited, and it does not take into account the undesirability of involuntary incarceration. While it may be clear that the payoff to addiction programs in general is very high, there is still a major issue as to what proportion of the addict population can be dealt with by each approach.

As of the end of 1969, there were about 11,000 New York City addicts in treatment programs. In addition, there were about 5,000 in pretrial detention[7] and others serving prison terms or on parole. Nearly all treatment funding comes from the New York State Narcotic Addiction Control Commission which has a current operating budget of $38 million per year and a $200 million capital construction program. The three

largest programs for the treatment of drug addicts in New York City are the program of the New York State Narcotic Addiction Control Commission, the Methadone Maintenance Program, and the Phoenix House Program of New York City's Addiction Services Agency.

The State program combines voluntary or involuntary incarceration with therapeutic and rehabilitation services for up to five years, followed by an aftercare phase involving surveillance. The program, depending strongly on court and parental coercion, has suffered abscondance rates of over one-third per year and high rates of recidivism. However, it has been successful in moving persons from an institutional setting into aftercare. Furthermore, it is the only one of the three largest programs to have given primary attention to younger addicts. One-third of the persons in the program are under age 20 and two-thirds are under age 25. The availability of rehabilitation services under the program appears to be increasing. At the end of 1969 there were 5,000 addicts in the program, with a large expansion planned as new facilities being constructed become available.

The Methadone Program uses the drug Methadone, itself addicting but providing no "high," to block the effects of opiates. After a few weeks of withdrawal, the drug is administered orally on an outpatient basis for an indefinite period of time. There are about 2,000 addicts currently under treatment, and a doubling of efforts is under way. This program tends to concentrate on older addicts as indicated by comparisons with the Narcotics Register for September 1969:

	Methadone Program	Narcotics Register
Less than 25	10%	33%
25 - 34	51	41
35 and over	39	16

The Methadone Program is the only one of the three to make public regular evaluation reports. The evidence of high retention rates, improvement in employment experiences, and reduced criminality have led to a belief that this is the most effective method currently available.

The Phoenix House program relies on encounter techniques involving confrontation of addicts with each other and with ex-addicts. After two years of institutionalization, a process of gradual re-entry into the community begins. Phoenix House has generally served about a thousand persons, but only a small fraction have re-entered the community through the program.

Scant information is available with which to compare the effectiveness of major program alternatives, even using a simplified framework devised to minimize data requirements.

The Methadone program reported about a .7 success rate for persons on drug maintenance for 36 months. Lack of success in that program reflects both voluntary and involuntary termination stemming from factors such as criminal behavior and alcoholism.

The State program reported that after its first 21 months of operation, 44 percent of the 1,893 persons returned to the community had not resumed drug use. Thirty percent were returned to a rehabilitation center after it was discovered that they were reusing narcotics, and 26 percent could no longer be located (warrants were issued against them).[8] In view of the fact that the program had only 188 persons on aftercare after its first year and 836 after 21 months, the average length of time in the community would have to have been substantially less than one year. In view of the short time, the program's experience is discouraging.

A study of a roughly similar program, that of the California Rehabilitation Center at Corona, found that 35 percent were in good standing (or had been removed from the program while in good standing) one year after release. After three years the figure had fallen 19 percent.[9] There is nothing in the experience of the New York State program to date to indicate it is doing any better than this.

If we take seriously the public mandate to prepare addicts for entry into the community, the fact that only a handful of Phoenix House residents have actually done so after their period of institutionalization must be treated as if the proportion dealt with successfully is negligible. This program could only be considered successful if society were willing to place a high value on withdrawal in a setting of permanent institutionalization.

We are now in a position to compare programs on the assumption that they continue to treat the same types of people as they now treat with the same degree of success. If we compare the benefits of the Methadone program designated by subscript 1 relative to the State program designated by subscript 2, we have

$$\frac{B_1}{B_2} = \frac{b_1}{b_2} \cdot \frac{\sigma_1}{\sigma_2} \cdot \frac{\ell_1}{\ell_2} \cdot \qquad (10)$$

The number of persons admitted to each program is assumed to be the same. Assuming the California experience to be applicable to New York State, $\frac{\sigma_1}{\sigma_2}$ equals about .7/.2 or 3 1/2.

The mean ages and corresponding years of addiction remaining for the three major programs are as follows:

	Age	Approximate Years Remaining
Narcotic Addiction Commission	25	13
Addiction Services Agency	27	11
Methadone Maintenance	32	8

The age distribution of the Methadone program implies that the cost of the program must be about 2/3 of the others to compensate for the difference in years of addiction remaining, if all had equally high success rates. If the years of addiction remaining were discounted, this difference would be modified somewhat. The value to society of treating the kinds of persons treated by the State program may be higher than those treated with Methadone. There is some evidence that older addicts commit fewer crimes. Younger addicts can be expected to remain on drugs longer, with greater adverse effects on health.. Furthermore, treatment of younger addicts may have greater benefits of preventing other persons from being induced to use drugs. However, there would have to be a ratio of b_1 to b_2 as low as about 3/7 in order for the State program to have equally large benefits.

When one considers costs, the problem of program choice becomes more difficult. In the past, the State program required over $8,000 in operating costs alone per man-year of incarceration, and currently employs nearly one person for every addict in residential or aftercare activities. Completion of the program probably requires an average of about $15,000 per person. For a comparable cost, the Methadone program could provide detoxification and drug maintenance for more than a decade. After that time, it may be possible for maturation effects to be substituted for drug maintenance.

While there may not be a large difference between the State and the Methadone programs in the cost per completed program, those programs within the lowest proportion of persons treated successfully will tend to have the lowest cost per person admitted to treatment. This occurs because the cost per person treated (c_t) is an average of the cost per person treated successfully (c_s) and the cost of persons who do not successfully complete the program, some of whom have partial treatment (c_u). (See Equation 6.)

Higher costs per person admitted to treatment in a more successful program will tend to offset part of the gains from a more successful treatment. The later stages in treatment at which persons drop out the larger will c_u be relative to c_s, and the less the cost per person admitted to treatment will vary with the probability of success.

When the cost per admission is considered, the weight of evidence is probably still heavily in favor of Methadone, since in the State program there is probably only a modest difference in cost between those who successfully withdraw and those who do not. However, this bears closer scrutiny, since success may depend on the amount of rehabilitation provided and the State has been expanding the amount of real rehabilitation service provided. Furthermore, some deduction of welfare of the addict must be made for the involuntary nature of the State program and the dependence on Methadone.

On the surface, the Addiction Services Agency program is by far the cheapest, estimated by the agency to cost $7,500 for the entire 2 1/4 year process. While in theory it could have an added benefit beyond the time of maturation out of drug use because it is directed to improvement in many aspects of social adjustment, this does not occur without re-entry.10

Choice of Age Group within a Program

Selecting age groups for treatment so as to maximize the number of man-years of addiction averted is equivalent to minimizing the number of addicts. If the success of treatment were the same at each age, we would concentrate on the youngest addicts who have the greatest number of years of addiction remaining. On the other hand, if the number of years of addiction remaining were the same at each age and success of treatment were greater for older persons, we would concentrate on the oldest addicts. (We are defining success net of any normal maturation tendencies.) Here we consider the optimal age when variations in both years of addiction remaining and success of treatment are taken into account.

The number of man-years of addiction averted for a program is given by

$$M = A \sigma \ell . \qquad (11)$$

For simplicity, we assume that the average number of years of addiction remaining in a program can be represented as a proportion (p) of the difference between some fixed age (a*) and the average age (a) of persons being treated

$$\ell = p (a^* - a) . \qquad (12)$$

Thus if a* is age 40 and p = .6 , addicts age 20 would be expected to remain addicted for another 12 years on the average. Those who were still addicted at age 30 would be expected to remain addicted for another 6 years. We further assume that the rate of success in withdrawal from addiction can be represented by a linear function of age

$$\sigma = s + t a , \qquad (13)$$

where $t > 0$.

Combining these equations we have

$$M = A s p (a^*-a) + A t a p (a^*-a). \qquad (14)$$

Multiplying through and differentiating with respect to age

$$\frac{dM}{da} = A\,t\,a^*\,p - A\,s\,p - 2\,A\,t\,p\,a\,. \quad (15)$$

The second derivative is

$$\frac{d^2M}{d\,a^2} = -\,2\,A\,t\,p \quad (16)$$

which, since A, t and p are positive, is negative indicating a maximum. Setting the first derivative equal to zero and solving, we derive the optimal level of a

$$a = \frac{a^*}{2} - \frac{s}{2t}\,. \quad (17)$$

One inference that can be drawn from this result is that the effect of age differences in the success rate on the optimal age is important. If, for example, s were -.3 and t were .03, indicating a success rate of .4 at age 20, and .7 at age 30, the $-\frac{s}{2t}$ term would add five years to the optimal age. If s is positive, however, the optimal age is reduced. For example, if s = .2 and t = .02, indicating success of .6 at age 20 and .8 at age 30, the optimal age would be reduced by five years.

With the functional form we have chosen for ℓ, p does not enter into the result since it does not change the terms of trade between age groups. Unfortunately, we have little information with which to determine a*. Our curves of years of addiction remaining suggest that over the range of ages 22-32 the curves could be approximated by an a* at about 40, with different p's for each ethnic group.[11] In that age range, a figure of age 20 for $\frac{a^*}{2}$ would be valid. This is very approximate of course.

If $\frac{a^*}{2}$ were as high as 25 and a function such as $\sigma = -.3 + .03\,a$ were approximately correct, we would come out with an optimal age very close to the average age now being treated in the Methadone program. If, instead, as the program claims, success varies little with age so that a function such as $\sigma = .2 + .02\,t$ is appropriate, then to corroborate the ages now treated we would need an a* of around 70 which is completely impossible. Even if a* is as high as 50, $s \simeq .2$ and $t \simeq .02$, then the Methadone program should be concentrating on persons as much as 10 years younger than they are now, even though the proportion successfully withdrawing would be lower if it did. This would take into account the likelihood that addiction will be prevented for a larger number of years when the young withdraw, rather than relying on the more visible success rate alone.

Final Comments

The results of this analysis are illustrative and suggestive rather than definitive. They tend to support the efficacy of the Methadone program relative to the State program, if the goal is to minimize the number of addicts. However, they raise serious questions about the merits of the Methadone program's practice of treating a disproportionate number of older addicts. Combining information on the number of years of addiction remaining from successful withdrawal at each age with assumptions about success in achieving withdrawal at each age, suggests that it may be possible for the Methadone program to increase its impact on the number of addicts by the order of magnitude of at least one-fourth, with no additional expenditures, by shifting emphasis in treatment to younger groups.

Footnotes

1. Director of Research and Director of Health Planning, Office of Comprehensive Planning. The views expressed are those of the author and need not represent those of the City Planning Commission, the Community Renewal Program, or any of their affiliates or consultants. Beginnings on this study were made while at the Rand Corporation. The comments of Zili Amsel, Sidney Leveson and Clarence Teng were most helpful.

2. The term addict is used to imply users of hard drugs whether or not physiologically or psychologically addicted.

3. One study of addicts with a mean age 30.7 showed a mean age of most arrests of 22.8. See Bernard Greenfield, "The Riverside Study - Ten Years Later." Paper prepared for the New York City Department of Health, Health Research Training Program, Summer 1967.

4. If we make the assumption that the ratio of the benefits per man-year of addiction averted to the discount function is an inverse function of age

$$\frac{b_j}{(1+r)^j} = \frac{k}{a}\,,$$

then

$$B = \sum_{j=1}^{\ell} \frac{k}{a}\,\ell_j\,N_j$$

or

$$B = \frac{k}{a}\,M\,.$$

The benefits of reducing addiction are proportional to the number of man-years of addiction

averted and inversely related to the age of those assisted.

5. The model could easily be extended to allow for some positive benefit for nonsuccesses due to a period of withdrawal prior to recidivism.

6. See Irving Leveson, "Drug Addiction: Some Evidence on Prevention and Deterrence," paper presented at the meetings of the Econometric Society, Detroit, Michigan, December 1970 and John Holahan, The Economics of Drug Addiction in Washington, D.C.: A Model for Estimation of Costs and Benefits of Treatment and Rehabilitation, Report No. 33, District of Columbia Department of Corrections, October 1970.

7. Based on Bronx District Attorney Burton Robert's estimate that about four-tenths of the persons in detention are addicts.

8. New York State "Report of the Narcotic Addiction Control Commission for the First Twenty-One Month Period." The Commission did not release comparable figures in its second annual report. In the week of January 25-31, 1970, only 48 percent were known to be gainfully occupied.

9. John C. Kramer and Richard A. Bass, "Civil Commitment for Addicts: The California Program," Report of the Committee on Problems of Drug Dependency of the National Academy of Sciences and the National Research Council, 1968.

10. The program avoids constraints on the availability of professional manpower by using ex-addicts. However, retaining ex-addicts in the program delays the time they will have to re-enter the community. The adjustment process may be made more difficult in the future if large numbers of persons must be absorbed into the community in a relatively short period of time. If the ratio of the number of addicts to ex-addict employees is R, the rate of growth per two-year treatment period needed to retain S percent of persons treated as employees is S R. If the growth of the program were suddenly halted, $\frac{R}{1+R}$ of those in the program would be ending treatment and have to find jobs.

11. At older ages the slopes are smaller and a*'s higher.