

TUBERCULOSIS, AIDS, AND DEATH AMONG SUBSTANCE ABUSERS ON WELFARE IN NEW YORK CITY

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Abstract Background. In New York City, the incidence of tuberculosis has more than doubled during the past decade. We examined the incidence of tuberculosis and the acquired immunodeficiency syndrome (AIDS) and the rate of death from all causes in a very-high-risk group — indigent subjects who abuse drugs, alcohol, or both.

Methods. In 1984 we began to study prospectively a cohort of welfare applicants and recipients 18 to 64 years of age who abused drugs or alcohol. The incidence rates of tuberculosis, AIDS, and death for this group were ascertained through vital records and New York City's tuberculosis and AIDS registries.

Results. The cohort was followed for eight years. Of the 858 subjects, tuberculosis developed in 47 (5.5 percent), 84 (9.8 percent) were given a diagnosis of AIDS, and 183 (21.3 percent) died. The rates of incidence per 100,000 person-years were 744 for tuberculosis, 1323 for AIDS, and 2842 for death. In this group of welfare clients,

the rate of newly diagnosed tuberculosis was 14.8 times that of the age-matched general population of New York City; the rate of AIDS was 10.0 times as high; and the death rate was 5.2 times as high. There was no significant difference in the rate of new cases of tuberculosis between subjects with positive skin tests and those with negative skin tests at examination in 1984.

Conclusions. Among indigent alcohol and drug abusers in New York City, the rates of tuberculosis, AIDS, and death are extremely high. In this population, a single positive or negative skin test does not predict the development of tuberculosis, probably because both anergy and new infections are common. If programs to control tuberculosis and AIDS are to be effective in groups of indigent substance abusers, health services must be integrated into the welfare delivery system. (N Engl J Med 1996; 334:828-33.)

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THE incidence of tuberculosis rose sharply in New York City over the past decade. Contributing to this resurgence were human immunodeficiency virus (HIV) infection,¹⁻⁷ drug abuse,^{8,9} alcoholism,¹⁰ homelessness,¹¹⁻¹⁷ immigration,¹⁸ drug resistance,¹⁹ and reduced vigilance on the part of public health organizations because of reduced funding for the control of tuberculosis.^{11,20} Between 1978 and 1984, when this study began, the number of new cases of tuberculosis in the city increased gradually from a low of 1307. During the study period, 1984 through 1992, the number of cases per year more than doubled, from 1629 to 3811.²¹ There are no long-term prospective data from this period of resurgence in tuberculosis, and no studies have examined the incidence of tuberculosis among drug abusers, as compared with other high-risk groups such as indigent abusers of alcohol.

In 1984, a group of 970 welfare clients — both applicants and recipients — with a history of drug or alcohol abuse were carefully screened for tuberculosis during a routine, mandatory, two-part medical examination to assess their employability.¹⁰ Most of these people were applying for Home Relief, a category of welfare whose clients are mostly single, black men.

Our original cross-sectional study described the high prevalence of tuberculous infection and disease among substance abusers on welfare, especially those who abuse alcohol.¹⁰ The purpose of our follow-up study was to determine the incidence of tuberculosis, the acquired immunodeficiency syndrome (AIDS), and death among

welfare clients who abuse drugs, alcohol, or both, and to examine selected outcomes according to initial skin-test status, the type of substance abuse, race or ethnic group, sex, and age.

METHODS

Initial Enrollment

Welfare clients, from 18 to 64 years of age, who were given an examination to assess employability on 10 preselected days in the third quarter of 1984 were included in the original study if they had a history of alcoholism or drug abuse.¹⁰ Alcoholism was defined as an average daily consumption of 2 oz (59 ml) of ethyl alcohol — approximately three mixed drinks, four cans of beer, or a pint of wine — for at least one month, or inebriation at the time of the examination. Drug abuse was defined as the unprescribed use of any parenterally taken drug at any time or the daily use of cocaine or any orally or nasally administered narcotic for at least one month. Three groups of subjects were established: those who abused only alcohol, those who abused only drugs, and those who abused both drugs and alcohol. Excluded from the study were pregnant women, persons who had previously been vaccinated with bacille Calmette-Guérin, and persons known to have AIDS.

A history of a positive tuberculin skin test was defined as a history of a skin test with purified-protein-derivative tuberculin read as positive by a qualified health care worker; any tine test or Mantoux test, as read by the subject, with an estimated swelling equal to or larger than a quarter coin (25 mm); or vesiculation in response to any tuberculin skin test. A Mantoux test (Tubersol [Connaught] or Aplisol [new master lot, Parke-Davis]) was performed in persons who were not known to have had a previous positive skin test. At the time of initial enrollment, in 1984, tests for HIV were not commercially available.

Each client examined was scheduled to return for further workup in two to three days. Because acceptance into the welfare program was dependent on undergoing both parts of the examination, most clients (93 percent) returned as scheduled. At the second examination, the skin test was read by two physicians and was considered positive if there was induration of 10 mm or more, borderline if less than 10 but at least 5 mm, and negative if less than 5 mm 48 to 72 hours after the test. The test was deemed unreadable if the subject returned more than 72 hours after administration and the induration was less than 10 mm, and the reading was considered equivocal if the two physicians disagreed.

When possible, the names, addresses, Social Security numbers, and dates of birth of the original cohort were confirmed at the city's De-

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partment of Income Maintenance. Subjects in the original study were excluded from follow-up if their date of birth was unknown, if they had had active tuberculosis at the 1984 screening, or if in retrospect it was determined that they ought to have been given a diagnosis of AIDS before the 1984 screening.

The follow-up period began in 1984, with the original screening examinations, and it ended on December 31, 1992 — the day before the publication of the 1993 AIDS definition, which includes pulmonary tuberculosis as a possible criterion, became the official standard.²² The starting date of follow-up for all patients was selected as the midpoint of the 10-week screening period — September 1, 1984 — because, for the patients with AIDS, we could not use an individual subject's actual screening date or any other potential identifier.

Follow-up was performed through matching with registry records. The names, dates of birth, Social Security numbers, and addresses of the subjects were matched with those on file at New York City's tuberculosis registry and vital-records registry. Only the names and birth dates were used as identifiers at the AIDS registry. The final matches were considered highly probable by a computerized matching program and were confirmed by an investigator after a detailed review.

Because of the strict confidentiality required by the AIDS registry, we sent a limited data set to the Office of AIDS Surveillance. This information on study subjects was returned to us with additional information on patients given a diagnosis of AIDS, which included the month and year of the diagnosis of AIDS and death, if it occurred, and the matching status (i.e., exact or nearly exact) for the subject's last name, first name, and date of birth. The final compilation of deaths in the cohort was a combination of those identified by computerized matching at the Bureau of Vital Records, with the cause of death entered as an *International Classification of Diseases* code derived from the death certificate, and a small number of deaths (19) that were known only through the data from the AIDS registry. Data from death certificates were not used to identify a diagnosis of tuberculosis or AIDS.

Statistical Analysis

The data were entered and categorized with dBASE IV software. Chi-square tests for risk ratios, 95 percent confidence intervals, Taylor series, and P values — with the Yates correction if appropriate — were calculated with EpiInfo version 6.02. These calculations were based on the number of cases in relation to the number of person-years of follow-up. Adjusted risk ratios, with 95 percent confidence intervals, were derived by proportional-hazards modeling (with SAS 6.10 for Windows). In the outcome analyses, person-years accumulated until the outcome event occurred, the subject died, or the study period ended. The number of person-years calculated for incidence rates in the age-adjusted New York City population was taken from 1990 census data for persons 18 through 64 years of age.²³ The 95 percent confidence intervals for incidence rates per 100,000 person-years were calculated with the Poisson distribution.²⁴ Cumulative-incidence curves were derived with the actuarial method.²⁵

RESULTS

The 1984 Cross-Sectional Study

In the 1984 cross-sectional study, 970 of the 2641 welfare clients who were initially screened (36.7 percent) met the entry criteria. Among these 970 subjects, 40 percent of those who abused only alcohol had a positive tuberculin skin test, as compared with 23 percent of those who abused only drugs ($P<0.001$). The prevalence of active tuberculosis was also higher in those who abused only alcohol (1.5 percent) than in those who

abused only drugs (0.9 percent), although this difference was not statistically significant. Nine cases of active tuberculosis were originally reported¹⁰; an additional case, in an abuser of drugs only, was discovered later and added to the series.

Excluded Subjects and the Final Cohort

Subjects of the 1984 study who were excluded from follow-up included 100 whose birth dates were not known, 10 who had active tuberculosis at the 1984 screening, and 2 who were found to have had AIDS before the study began. The final cohort consisted of 858 persons, of whom 809 (94.3 percent) were in the Home Relief category of welfare. Of all drug abusers in the final cohort, 93.0 percent used intravenous drugs, 86.1 percent had either fresh or old injection marks, and 36.8 percent were found to have had illicit drugs in their urine in 1984.

Tuberculosis

Of the 858 subjects, 47 (5.5 percent) eventually had tuberculosis, an incidence of 744 cases per 100,000 person-years, and a rate 14.8 times that of the age-matched general population of New York City (Table 1 and Fig. 1).

There was no significant difference in the rate of development of tuberculosis according to whether subjects had a positive or negative skin test at examination in 1984 (619 and 706 cases per 100,000 person-years, respectively) (Table 2). There was no difference even if subjects were stratified according to type of substance abuse, race or ethnic group, sex, age, or referral for chemoprophylaxis. The results were not affected by inclusion of the eight subjects with borderline skin tests — in none of whom tuberculosis developed — in the positive-skin-test group. There were 15 cases of coincident tuberculosis and AIDS (1.7 percent), representing 17.9

Table 1. Rates of Tuberculosis, AIDS, and Death in the Study Group and the General Population of New York City.*

OUTCOME	CASES	CASES/100,000 PERSON-YEARS	RISK RATIO (95% CI)	P VALUE
	no. (%)	no. (95% CI)		
Tuberculosis				
Study	47 (5.5)	744 (546–989)	14.8 (11.1–19.7)	<0.001
New York City yearly average†	2,346	50		
AIDS				
Study	84 (9.8)	1323 (1055–1638)	10.0 (8.1–12.4)	<0.001
New York City yearly average‡	6,182	132		
Death				
Study	183 (21.3)	2842 (2445–3285)	5.2 (4.5–6.0)	<0.001
New York City yearly average§	25,544	547		

*The total number of person-years (4,669,486) for New York City was taken from the 1990 U.S. Census, for persons 18 through 64 years of age. CI denotes confidence interval. The risk ratios in this table do not reflect direct comparisons with a control group followed longitudinally.

†The average yearly number of tuberculosis cases was calculated by multiplying the percentage of cases in persons 18 through 64 years of age in 1992 by the average number of cases per year from September 1, 1984, through 1992.

‡The average yearly age-adjusted number of AIDS cases for September 1, 1984, through 1992 was calculated directly at the Office of AIDS Surveillance.

§The average yearly number of deaths was calculated by multiplying the percentage of deaths in persons 18 through 64 years of age in 1990 by the average number of deaths per year for September 1, 1984 through 1992²⁵ (and Office of Vital Statistics and Epidemiology, unpublished data for 1991 and 1992).

Table 2. Rates of AIDS, Death, and Tuberculosis and Risk Ratios for Tuberculosis According to Selected Characteristics.*

CHARACTERISTIC	No. OF SUBJECTS	AIDS	DEATH	TUBERCULOSIS	CASES OF TUBERCULOSIS/100,000 PERSON-YEARS (95% CI)	CRUDE RR OF TUBERCULOSIS (95% CI)	P VALUE	ADJUSTED RR OF TUBERCULOSIS (95% CI)	P VALUE
Skin-test status									
Negative on examination†	481	54 (11.2)	105 (21.8)	25 (5.2)	706 (457–1042)	1.0		1.0	
Positive on examination‡	196	8 (4.1)	35 (17.9)	9 (4.6)	619 (283–1175)	0.9 (0.4–1.9)	0.7	1.1 (0.5–2.5)	NS
Positive by history only	80§	11 (13.8)	22 (27.5)	9 (11.3)	1585 (725–3008)	2.2 (1.1–4.8)	0.03	2.4 (1.1–5.1)	0.03
Equivocal on examination¶	36	4 (11.1)	7 (19.4)	3 (8.3)	1086 (224–3177)	1.5 (0.5–5.1)	0.7	1.9 (0.6–6.5)	NS
Substance abused									
Alcohol only†	347	11 (3.2)	64 (18.4)	12 (3.5)	464 (240–811)	1.0		1.0	
Drugs only	289	41 (14.2)	59 (20.4)	21 (7.3)	982 (608–1501)	2.1 (1.0–4.3)	0.03	2.1 (1.0–4.4)	0.04
Drugs and alcohol	222	32 (14.4)	60 (27.0)	14 (6.3)	876 (479–1470)	1.9 (0.9–4.1)	0.1	1.8 (0.8–3.9)	NS
Race or ethnic group 									
White†	89	8 (9.0)	16 (18.0)	3 (3.4)	444 (92–1297)	1.0		1.0	
Hispanic	297	28 (9.4)	55 (18.5)	9 (3.0)	399 (183–758)	0.9 (0.2–3.3)	0.9	0.9 (0.2–3.2)	NS
Black	468	48 (10.3)	111 (23.7)	35 (7.5)	1043 (726–1450)	2.4 (0.7–7.6)	0.2	2.3 (0.7–7.4)	NS
Sex									
Female†	158	15 (9.5)	38 (24.1)	7 (4.4)	609 (245–1254)	1.0			
Male	700	69 (9.9)	145 (20.7)	40 (5.7)	774 (553–1053)	1.3 (0.6–2.8)	0.6		
Age in 1984 (yr)									
18–24†	61	3 (4.9)	5 (8.2)	2 (3.3)	412 (50–1487)	1.0			
25–34	363	46 (12.7)	68 (18.7)	24 (6.6)	882 (565–1313)	2.1 (0.5–9.0)	0.4		
35–44	247	25 (10.1)	59 (23.9)	17 (6.9)	958 (558–1533)	2.3 (0.5–10.0)	0.4		
45–54	143	9 (6.3)	40 (28.0)	2 (1.4)	194 (24–702)	0.5 (0.1–3.3)	0.8		
55–64	44	1 (2.3)	11 (25.0)	2 (4.5)	642 (78–2323)	1.6 (0.2–11.0)	0.95		

*RR denotes risk ratio, CI confidence interval, and NS not significant.

†Reference category.

‡Seven of these subjects reported a history of old tuberculosis after their skin tests were read as positive. Tuberculosis developed again in one of the seven.

§Eighteen of these patients had a history of tuberculosis; tuberculosis developed again in 3 of the 18.

¶This category includes 8 subjects with borderline readings (induration <10 mm and ≥5 mm), in none of whom tuberculosis developed, and 28 subjects with equivocal readings, in 3 of whom tuberculosis developed. There were 65 patients, not included here, whose skin-test status was unknown; tuberculosis developed in 1 of them.

||There were also four Asian subjects, all male. One died, and none had tuberculosis or AIDS.

percent of the 84 AIDS cases and 31.9 percent of the 47 cases of tuberculosis; of these, 8 occurred in the 481 subjects with negative skin tests (1.7 percent).

All subgroups in the cohort were at increased risk for tuberculosis, but persons who abused only drugs or had a history of a positive skin test were at significantly higher risk than persons in other subgroups (Table 2). The risk for persons with a history of a positive skin test remained high even when those with a history of "old" tuberculosis were excluded.

Of the 25 subjects with a history of old tuberculosis, tuberculosis developed again in 4 and AIDS was diagnosed in 2; none had both diseases. Of the 107 subjects for whom prophylaxis against tuberculosis was recommended in 1984, tuberculosis developed in 8 (7.5 percent); however, we do not know whether they actually began or completed prophylactic therapy. Of the 27 patients who were tested for drug susceptibility, 2 were found to have isolates with resistance to both isoniazid and rifampin.

There was 1 case of tuberculosis among the 66 persons in methadone-maintenance programs in 1984 (1.5 percent) and 8 cases among the 129 persons who, in 1984, had a history of recent incarceration (6.2 percent). Only 1 of the 36 persons who used nonparenteral drugs had tuberculosis during follow-up (2.8 percent).

Of the 47 subjects who had active tuberculosis,

7 (14.9 percent) completed therapy within 12 months; 9 (19.1 percent) completed therapy in more than 12 months; 16 (34.0 percent) died during therapy; 13 (27.7 percent) were lost to follow-up; and 2 (4.3 percent) refused therapy.

AIDS

AIDS developed in 84 of the 858 subjects (9.8 percent), an incidence rate of 1323 cases per 100,000 person-years, 10.0 times that of the age-matched general population of the city (Table 1 and Fig. 1). The risk was greatest in those who abused only drugs (1907 cases per 100,000 person-years; adjusted risk ratio, 4.0; 95 percent confidence interval, 2.1 to 7.9) and in those who abused both drugs and alcohol (2012 cases per 100,000 person-years; adjusted risk ratio, 4.4; 95 percent confidence interval, 2.2 to 8.8). The risk was reduced in persons with a positive skin test for tuberculosis on examination (541 cases per 100,000 person-years; adjusted risk ratio, 0.5; 95 percent confidence interval, 0.2 to 0.99).

There also was a high incidence of AIDS — 422 cases per 100,000 person-years — in subjects who abused only alcohol.

Deaths

There were 183 deaths in the cohort during follow-up (21.3 percent) of the subjects, a rate of 2842 deaths per

100,000 person-years, 5.2 times that of the age-matched general population (Table 1 and Fig. 1). The causes of death are listed in Table 3. The adjusted risk of death for persons in the oldest age category was more than five times that of persons in the youngest. Abusers of both drugs and alcohol were at significantly higher risk of dying (adjusted risk ratio, 1.7; 95 percent confidence interval, 1.2 to 2.5); persons with a positive skin test on examination were at significantly lower risk (adjusted risk ratio, 0.6; 95 percent confidence interval, 0.4 to 0.9). Of the 47 subjects with tuberculosis, 21 (44.7 percent) died before the end of 1992; 12 (57.1 percent) of those who died also had AIDS. Of 15 persons with both tuberculosis and AIDS, 12 (80.0 percent) died before the end of 1992 and 8 died before completing antituberculous therapy. Of the 84 study subjects with AIDS, 68 (81.0 percent) died before the end of 1992.

DISCUSSION

We found that the rates of tuberculosis, AIDS, and death were much higher in this group of welfare clients who abused drugs and alcohol than in the age-matched general population of New York City. The rate of tuberculosis (744 per 100,000 person-years) was more than 4 times the average rate in developing countries and more than 70 times the rate in the United States as a whole.^{27,28} In our 1984 cross-sectional study, active tuberculosis was slightly more prevalent among those who abused only alcohol, as compared with the other study subgroups, and tuberculosis infection was much more prevalent. In the follow-up study, however, those who abused only drugs were more than twice as likely as those who abused only alcohol to have active tuberculosis.

The true incidence rates in this study would be even higher if a substantial number of persons moved out of the city before falling ill or dying. However, only a small proportion of welfare cases are closed each month with the status "whereabouts unknown,"²⁹ and there is no evidence to suggest that any large proportion of the study subjects actually left New York City.

Surprisingly, there was no difference in the rate of tuberculosis between persons with a positive tuberculin skin test on examination and those with a negative test on examination, even when the cohort was stratified into subgroups. This may be explained by the higher incidence of AIDS in the group with negative skin tests on examination and thus the possibility that there was a considerable number of anergic subjects who were infected with both HIV and *Mycobacterium tuberculosis* and therefore at higher risk of progression to tuberculosis.³

Furthermore, some subjects with an initially negative skin test may have been infected, or reinfected, after 1984 and thus were at higher risk for progression.³⁰ These findings may corroborate other recent evidence that there is a high level of new tuberculous infections in New York City³¹ and thus support current efforts to treat cases of active tuberculosis aggressively. Alternatively, if these subjects with negative skin tests in whom tuberculosis later developed were, in fact, already infected in 1984 but were anergic, these data may support one recent proposal — the use of isoniazid prophylaxis

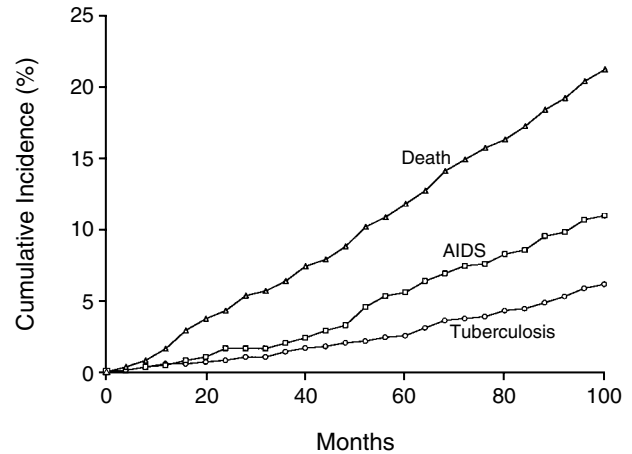


Figure 1. Cumulative Incidence of Tuberculosis, AIDS, and Death.

The definition of AIDS was revised and expanded on September 1, 1987 (month 36).²⁶

against tuberculosis in all HIV-positive intravenous-drug abusers, regardless of skin-test results, except in black women with negative skin tests.³²

In our study, persons with a history of a positive skin test before the 1984 assessment (who were therefore not retested) were at higher risk for the development of tuberculosis than persons with either a positive or a negative test at the 1984 examination. This may be explained by the higher incidence (13.8 percent) of AIDS in the group with a history of a positive skin test, reflecting a higher proportion of persons with HIV and

Table 3. Causes of Death in the Study Group.*

CAUSE OF DEATH	NO. OF SUBJECTS (%)	AVERAGE AGE AT DEATH (YR)
AIDS	66 (36.1)	40
Infectious diseases†	18 (9.8)	43
Cirrhosis	16 (8.7)	43
Tuberculosis	11 (6.0)	42
Coronary artery disease	10 (5.5)	47
Pneumonia (pathogen not specified)	9 (4.9)	42
Cancer	8 (4.4)	54
Overdose or ingestion of non-narcotic substance	8 (4.4)	42
Other heart disease	7 (3.8)	43
Drug dependence	4 (2.2)	37
Alcohol abuse	3 (1.6)	43
Cerebrovascular disease	3 (1.6)	47
Diabetes	3 (1.6)	53
Upper gastrointestinal bleeding	3 (1.6)	44
Wound	3 (1.6)	47
Chronic renal failure	2 (1.1)	59
Respiratory arrest	2 (1.1)	46
Other	7 (3.8)	48
Total	183	43

*Listings of tuberculosis or AIDS on death certificates did not correlate well with data in the tuberculosis and AIDS registries and were not considered reliable. For AIDS, data on causes of death are from death certificates (n=47) or the AIDS registry alone (n=19).

†Not including the others on this list.

tuberculous coinfection and thus a higher proportion of persons who were at risk for the development of active tuberculosis. However, we do not know how many of this group would have been anergic, if newly tested in 1984, and thus would have been included in the negative-skin-test group. Also, it is possible that some subjects who reported a history of a positive skin test actually had a history of earlier, incompletely treated tuberculosis.

AIDS occurred, as expected, predominantly in those who abused drugs, whether or not they also abused alcohol, and the rate of AIDS was significantly lower in persons with a positive skin test on examination. In this cohort, ironically, a positive skin test on examination indicated that a subject was less likely to have AIDS, less likely to die, and possibly less likely to have subsequent tuberculosis than a person infected with tuberculosis who was also anergic. The rate of AIDS was also high in those who abused only alcohol. However, we do not know whether these subjects later participated in other high-risk activities including the use of drugs. Alcohol abusers are at significant risk for HIV infection from heterosexual contact,^{33,34} and they may be subject to an accelerated progression of AIDS.^{35,36}

If we apply the rate of tuberculosis in those who abused only drugs (982 cases per 100,000 person-years) to the estimated 1984 population of 182,100 narcotics abusers, 18 years of age and older, in New York City,³⁷ this population could have accounted for 1788 cases of tuberculosis per year, or 66 percent of the total number of cases in the city from 1984 to 1992. If we apply the average yearly rate of AIDS, as calculated with the 1987 case definition, in those who abused only drugs (1907 cases per 100,000 person-years) to the same population of 182,100 narcotics abusers in the city, the result is an average of 3473 cases of AIDS per year during the 1984–1992 study period, or 55 percent of the total number of cases reported during that period in New York City. In fact, this figure approximates the actual proportion of patients with AIDS who were intravenous drug abusers, as recorded by the Office of AIDS Surveillance, during the years of the study: 48 percent (Office of AIDS Surveillance: unpublished data). Our estimate of the number of drug abusers in whom AIDS developed would have been much higher if AIDS had been defined according to the 1993 criteria.²²

The adult population on Home Relief in New York City increased from 140,000 in 1984 to more than 200,000 in 1994.^{29,38} Current attempts at welfare reform in the city have specifically targeted the Home Relief program and have led to a reduction in the number of recipients over the past year. Our data demonstrate the high rates of tuberculosis, AIDS, and death in this group and underscore the need to improve comprehensive health services for indigent, substance-abusing populations.

In our study, a population of welfare clients showed extremely high compliance (93 percent) with a two-part medical examination, under circumstances in which public assistance was contingent on completion of the ex-

amination. A similar, but expanded, incentive program could be part of a public policy to diagnose and treat tuberculous infection and disease. In a restructured welfare program, the provision of health services that include tuberculosis prevention and control, AIDS prevention, and the treatment of drug abuse and alcoholism could not only improve the health of welfare recipients, but also produce social and public health benefits accompanied by substantial cost savings.

We are indebted to Pauline Thomas, M.D., Dan Ruggiero, Yelena Shuster, M.S., Judith Roche, Frank Cascio, Pauline Alston, Philip Alcabes, Ph.D., Jeffrey McFarland, M.D., Kai H. Yang, M.D., James W. Biondi, M.D., Peter A. Selwyn, M.D., M.P.H., Jack Adler, M.D., Alje Vennema, M.D., Chandrakant Patel, Steven Matchett, M.D., Christine L. Roberts, M.P.H., Thomas J. Yang, Ph.D., D.V.M., Kenneth G. Castro, M.D., Patricia M. Simone, M.D., John Concato, M.D., and Raymond P. Daddazio, Ph.D.

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