

Delivery of Treatment for Tuberculosis

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Despite the high potential for cure with current anti-TB treatment regimens, actual achievement of such cure in practice is far less certain. The multidrug and long-term nature of current treatment make the attainment of cure an exercise in perseverance. As described in chapter 5, treatment in uncomplicated cases typically involves taking 3 to 4 different drugs together on a daily, twice-weekly, or thrice-weekly schedule continuously for 6 months or more¹.

Furthermore, some of the drugs cause unpleasant side effects or toxic reactions, so treatment also involves regular medical monitoring and substitution of different drugs, if necessary, in order to minimize adverse effects. Even though symptoms usually abate early in treatment and infectiousness may be quickly reduced, regular and complete administration of anti-TB drugs is necessary for eventual cure, prevention of relapse, and avoidance of drug-resistant disease. An adequate course of treatment for drug-sensitive TB is generally an arduous task, requiring a continual effort on the part of both patients and health care workers over a long, uninterrupted period of time.

In a broader sense, the achievement of cure with current treatment also depends on the quality and availability of local treatment services—Complete case reporting, rapid and accurate diagnosis, appropriate prescription and provision of treatment, sustained followup of each case, and education of health professionals and patients concerning the disease and its treatment. Although efforts combining all of these activities are needed to control the spread of TB, methods of treatment



¹In more complicated cases, such as those with resistance to two or more drugs, treatment involves taking at least 4 different drugs a day for 12 to 24 months, or even longer, in addition to more extensive medical care in a hospital or long-term care facility.

delivery and followup that foster close supervision and support of each patient are particularly important in the prevention and control of multidrug-resistant TB (MDR-TB).

Various social problems, such as hopelessness, substance abuse, and poverty, increase the difficulty of assuring that patients receive regular and continuous treatment for TB in many areas of the United States. For some patients, access to other health services and social assistance, such as treatment for substance abuse, provision of stable housing, or mental health services, may play a critical role in their ability to make use of available TB treatment services and to adjust to a long-term treatment schedule (83).

Patients with active TB who do not receive an adequate course of treatment face the prospect of a progressively deteriorating condition and a substantial risk of dying from the disease within a short period of time. Moreover, for the patient family, coworkers, and community, consequences of treatment failure include the risk of further spread of tuberculous infection to others, producing more cases of active TB and MDR-TB. Although drug-resistant tuberculous infection can be transmitted from person to person, virtually all strains of drug-resistant bacilli initially develop from erratic or inappropriate treatment in individuals with drug-susceptible TB. Furthermore, coinfection with the human immunodeficiency virus (HIV) shortens the time between tuberculous infection and active TB, further heightening the medical and public health significance of treatment failure.

Since the recent upturn in TB case rates, health officials have begun reexamining various strategies for improving the delivery of care for TB patients and for reducing the probability of treatment failure. Recent increases in MDR-TB cases, as in New York City (107), indicate that the inadequacy and ineffectiveness of current treatment delivery services are relevant issues for Federal and State policy makers to examine.

This chapter summarizes available data indicating the magnitude of the problem of treatment

failure, and then briefly reviews the literature concerning factors involved in treatment failure. The final section summarizes various types of treatment delivery strategies that have been proposed to augment current services.

MAGNITUDE OF THE PROBLEM

Outcome data based on samples of U.S. TB case reports suggest that approximately 75 percent of U.S. patients being treated for TB complete treatment within a 12-month period and that 80 percent take their medication on a continuous basis (136). These aggregate data are derived from annual program management reports submitted on a voluntary basis to the Centers for Disease Control and Prevention (CDC) by some State and local TB programs, separately from the mandatory "Report of a Verified Case of Tuberculosis" (RVCT) surveillance system (see chapter 3). Beginning in 1993, the RVCT system will be expanded to include reporting of data on treatment completion and outcome in individual cases (363).

Before 1985, these data were reported as the percentage of patients completing 12 continuous months of treatment within a 24-month period. Since 1985, the reporting criteria have been changed (reflecting the use of shorter treatment regimens) to completion of 6 continuous months of treatment within a 12-month period. Before this change in reporting criteria the average percentage of patients completing treatment rose steadily from 69 percent in 1970 to 89 percent in 1985 (333a). At the same time, the sample size increased from 24 reporting areas in 1970 to 79 areas in 1985. Whether a real increase in the average completion rate during this period occurred is not known. Increased ascertainment of data could account for the change. Since 1985, the average rate of completion has changed little, varying between 74 and 78 percent, while the number of reporting areas increased from 82 to 93 (333a).

As of 1991, 93 reporting areas (including States, counties, and cities) were included in this database, corresponding to about three-quarters of all cases reported that year. No information is available from the remaining one-quarter of cases not reported in this system; to the extent that areas with poor reporting capabilities may also have deficiencies in other TB control services, the reported data may underestimate the average U.S. rate of treatment failure. Even if the data were complete, however, a single national average rate of treatment completion reveals only limited information about the nature of the problem, because of the wide variation in completion rates among programs and regions. For example, in the late 1980s, cities such as Chicago, New York, and the District of Columbia reported completion rates ranging from 54 to 60 percent, while Dallas, San Francisco, and El Paso reported rates above 94 percent. Outcome data for patients in Los Angeles were not reported at all, and are not reflected in the national average data (31). The specific reasons for these differences have not yet been determined. According to the National TB Action Plan, CDC plans to evaluate and compare TB control programs with the highest and lowest rates of treatment completion rates, in order to identify aspects of service delivery that contribute to successful outcomes of treatment (363).

Additional information about the extent of the problem in different populations or regions is available from various published reports on groups of patients undergoing treatment for TB. For example, in a multicenter clinical trial conducted by the Public Health Service (PHS) in 22 TB clinics around the country enrolling a total of 1,451 patients, only 61 percent of patients on a 6-month regimen and 51 percent of patients on a 9-month regimen completed their treatment for TB. Patients participating in this trial were treated under actual program conditions in effect in their local area; in general, treatment was self-

administered (not directly supervised by program staff), although some incentives and educational interventions were offered (62).

In another paper, 80 TB patients treated between 1978 and 1982 in a hospital-based general outpatient clinic were compared with 104 patients treated between 1982 and 1987 in a hospital-based outpatient clinic specializing in TB treatment (385). The latter was designed specifically to improve followup of each case and maximize patients' abilities to stay on treatment.² In this setting, only 12 percent of patients completed treatment in the general outpatient clinic, whereas 86 percent of patients in the specialized clinic completed treatment.

The most widely cited report of treatment failure describes a group of 224 consecutive patients with TB admitted to Harlem Hospital in New York City during the first 9 months of 1988 (45). Of the 178 patients who were discharged while still on treatment, 89 percent were lost to followup service and did not complete their prescribed regimens. Forty-eight of these patients were later readmitted to the hospital with active TB; 40 were later discharged while still on treatment again; at least 35 of these patients were again lost to followup. Patients in this group who were homeless or alcoholic were significantly less likely than the other patients to complete treatment in the outpatient setting. Although the report states that patients discharged from the hospital were given an appointment for followup care at the hospital's chest clinic, no other details of their management at discharge or at that clinic were given.

At present, there are no national data on rates of cure, failure, or relapse among TB patients, since there has been no system for collecting and reporting such data to CDC. Some local programs may collect such data, but do not generally make the data available. Annual reports published by the New York City Department of Health and the

² For example, they used nurse specialists to follow each patients' progress, offering combination drug preparations, and provided money for public transportation to the clinic.

City of Chicago Department of Health, include detailed information on the epidemiology of TB in New York City and Chicago, respectively, but no data on outcome of treatment (56,57). As of 1993, CDC'S expanded RCVT system will reportedly include such data.

FACTORS INVOLVED IN TREATMENT OUTCOME

The medical and public health literature contains ample recognition of the difficulty of achieving successful outcomes in patients with TB using available long-term treatment regimens. Some experts noted the problem as early as the 1950s when outpatient treatment using anti-TB drugs first became available (105,266). Analysis of the underlying causes appears uneven, however, with greater emphasis on patients' behavioral and social characteristics and much less on factors relating to the delivery of treatment services (43,53,92, 124,3 17,326). The terms commonly used in the literature to refer to treatment failure—noncompliance or nonadherence—reflect a primary focus on the patient's willingness to follow treatment instructions, generally without specific consideration of whether such treatment is actually available, feasible, appropriate, or affordable. With a few recent exceptions, (cited below) there have been no critical assessments of TB control programs themselves regarding the provision of adequate resources, expertise, and coordination for effective treatment delivery available. Similarly, little systematic information exists on successful TB control programs responsible for high rates of treatment completion.

Nevertheless, greater examination of past experience with TB control and the broader service delivery issues will be needed to fully address the problem of how to reduce rates of TB in the future and, particularly, to avoid further generation of MDR-TB. The issue of treatment failure has immediate repercussions for patients with active TB and their communities. It is most likely to be the focus of future efforts to control the disease.

In particular, the ability of a program to effectively supervise treatment such as in directly observed treatment (DOT) may depend, in part, on the quality of its overall management and organization (46).

Because of inadequacies in the information base, it is not feasible in this chapter to review all the relevant issues regarding treatment failure in the same detail or to capture all of their important specifics. However, it is possible to make some preliminary comments about the nature of the problem and about potential causes of treatment failure, if only to provide a general framework for subsequent study. Discussed below are a number of overlapping and interrelated issues relevant to treatment outcome, grouped into the following general categories: availability and quality of TB control services; prescription of optimal treatment regimens; and personal behavioral characteristics influencing completion of treatment. The relative importance of each of the factors in the overall problem cannot be assessed at present with the available data.

Provision of TB Control Services

All States delegate overall responsibility for controlling the spread of TB and other communicable diseases to State and local health agencies, most of which, in turn, contract with local hospitals and clinics to provide TB services. Statutes enacted by State legislatures provide both mandatory and discretionary authorities concerning the conduct of TB control in each State. Although the specific terms of these authorities vary among States, common elements include the ability to order medical examination of individuals suspected of having active TB, to deliver treatment, and, if necessary, use a range of public health powers to impose such treatment or to detain and isolate infectious individuals. A recent analysis of State TB laws concluded that the majority of such statutes are antiquated and may be incompatible with current standards of constitutional law and public health. Such laws

include many of those concerning the way in which health officials determine whether an individual poses a significant risk to the public's health, whether the individual has a right to a fair hearing, and whether health officials should be required to try less restrictive measures before imposing more restrictive ones in order to impose compulsory treatment (124). In general, these statutes focus on specifying the circumstances in which health officials can compel an infectious individual to receive treatment, rather than specifying the public health requirements and objectives of a publicly funded TB control system.

There is little systematic information on how State and local programs have carried out their statutory authorities regarding TB control in recent years. Preliminary results of a recent CDC survey of TB control laws and regulations (conducted independently of the one cited above) indicate that State programs differ in basic approaches to TB control. CDC'S survey found variations in services designed to assure that patients are treated until cured and in services for monitoring treatment (such as hospital discharge planning) (336). CDC is currently drafting recommendations that States can use in improving their TB control laws and regulations, in an effort to enhance the quality and uniformity of TB control services across the country,

Although States have broad public health powers to order treatment and detention, if deemed necessary, for patients with active TB, they are not legally required to assure that patients are treated until cured. Communicable disease statutes generally limit the scope of that authority to the point of ensuring that patients are rendered noninfectious (which may well be temporary if treatment is not continued until completion) (9).

Nevertheless, completion of treatment is one of the primary goals of TB control, despite the absence of a specific legal responsibility for it. In practice, health departments and TB control programs are responsible for a variety of TB services (some of which are uniquely public

health activities), although not all programs provide all of these services listed below:

- surveillance (maintaining registries of clinical information concerning cases and suspected cases and conducting contact investigations to locate additional cases);
- containment (screening for tuberculous infection, diagnosis and treatment of active disease, and preventive treatment);
- purchasing supplies of anti-TB drugs;
- education (professional, public, and patient-oriented);
- laboratory services for diagnosis and drug susceptibility testing;
- medical consultation for primary care providers treating TB patients; and
- followup services (e.g., supervising treatment delivery, including rapid detection and response to evidence of treatment interruption or failure), and coordinating social assistance, substance abuse treatment, or housing services for patients (92).

It is widely held, though infrequently documented, that public health services in the United States have generally not kept pace with health problems in recent years, resulting in part from dwindling resources, lack of expertise, and outdated technologies (12,146). Similarly, serious problems in TB control programs have been noted, including a decline in public funding, lack of access to outpatient TB treatment services and supportive services (such as substance abuse treatment, social assistance, mental health care, and stable housing), and problems maintaining follow up of patients entreatment (45,46,83,90,240). In addition, numerous aspects of clinic management that present practical obstacles to care (such as long waiting times, an inhospitable environment for personal care, and lack of flexible service hours, etc.) have been discussed (92).

Thus far, the critiques reporting serious problems have focused on New York City's TB services; detailed accounts of such services else-

where are absent from the literature, even though similar types of problems are believed to exist in other areas, both urban and rural. CDC'S two recent major initiatives, the 1989 Strategic Plan for the Elimination of TB and the 1992 National Action Plan to Combat MDR-TB (see chapter 7) were aimed, in part, at correcting common deficiencies in State and local TB control services (in addition to refocusing and reinvigorating Federal involvement in TB control). The extent to which States have addressed the issues locally, by adopting their own plans to control TB and by supporting high-quality services, are not well documented.³

Medical Care Practices

Practicing physicians play a direct role in the outcome of treatment for TB patients in several ways, the most obvious of which is the prescription of an optimal regimen of anti-TB drugs. Related to this is the ability to diagnose the disease promptly and accurately, and to report and record susceptibility testing results. Patients' immunosuppression (due to HIV or other conditions) increase the practical difficulties physicians face in diagnosing TB (see chapter 5).

Closure of many of the specialized facilities for treating TB in the 1960s and 1970s has gradually shifted the job of TB diagnosis and treatment to primary care physicians, many of whom, even in high TB prevalence areas, are unaccustomed to seeing patients with active TB or MDR-TB. As a result, physicians may be less likely to suspect TB, to diagnose it quickly, and to prescribe the most efficacious treatment regimens (or to refer to others with greater expertise) (241). Practical limitations of confirmatory testing to verify the diagnosis may add to these difficulties (92). A critical mistake physicians can make is to add a single drug at a time to a failing regimen; patients treated this way have been found to develop drug

resistance sequentially to each additional agent (116,153,366).

A 1983 survey of patients who developed TB again after a course of treatment documented prescribing errors by physicians in the failure of previous treatment. The survey, including 800 patients reported as having recurrent TB disease in 23 health jurisdictions nationwide, found that many of the patients were prescribed inadequate or inappropriate treatment with regard to choice of drugs, dosage, and/or duration for their original episode of TB. In addition, the survey found physicians in private practice were more likely to make these mistakes than physicians in other types of practices (such as health departments) (173).

Additional data on the extent and nature of prescribing errors in TB treatment recently became available from a CDC-sponsored survey of 1,772 physicians in public and private practice, including both generalists and specialists (318). Using a mailed questionnaire, the survey was assigned to determine the extent of physician awareness of CDC and American Thoracic Society guidelines on recommended treatment regimens and the extent that physicians would prescribe efficacious treatment regimens as specified in those guidelines. preliminary results of the survey suggested that only about 58 percent of the physicians, when asked how they would treat a hypothetical patient with active TB, specified one of the recommended regimens. Specialists or those with fewer years in practice were more likely than generalists or those with more years in practice to describe a recommended regimen.

Another way in which physicians can influence the outcome of treatment is by assuming at least partial responsibility for ensuring that patients take the prescribed treatment continuously and completely (155,265,266). In certain areas, responsibility for monitoring patients on treatment is shared with, or completely delegated to, staff

³ Through State reports and funding applications, CDC collects some of this information, and reports it in its quarterly publication for public health departments, *TB Notes*, but has not published it for general review.)

from the local TB control program-nurse case managers or outreach workers (92). In other areas, there may be no standard procedure in place to follow patients' progress with treatment, a carry-over from the privatization of TB care that followed the closure of sanatoria and most specialized TB clinics in the 1960s and 1970s and their incorporation into general medical practice (153).

Patient Behavior

In cases where an optimal combination of anti-TB drugs is prescribed, available, and feasible for the patient to take for the entire period of time, success of treatment ultimately hinges on patients taking their medication according to schedule. In practice, this also requires that the patient regularly submit sputum samples (so that progress with treatment can be measured) and that the patient regularly picks up medication supplies and keeps to a schedule of appointments with the health care provider responsible for delivering and monitoring the treatment. Aside from the small proportion of patients who refuse treatment under any circumstances or who are mentally or psychologically unable to follow a course of treatment, the bulk of the available evidence suggests that most patients would complete treatment if it were feasible to do so or if encouraged to do so through progressively more stringent measures (43, 149), as allowed by law to protect the public health.

The medical literature pertaining to patients' willingness and ability to follow an entire course of TB treatment dates back to the 1950s, when it was noted that many hospitalized patients who were given their TB medication at the bedside still did not actually take it and that only about half of patients on outpatient treatment took their medication (266,269). Since then, the issue of patient noncompliance or nonadherence, as it is generally referred to, has been extensively reviewed, most notably over the years by Sbarbaro and in a recent comprehensive review by Sumar-

tojo (266,317). These and other reviews of the role of patient behavior in the success of TB treatment suggest that the relevant context for such behavior encompasses factors both within and beyond a patient's control.

In some cases, a variety of social, *economic*, and cultural factors, such as homelessness, substance abuse, financial barriers to medical care or general poverty in general, and unfamiliarity with or distrust of Western medical care, may be very relevant to patients' behavior toward TB treatment (95,263,317). In other cases, none of the above may apply. Etkind and colleagues cite examples of a physician at a local teaching hospital in Massachusetts who would not complete his own treatment regimen and of a working corporate executive who had active TB for 4 years and developed MDR-TB as a result of erratic drug-taking (94). One expert noted that the majority of newly diagnosed cases of TB occur among "just plain folks" i.e., individuals with no apparent social or behavioral characteristic(s) that would suggest that he or she is likely to take the medication emetically or not at all (149).

Not surprisingly, researchers have been unable to identify a set of patient characteristics that would permit reliable predictions of patients who will complete treatment with little or no encouragement and those who will fail treatment even with extraordinary amounts of assistance (317). To some extent, this naturally complex behavior may be difficult to simplify to a set of predictive traits. Given the nature of the treatment regimen, it may be reasonable to assume that many, if not most, patients could encounter difficulties staying the course, but that those with major problems, such as hopelessness or mental illness, would be more likely to fail treatment without special assistance or residential care (94,271). The most difficult practical issue in this regard concerns the majority of patients without such major problems whose behavior toward the treatment regimen cannot be reliably predicted.

AVAILABLE STRATEGIES FOR IMPROVING TREATMENT DELIVERY

As discussed above, the outcome of TB treatment may be determined by a number of interrelated factors concerning the organization and quality of services, the prescription of an optimal regimen, and the behavior of patients. Accordingly, strategies to improve the chances of cure following treatment may need to involve several types of changes in treatment delivery. Although these changes can be guided by Federal recommendations such as those developed by CDC'S Advisory Council for the Elimination of Tuberculosis), the actual decisions about the nature and extent of such changes in treatment delivery will be made by State and local health officials, based in part on available resources and expertise, social and cultural characteristics of the patient population, and available medical services.

Current methods of treatment delivery in the United States can be characterized as heterogeneous, encompassing self-administered (unsupervised) treatment, various degrees of supervision, and even involuntary commitment with compulsory treatment. During the past several decades, self-administered treatment has generally been the norm. Treatment is delivered in many different types of sites, including general outpatient clinics, chest clinics, correctional facilities, private medical practices, hospitals, and long-term care facilities (92).

A number of strategies for improving treatment delivery are currently being considered and debated among health officials, community groups, and policy makers. Many of these are already being used to some extent in some areas. These strategies include:

- greater use of combination medications, such as Rifamate™ (INH and RIF) or a three-drug combination, Rifater™ (INH, RIF, and PZA), which is expected to be commercially available in the United States in 1993.
- greater use of intermittent regimens, rather than daily regimens, which make direct observation of treatment feasible on a wider scale.
- greater use of DOT, either in a treatment facility or in the community, conducted by health care workers or outreach workers.
- greater attention to followup of each case, by public health nurses or outreach workers, involving planning for continuation of treatment and referral to other health and social services after patient discharge such as treatment for substance abuse, HIV treatment, stable housing, mental health services.
- use of incentives, as appropriate, including provision of money, bus tokens, food, or individually determined 'gifts' to encourage sustained participation in treatment.
- administrative changes in clinic operations, such as reduced waiting times, appointment reminders, followup of missed appointments, weekend hours.
- use of residential or long-term treatment facilities, as necessary.
- improved professional training for TB diagnosis and treatment.
- educational programs for patients and the community at large.

An adequate public health approach for improving the delivery of TB treatment would likely involve some or all of these strategies, and perhaps others as well, depending on local needs and conditions. In the long run, the ability of TB control programs to implement these strategies will depend on consistent funding provided by the State or Federal Government and the quality of each program's organization, management, and expertise. Inevitably in some areas, strategies designed to assist patients in completing TB treatment will also address problems such as acquired immunodeficiency virus (AIDS), substance abuse, homelessness, and mental illness.

A central issue in improving outcomes of TB treatment concerns the degree to which supervision by HCWS is necessary to bring about higher

rates of treatment completion. Much of the recent policy debate about TB control at national and local levels has focused on this issue. Although supervised treatment was recommended by experts long ago, and has been used extensively in other countries for many years, it has been used to only a limited extent in the United States (193,266,273). CDC estimated that in 1991, approximately 17 percent of TB patients (approximately 4,400) were receiving treatment under direct observation. Two-thirds of this was paid for by CDC cooperative agreement funds employing 213 outreach workers (370). In 1991, \$8.5 million was awarded through 46 TB cooperative agreements to 34 States, the District of Columbia, Puerto Rico, Guam, and nine major U.S. cities. In New York City, approximately 500 patients are currently receiving directly observed treatment regimens, and this number is expected to double by the end of 1993 (130). Only three States' statutes (Maine, Michigan, and Minnesota) explicitly provide for DOT as a routine service (124).

CDC defines DOT as observation of the patient by a health care provider or another responsible person (who has frequent contact with the patient, such as family members, social workers, or clergy) as the patient ingests anti-TB medications (366). Some programs limit DOT to health care facilities, which require that the patient visit the facility 2 or 3 times a week. In other areas, workers go out into the community, meeting patients at their residence or at another site (366). DOT can rarely be offered by private physicians without assistance from the local health department because private practices generally do not employ staff to perform this function (43). Although simple in concept, DOT is a labor-intensive effort in practice, requiring skill, diligence, and perseverance on the part of outreach workers (43,266). Furthermore, in some populations, its effectiveness may depend on the simultaneous use of other interventions, such as provision of methadone treatment and on the use of field workers familiar with the practical issues of

working with individuals with AIDS and those who use intravenous drugs (68).

Expert groups have recently recommended more widespread use of DOT for most patients with TB, particularly those with resistance to one or more of the first-line drugs (157,366). CDC recommended that all patients be considered for DOT, but that local decisions regarding the expanded use of DOT should be based on completion rates for each area. A report by the United Hospital Fund, which focused on TB control issues in New York City, went further by recommending mandatory DOT for all patients; this would remain in effect until there was convincing evidence mounted in each case showing treatment was longer needed (83).

Critics argue that requiring all patients' treatment be directly observed is "wasteful, inefficient, and gratuitously annoying" and "undercuts the legitimate desire to individualize treatment and to use the least restrictive and intrusive public health interventions" (9). Moreover, it is argued that other interventions, such as effective discharge planning and provision of stable housing, can also increase completion rates without DOT, although close followup of patients' progress would be needed to judge when DOT would become necessary (9). Others hold that universal, mandatory DOT would be a violation of individual liberty and would create undue burden on those who can complete treatment without it; accordingly, it is argued, DOT should be imposed only after an administrative or judicial hearing in each case to determine whether the patient has not taken treatment or is at high risk of taking treatment erratically or not at all (83).

Several programs have described high completion rates among patients treated under direct observation (92). In Denver, where DOT has been used for many years for patients on intermittent regimens, more than 90 percent of patients complete treatment (61). Even higher rates were reported in South Carolina, where the health department routinely uses a variety of strategies, including DOT (and even court-ordered DOT,

when necessary) (354). There are also several examples in the literature on programs in which patients who have previously failed treatment were successfully treated under direct observation (187,272). Recent data on results of DOT in Mississippi suggests that TB case rates leveled off and then, after DOT was expanded to include over 90 percent of cases on treatment, began to decline (139). Some populations may be difficult to reach even through DOT: a recent report cited data indicating that among individuals using crack cocaine, DOT alone was not particularly successful in increasing treatment completion rates (349).

While these descriptive studies suggest that DOT may work under certain circumstances and not in others, the effectiveness of DOT compared with other strategies or among broader populations has not yet been examined in prospective, controlled studies. The cost-effectiveness of DOT compared with other strategies is similarly unknown. Comparisons between the cost of treating a patient under DOT versus the cost of treating a patient with MDR-TB are not relevant for public policy discussions since not all patients treated without DOT develop MDR-TB and not all patients on DOT are assured of cure (157). A more complete assessment of costs and outcomes is needed to generate useful information.

In general, improvement in delivery of TB treatment will require the availability of several different treatment strategies that can be applied according to local needs and customs, levels of community involvement, and amounts of public health resources. As a public health strategy, unsupervised treatment appears to be an inadequate approach to control TB and to prevent MDR-TB, even though some patients may succeed without supervision. More active involvement by public health workers in each patient's course of treatment would appear necessary in many areas, along with improved educational efforts for physicians concerning the prescription of optimal TB treatment. The adoption of a comprehensive system of services and support may be a valuable objective for many programs. As described by Sumarjo, such a comprehensive system would include: teams of HCWS responsible for continuity of care, careful case management and followup, clinical TB services that are accessible and acceptable to patients, social assistance provided to patients who need it, and supervision of treatment (317). Ongoing evaluation of effectiveness of treatment will be needed to make judgments about long-term changes in the delivery of TB treatment.