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'Sputnik': a programmatic approach to improve tuberculosis treatment adherence and outcome among defaulters

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SUMMARY

SETTING: A novel patient-centered tuberculosis (TB) treatment delivery program, 'Sputnik', was introduced for patients at high risk of treatment default in Tomsk City, Russian Federation.

OBJECTIVE: To assess the effects of the Sputnik intervention on patient default rates.

DESIGN: We analyzed the characteristics of patients referred to the program, treatment adherence of Sputnik program enrollees before and during the intervention, and final outcomes for all patients referred to the Sputnik program.

RESULTS: For patients continuing their existing regimens after referral to the program (n = 46), mean adherence to treatment increased by 56% (from 52% of prescribed doses prior to enrolment to 81%). For patients initiating new regimens after referral (n = 5), mean adherence was 83%. Mean adherence for patients with multidrug-resistant TB (MDR-TB; n = 38) was 79% and for all others (n = 13) it was 89%. The cure rate was 71.1% for patients with MDR-TB, 60% for all others and 68% in the program overall.

CONCLUSION: The Sputnik intervention was successful in reducing rates of treatment default among patients at high risk for non-adherence.

KEY WORDS: treatment adherence; patient-centered; MDR-TB; Tomsk; Russia

TUBERCULOSIS (TB) remains one of the leading causes of adult mortality worldwide, with an estimated 9.2 million new cases and 1.7 million deaths annually.[1] Non-adherence to treatment is linked to prolonged infectiousness, mortality and amplification of resistance to anti-tuberculosis medications.[2–4] For patients with multidrug-resistant tuberculosis (MDR-TB, defined as resistance to both isoniazid and rifampin) and requiring up to 24 months of treatment with second-line drugs,[5,6] default rates range between 10% and 48%.[7–15]

In Russia, the collapse of the Soviet Union resulted in increased poverty and a breakdown in health and social services.[16,17] Infectious and non-communicable disease mortality increased markedly.[18–21] Prison- and civilian-based epidemics of TB—driven by a growing pool of vulnerable individuals, often poor and unemployed, faced with comorbidities (such as alcoholism, drug abuse, human immunodeficiency virus infection and mental illness) and residing in congregate settings—reversed more than 30 years of successful TB control.[22–24] Between 1991 and 2001, TB incidence in Russia increased from 34 to 88 per 100 000 population, while mortality climbed from 8.1 to 19.9/100 000.[25,26]

In the face of a growing epidemic of drug-resistant TB,[17,27,28] the western Siberian region of Tomsk Oblast (population in 2006: 1 036 000) expanded its DOTS program in 2000 to include the treatment of MDR-TB.* This integrated approach strengthened program capacity, resulting in a decreased default rate among new smear-positive TB patients to 2.9% in 2004 in the civilian sector.[29] However, as the civilian program expanded, the proportion of MDR-TB patients defaulting from treatment increased, from 12% in 2001 to almost 30% in 2004. We found that alcohol and drug abuse, history of incarceration, homelessness and urban residence were risk factors for non-adherence to TB treatment, consistent with reports from other projects in Russia.[30–32]

In the present study, we describe the impact of an intervention designed for this population based on models used to improve treatment adherence in other settings.[33–36]

*A joint program run by the Tomsk Oblast Tuberculosis Services, the Federal Penitentiary Service of the Ministry of Justice and the non-profit Partners In Health that included treatment of MDR-TB in prison and civilian sectors.

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METHODS

Setting

Between 1991 and 2006, the TB notification rate in the Tomsk civilian sector increased from 43.6 to 93.3/100 000 (unpublished data, Tomsk Oblast TB Services, 2010). In 2006, MDR-TB accounted for 16.9% of all new TB cases. The 'Sputnik' program was implemented as a joint program by the Tomsk Oblast Tuberculosis Services (TOTBS) and Partners In Health (PIH) in the Tomsk City metropolitan area (population: 526 000) in December 2006.

In-patient and ambulatory care for tuberculosis patients in metropolitan Tomsk

TB treatment is delivered in both in-patient and ambulatory settings. Patients with drug-susceptible and drug-resistant TB receive treatment according to international standards of care.[5,6] Treatment progress is assessed by monthly sputum and mycobacterial culture examinations and quarterly X-ray examinations. Patients receive regular clinical follow-up, including monitoring to detect and manage adverse events.[37] All anti-tuberculosis and ancillary medications are available free of charge.

The majority of smear-positive patients remain in hospital until smear-negative; socially disadvantaged individuals can remain for the duration of treatment. After discharge, patients are provided with transportation passes, daily food sets and monthly hygiene sets. Most patients receive ambulatory care at a day care hospital, the central TB polyclinic or at Red Cross treatment sites. Homeless patients can continue treatment at a local shelter with dedicated TB beds and trained personnel. Patients with mobility and adherence problems are treated by a 'hospital at home' team (one nurse, capacity = 50 patients/day, approximately 15% of all urban ambulatory patients). Patients have access to a substance abuse specialist, a psychologist and a social worker. The Tomsk TB polyclinic registers all cases, maintains a database and performs daily defaulter searches. Patients facing treatment difficulties, including non-adherence, are presented at weekly clinical committee meetings.*

Sputnik intervention

The aim of the intervention is to improve treatment adherence to 80% of prescribed doses among TB patients defaulting from the standard ambulatory program.[38] The following drug-susceptible and drug-resistant TB patients were eligible for referral to the program by the clinical committee: patients who refused to start treatment or stopped taking medications; those missing more than 25% of prescribed doses; those with a history of default in the previous 6 months; and those considered to be at high risk for default for other medical, social or economic reasons. Due to limited program capacity, patients are only referred to the Sputnik program after all standard options are exhausted.† Patients can be enrolled in the program at any point during their treatment if they are deemed to be at high risk of default.

Sputnik differs from the standard ambulatory care program in the following respects: 1) a high nurse-to-patient ratio (2:15), 2) more staff time per patient to facilitate bonding and defaulter searching, 3) provision of cellular telephones to nursing staff (which increases flexibility), and 4) easier access to specialists and expanded social and psychological support (e.g., clothing and assistance with procuring documentation required to access state social services). Emphasis is placed on care giving; in addition to clinical preparation, program nurses undergo training on how to care for patients facing myriad bio-social challenges.[39] Sputnik care providers accompany patients through treatment by remaining responsible for patients from the time of enrollment in the program until the end of treatment.

The program is staffed by a team of two nurses, guided by a physician and accompanied by a dedicated driver and vehicle. They provide a minimum of 25 patient visits/day, at the patient's convenience, over a 12-hour period. Medications are given under direct observation (twice daily for MDR-TB patients), 6 days/week. The supervising physician joins the team every 10 days for home visits, and performs regular clinical follow-up. The program receives administrative support from PIH coordinators who participate in weekly team meetings, perform biweekly visits, help arrange transportation, consultations and hospitalizations as needed, and provide regular feedback to staff.

Study design

We compared the characteristics of patients referred to the Sputnik program and those not referred to the program using 2×2 tables and χ^2 analysis. Our overall denominator included aggregate data from all Tomsk City metropolitan area patients receiving TB treatment between 17 December 2006 and 30 November 2008. We defined Sputnik patients as all patients referred by the clinical committee to the Sputnik program during that period. All other patients were designated as non-Sputnik patients.

To assess the impact of the Sputnik program, we performed the following analyses: 1) comparison of treatment adherence of Sputnik enrollees before and

*The default sub-committee of the clinical committee was established in the summer of 2005 to discuss all patients (drug-susceptible and drug-resistant) living in the region of Tomsk Oblast who were at risk of default.

†The Sputnik program was developed as an alternative to compulsory TB treatment, which is not currently available in Tomsk Oblast.

during the intervention, and 2) description of final treatment outcomes (based on intention to treat).

Data were entered into Microsoft Access 2007 (Microsoft Corporation, Seattle, WA, USA) and analyzed using Stata version 11 (StataCorp LP, College Station, TX USA). The study protocol was approved by the Siberian State Medical University (Tomsk, Russia) and Partners Health Care Human Research Committee at Brigham and Women's Hospital (Boston, MA, USA).

Patient characteristics

We collected the following data on Sputnik and non-Sputnik patients from the TOTBS database: age on 30 November 2007, sex, and key clinical and social variables at the beginning of treatment—employment status, homelessness, marital status, history of previous incarceration, history of previous TB treatment, sputum smear and culture results, drug susceptibility profiles, treatment regimen, comorbidities, including human immunodeficiency virus, hepatitis and diagnosis of chronic alcoholism and/or drug addiction by an addiction specialist (using International Classification of Diseases 10 criteria). A comparison of demographic and baseline clinical characteristics of patients referred to Sputnik was made with those who were not referred to the program. Proportions were compared using the χ^2 test or Fisher's exact test, as appropriate.

Adherence and outcomes

Information was abstracted from Sputnik registration forms using standardized tools: start and end dates of current treatment episode, dates of program enrolment and first contact with a Sputnik nurse, interventions to improve adherence before enrolment on Sputnik, hospitalizations while on Sputnik, outcomes of treatment, and social problems addressed by the program. A treatment episode was defined as time from start of current treatment until either the end of treatment or transfer out of the civilian service area. Time in the Sputnik program was calculated from the date patients received their first dose of medication under Sputnik supervision until the end of treatment or transfer out of the civilian service area.

Adherence data were obtained from treatment cards: doses taken, stopped due to adverse events or missed. Adherence was calculated as the proportion of doses taken over the total prescribed. For patients who started their current treatment episode elsewhere, adherence before enrolment was compared with adherence levels while enrolled in Sputnik. Change in mean yearly adherence was assessed by paired *t*-test.

Outcomes were assessed according to international consensus definitions of cure, failure and death.[40] Patients were considered to be defaulting if they missed all doses for 2 consecutive months during the designated treatment period. Patients who did not start treatment on Sputnik after referral were considered to be early defaulters.

RESULTS

Patient characteristics

Between 17 December 2006 and 30 November 2008, 1419 patients received TB treatment in Tomsk City; of these, 53 were referred to the Sputnik program while 1366 others received treatment from the standard program (Table 1). Younger age, unemployment, previous incarceration, chronic alcoholism, drug abuse, previous treatment for TB, previous default, smear and culture positivity at the start of treatment, and having MDR-TB were associated with referral to the Sputnik program, while homelessness was not.

Adherence and outcomes

Of the 53 patients referred to the Sputnik program, six (11.3%) were referred to begin a new treatment cycle. The other 47 (88.7%) patients were referred for continuation of their current treatment after already spending a median 188 days (interquartile range [IQR] 91–306) in other TB facilities. Among these latter 47 patients, 15 had not taken any medicines for at least 4 consecutive weeks. All 53 patients had participated in at least one intervention to improve adherence before referral: 32 (60.4%) had received treatment from the 'hospital at home' team, 29 (54.7%) had consulted a substance abuse disorder specialist, 28 (52.8%) had consulted a psychologist, 11 (20.8%) had been visited by police authorities to discuss the consequences of non-adherence and three (5.7%) had been issued a court order for compulsory treatment (for which no mechanism currently exists in Tomsk). Two patients were homeless, six did not have valid passports and two did not have any winter clothing.

After referral, two patients refused to enroll in the program. We considered these to be early defaulters. The remaining 51 patients were enrolled in the program, with five initiating a new treatment cycle and 46 continuing their existing regimens (see Figure). Enrolled patients (n = 51) spent a median 251 days (IQR 147–344) within the Sputnik program; those with MDR-TB (n = 38) remained a median of 259 days (IQR 147–345), while all others remained a median of 241 days (IQR 168–329). The median total duration of treatment (in and out of the program) was 551 days (IQR 393–611) for MDR-TB patients and 303 days (IQR 241–332) for all others.

The 46 patients referred to the program for continuation of their current regimens spent a median of 245 days (IQR 147–345) in the Sputnik program. Their adherence to treatment, calculated as the proportion of doses taken over the total number of doses prescribed, increased from 52.2% (95% confidence interval [CI] 47.5–56.9) prior to enrolment to 81.4% (95%CI 76.8–86.0). Among the five patients who initiated new treatment regimens after referral to the Sputnik program, adherence was 82.8% (standard deviation [SD] ± 26.4). Mean adherence for patients

Table 1 Social and clinical characteristics of patients referred to the Sputnik program (n = 53) compared to other Tomsk City metropolitan area patients receiving TB treatment between 17 December 2006 and 30 November 2008 (n = 1419)

	Sputnik patients		Other patients		
Characteristic	*n/N*	%	*n/N*	%	*P* value
Male sex	40/53	75.5	910/1366	66.6	0.179
Younger age, <38 years	36/53	67.9	732/1366	53.6	0.040
Married/living together	18/52	34.6	642/1332	48.2	0.054
Unemployed	42/53	79.2	638/1365	46.7	<0.001
Previously incarcerated	17/53	32.1	240/1366	17.6	0.007
Homeless	2/53	3.8	69/1366	5.1	1.000*
Chronic alcoholism	44/53	83.0	422/1366	30.9	<0.001
Drug abuse	18/53	34.0	111/1366	8.1	<0.001*
Psychiatric disorder	3/53	5.7	60/1366	4.4	0.508*
Hepatitis	9/53	17.0	166/1366	12.2	<0.294
HIV infection	0/53	0	21/1366	1.5	
Newly detected (first treatment course)	22/53	41.5	998/1366	73.1	<0.001
Previous default	6/53	11.3	14/1366	1.0	<0.001*
Smear/culture-positive at treatment start	52/53	98.1	875/1366	64.1	<0.001
MDR-TB out of all patients with DSTs available	38/53	71.7	328/842	39.0	<0.001
Treatment regimen					
Category I/II/III†	10/53	18.9	1035/1366	75.8	
Category IV (MDR-TB treatment)	38/53	71.7	284/1366	20.8	
Mono- and polydrug-resistant treatment; other schemes‡	5/53	9.4	45/1366	3.3	<0.001

*Fisher's exact test.
†Category I regimen: 2HRZE/4HR or 2HRZS/4HR—prescribed for new pulmonary TB patients (sputum smear-positive or -negative) with extensive disease of lung parenchyma (as determined by chest X-ray). Category II regimen: 2HRZES/1HRZE/5HRE—prescribed for previously treated cases when DST is unavailable and the treating physician believes that the risk of drug-resistant disease is low. Category III regimen: 2HRZE/4HR or 2HRZ/4HR—prescribed for extrapulmonary TB.[41]
‡Other schemes: local treatment regimens differing from WHO-recommended treatment Categories I, II, III or IV.
TB = tuberculosis; HIV = human immunodeficiency virus; MDR-TB = multidrug-resistant TB; DST = drug susceptibility test; H = isoniazid; R = rifampin; Z = pyrazinamide; E = ethambutol; S = streptomycin; WHO = World Health Organization.

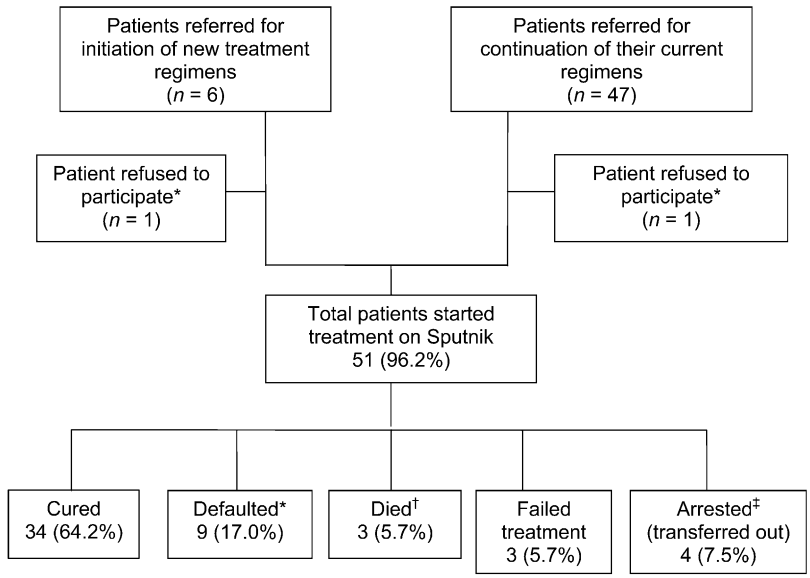

Figure Study population, 17 December 2006–30 November 2008. *One patient stopped treatment because the doctor considered him 'cured'. However, the duration of treatment was too short to classify the patient as cured using international consensus definitions, and he was thus classified as a default. Two patients refused to participate in the Sputnik program and were considered 'early defaulters'. They are included in the total number of defaulters listed in the tables. †All deaths were unrelated to tuberculosis (murder, alcohol poisoning, acute heart failure). ‡All four arrested patients continued treatment in prison. Two successfully finished treatment, the two others were subsequently transferred to a prison outside Tomsk Oblast and their final outcomes are unknown.

Table 2 Treatment outcomes for all patients referred to the Sputnik program (n = 53)

	Patients referred for a new treatment episode (n = 6)	Patients referred for treatment continuation (n = 47)	Total (n = 53) n (%)
Cured/treatment completed*	4	32	36 (67.9)
Failure	0	3	3 (5.7)
Died†	0	3	3 (5.7)
Transferred out	1	1	2 (3.8)
Default‡	1	8	9 (17.0)

*Includes two patients who successfully finished treatment after being transferred to prison.
†All patients died of non-tuberculous causes. All were culture-negative at the time of death.
‡Includes two early defaulters (one referred for a new treatment episode and the other referred for treatment continuation) who refused to enroll in the Sputnik program and did not initiate treatment.

Table 3 Treatment outcomes for all patients referred to the Sputnik program (n = 53) divided by MDR-TB vs. all others

	Patients receiving treatment for MDR-TB (n = 38) n (%)	All other patients (n = 15) n (%)	Total (n = 53) n (%)
Cured/treatment completed*	27 (71.1)	9 (60.0)	36 (67.9)
Failure	2 (5.3)	1 (6.7)	3 (5.7)
Died†	2 (5.3)	1 (6.7)	3 (5.7)
Transfer out	1 (2.6)	1 (6.7)	2 (3.8)
Default‡	6 (15.8)	3 (20.0)	9 (17.0)

*Includes two patients who successfully finished treatment after being transferred to prison.
†All patients died of non-tuberculous causes. All were culture-negative at the time of death.
‡Includes two early defaulters (one referred for a new treatment episode and the other referred for treatment continuation) who refused to enroll in the Sputnik program and did not initiate treatment.
MDR-TB = multidrug-resistant TB; TB = tuberculosis.

with MDR-TB (n = 38) was 79.0% (SD ± 16.9%), and for all others (n = 13) it was 89.1% (SD ± 13.1%). Treatment outcome for all patients is summarized in Tables 2 and 3.

DISCUSSION

Ensuring adherence to TB treatment is a major programmatic challenge. The patients referred to the Sputnik program suffered from myriad social problems, including chronic alcoholism, drug abuse and unemployment, exacerbated by the absence of a social network (family and friends) able to support them through treatment, and missing documentation that prevented their access to state social services. The threat of treatment default is extremely high in this group of patients, and without appropriate care not only is there continued transmission of bacilli in the community, but the risk of mortality is high.

The Sputnik program is a targeted, patient-centered program of intense treatment support and accompaniment that, like the models on which it is based, attempts to find programmatic solutions to social and economic barriers that prevent patients from successfully completing treatment.[29,33,36] In Tomsk, the Sputnik program has become an important facet of a multi-tiered approach to TB care delivery. The program successfully helped patients at high risk of treatment default to achieve an appropriate level of adherence—in this case, patients continuing treatment improved their adherence by 56%, taking on average 81.4% of prescribed doses, while those starting new treatments had a mean adherence of 82.8%. The observed cure rate of 71.1% for patients with MDR-TB (who constitute 72% of the referred patients) is comparable to those observed in other settings.[11,13,14,35,42] For the other patients, the cure rate of 60% suggests that more needs to be done for this group, including reassessment of drug resistance. In both cases, the cure rates are higher than would have been expected for patients on the verge of treatment default.

Although the Sputnik program requires important programmatic input such as properly trained health workers, dedicated transportation and a staff-to-patient ratio that allows for close treatment accompaniment, our findings suggest that the Sputnik approach has the potential to reduce both mortality and TB transmission. The cost of treating a Sputnik patient was approximately US$6.50/day; in the Russian context, where the cost of the alternative—in-patient care for the duration of treatment—ranges from US$9.30/day to as high as US$35.00/day, this non-coercive out-patient program provides exceptional social and economic value.[43,44] In other settings, the Sputnik-style approach of intense accompaniment offers a viable and affordable alternative to compulsory treatment of non-adherent patients without detrimental human rights implications and the risk of nosocomial transmission.[45,46]

There is no doubt that successfully treating patients at high risk of default is exceptionally difficult. It requires strong programmatic commitment, and innovative approaches. By reconfiguring what are usually characterized as 'patient problems' into programmatic challenges, and by working in pragmatic solidarity with patients, the Sputnik program has demonstrated that, through a system of intense treatment accompaniment by a trained and well-supported health worker, it is possible to improve treatment adherence and lower rates of default among patients at high risk of not completing their TB treatment. Although limited by the absence of a comparison group —and by qualitative and quantitative metrics to measure the effects of the Sputnik program on the broader culture of TB patient care in the areas where it was implemented—this analysis suggests that the Sputnik program offers a model that addresses many of the concerns and barriers to care identified by those working in the Russian TB system.[47–49] We argue that this approach can contribute to improving TB treatment outcomes in Russia and elsewhere.

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RÉSUMÉ

CONTEXTE : Un nouveau programme d'administration du traitement de la tuberculose (TB) centré sur les patients, « Sputnik », a été introduit pour les patients à risque élevé d'abandon du traitement dans la ville de Tomsk, Fédération de Russie.

OBJECTIF : Evaluer les effets de l'intervention Sputnik sur les taux d'abandon chez les patients.

SCHÉMA : Nous avons analysé les caractéristiques des patients référés au programme, et évalué l'adhésion thérapeutique des sujets recrutés dans le programme Sputnik avant et pendant l'intervention ainsi que les résultats finaux de l'ensemble des patients référés au programme Sputnik.

RÉSULTATS : Chez les patients poursuivant le régime existant après avoir été référés au programme (n = 46), l'adhésion moyenne au traitement a augmenté de 56% (de 52% des doses prescrites avant le recrutement jusqu'à 81%). Chez les patients commençant le nouveau régime après avoir été référés (n = 5), l'adhésion moyenne est de 83%. L'adhésion moyenne chez les patients atteints de la TB multirésistant (TB-MDR ; n = 38) est de 79%, et chez l'ensemble des autres (n = 13) de 89%. Le taux de guérison est de 71,1% chez les patients atteints de TB-MDR, de 60% pour l'ensemble des autres et de 68% pour l'ensemble du programme.

CONCLUSION : L'intervention Sputnik a été couronnée de succès pour réduire les taux d'abandon du traitement parmi des patients à risque élevé de non-adhésion thérapeutique.

RESUMEN

MARCO DE REFERENCIA: En la ciudad de Tomsk de la Federación de Rusia, se introdujo un nuevo programa de administración del tratamiento antituberculoso centrado en el paciente ('Sputnik').

OBJETIVO: Se buscó evaluar el efecto de la intervención Sputnik sobre las tasas de abandono del tratamiento antituberculoso.

MÉTODO: Se analizaron las características de los pacientes remitidos al programa Sputnik, y se evaluó el cumplimiento terapéutico de los pacientes registrados antes y después de la intervención y los desenlaces clínicos finales de todos los pacientes remitidos al programa Sputnik.

RESULTADOS: En los pacientes que continuaron su tratamiento previo después de la remisión al programa (n = 46), el promedio de cumplimiento terapéutico aumentó un 56% (de 52% de las dosis recetadas antes de ingresar hasta 81% en el programa). En los pacientes que iniciaron nuevas pautas terapéuticas después de la remisión (n = 5), el cumplimiento promedio fue 83%, en los pacientes con tuberculosis multidrogorresistente (TB-MDR; n = 38) fue 79% y en todos los demás (n = 13) fue 89%. La tasa de curación fue 71,1% en los pacientes con TB-MDR, 60% en todos los demás y la tasa global de curación del programa fue 68%.

CONCLUSIÓN: La aplicación del programa Sputnik redujo eficazmente los abandonos terapéuticos de los pacientes que presentaban un alto riesgo de incumplimiento terapéutico.