Seasonal variation and hospital utilization for tuberculosis in Russia: hospitals as social care institutions

R.A. Atun1, Y.A. Samyshkin1, F. Drobniowski2, S.I. Kuznetsov3, I.M. Fedorin3, R.J. Coker4

Background: Clinical management of tuberculosis in Russia involves lengthy hospitalizations, in contrast to the recommended strategy advocated by the World Health Organization. Methods: We used Fourier transform, spectral analysis and Student’s t-test to analyse periodic and seasonal variations in admission and discharge rates for tuberculosis hospitalizations in 1999–2002, using routinely captured data from the Samara Region, Russia. Results: Hospital admissions in colder months were significantly higher than in warmer months. The mean monthly adjusted number of admissions in colder and warmer months for all adults was 413 and 372 (P > 0.01), for unemployed adults 218 and 198 (P > 0.02) and for pensioners 104 and 82 (P > 0.05). Hospital discharges varied seasonally. Maximum differences between admissions and discharges occurred in colder months and minimum differences were observed in warmer months. Conclusions: As hospitalizations of tuberculosis patients in colder months fulfil an important social need, shifts to ambulatory care must be carefully managed.

Keywords: hospital, Russia, season, social care, tuberculosis

The Russian Federation has witnessed seismic political, cultural and economic changes over the past decade. These have been reflected in changing patterns of disease including tuberculosis, for which notifications tripled in the period 1991–2001 to reach a level of 90 per 100 000 population.1,2 Since 1995, demonstration projects using the World Health Organization (WHO)-approved tuberculosis control strategy have been initiated in the Russian Federation with the hope that this model of control will halt the rise in incidence. A particular feature of tuberculosis control in the Russian Federation and former Soviet Union countries is lengthy hospitalization of patients.3 This is despite cost-effectiveness evidence that suggest WHO- and International Union Against Tuberculosis and Lung Disease (IUATLD)-approved methods of managing tuberculosis do not make explicit recommendations on social, organizational and financing issues that impact on tuberculosis care; although changes to medical practice may be achieved, social, structural and political factors may limit the sustainability or benefits of improved clinical management.4 Indeed, in the regions of the Russian Federation where WHO-approved methods of tuberculosis control strategy have been adopted, a decline in hospitalization rates has not been documented. High hospitalization rates are a feature in Samara Oblast, one of 89 regions of the Russian Federation, where in 2001 the Oblast Health Department (OHD) committed itself to introducing a WHO/IUATLD-approved tuberculosis control strategy. This strategy is supported by the UK Department for International Development through a collaborative project involving UK and Russian partners.

Tuberculosis affects many of the most marginalized members of society, and most hospitalized patients in Samara Oblast are unemployed, either permanently or temporarily, are often homeless, and many are ex-prisoners with few social support networks.5 Shelter and social support needs are especially important in a country like Russia that suffers very harsh winters (the average winter temperature in Samara Oblast is 10°C, or −12°C). Anecdotally, many Russian clinicians and policy makers have suggested that in-patient care often serves as much a social as a medical need. This paper describes seasonal variations in hospitalization of patients with tuberculosis and determines variables influencing service use.

Methods

Through a decree issued by the OHD, the research team was given access to financing data and information on patients notified with tuberculosis in primary and secondary care settings, including all hospitalizations. Two datasets were constructed from official patient records.

The first dataset comprised 100 000 individuals on the regional tuberculosis register, including 42 000 patients (new cases, contacts and re-treatment cases for interruptions) for the period 1999–2002. This database captured all notifications, episodes of primary care-based consultations, out-patient attendances and hospitalizations for individuals in the civilian sector where tuberculosis was the main diagnosis (as opposed to those classified as ‘under investigation’), discharges from hospitals and patients’ socio-demographic details. Patient data were stratified by year of registration with the tuberculosis service, age, gender, employment status, disability status and clinical categorization (according to the traditional Russian classification system).6 The second dataset included 20 500 tuberculosis-related hospitalization episodes for 13 900 patients for the period January 1999 to end of December 2002. This dataset included patient information on gender, date of birth, socio-demographic status, employment status, district of origin, main diagnosis, hospitalization

1 Health Centre for Health Management, Tanaka Business School, Imperial College London, South Kensington Campus, London, UK
2 Department of Infectious Diseases, Guy’s King’s and St Thomas’ Medical School, East Dulwich Grove, London, UK
3 Samara Oblast Health Department, Samara, Russia
4 Department of Public Health and Policy, London School of Hygiene and Tropical Medicine, Keppel Street, London, UK
Correspondence: Dr Rifat A. Atun, Health Centre for Health Management, Tanaka Business School, Imperial College London, South Kensington Campus, London SW7 2AZ, UK, tel: +44 20 7954 9160, fax: +44 20 7823 7685, e-mail: r.atan@imperial.ac.uk

episodes, operations, status on discharge (completed treatment, interrupted, death, transfer), payment rate and length of stay. The two datasets were combined using key patient identifiers of name, gender and date of birth.

The data quality and integrity check for data mining were carried out by standardizing parameter definitions in Microsoft Access and further processed in Microsoft Excel, and analysed using SPSS software. Data reliability was tested at source prior to the analysis by cross checking patient attributes in the database with patients’ records.

We analysed by month all admissions to and discharges from tuberculosis hospitals in Samara Oblast for all patients in the 4-year period 1999 to 2002. Regional temperature records were obtained from official weather records.

Periodic and seasonal variations in admission and discharge rates were tested using Fourier transform and spectral analysis, and Student’s t-test was used to compare average admission rates for patient categories in the warm and cold seasons. The monthly data used were adjusted for different number of days in each month.

We tested for the null hypotheses: (i) admissions, discharges and hospital utilization for tuberculosis time are independent of season or temperature; and (ii) notifications for tuberculosis are independent of season.

Ethical approval was obtained from the local ethics committee.

Results

Sixty-nine per cent of new tuberculosis cases registered in the period 1999 and 2002 were male and 21% were female. The distribution of pensioners, adults (age ≥18 years) and children in the male and female patient groups was similar. Adults comprised 88% of male patients and 86% of female patients. The majority of the male and female adult patients had no formally documented disability (88% and 90%, respectively). Fifty-three per cent of adult patients were classified as non-working (52.8%), the majority of name, gender and date of birth.

The data quality and integrity check for data mining were carried out by standardizing parameter definitions in Microsoft Access and further processed in Microsoft Excel, and analysed using SPSS software. Data reliability was tested at source prior to the analysis by cross checking patient attributes in the database with patients’ records.

We analysed by month all admissions to and discharges from tuberculosis hospitals in Samara Oblast for all patients in the 4-year period 1999 to 2002. Regional temperature records were obtained from official weather records.

Periodic and seasonal variations in admission and discharge rates were tested using Fourier transform and spectral analysis, and Student’s t-test was used to compare average admission rates for patient categories in the warm and cold seasons. The monthly data used were adjusted for different number of days in each month.

We tested for the null hypotheses: (i) admissions, discharges and hospital utilization for tuberculosis time are independent of season or temperature; and (ii) notifications for tuberculosis are independent of season.

Ethical approval was obtained from the local ethics committee.

Results

Sixty-nine per cent of new tuberculosis cases registered in the period 1999 and 2002 were male and 21% were female. The distribution of pensioners, adults (age ≥18 years) and children in the male and female patient groups was similar. Adults comprised 88% of male patients and 86% of female patients. The majority of the male and female adult patients had no formally documented disability (88% and 90%, respectively). Fifty-three per cent of adult patients were classified as non-working (52.8%) (figure 1); 75.6% of the patients in the sample were from urban and 24.4% from rural areas. The mean age for the sample was 40.5 years.

Seasonal variation of the mean daily temperature in Samara City is shown in figure 2, together with a 20-day moving average and best-fit sine function.

There was seasonal variation in admissions, discharges and in the numbers of patients in hospital for tuberculosis across all socio-demographic groups. Single spectrum analysis of periodic components of admission and discharge with Fourier transform confirmed seasonal components at 3, 6 and 12 months. Twelve-month variations occurred synchronously with changes in weather.

Hospital admissions for adults in the colder season (October to March) were significantly higher than those in the warmer months (April to September) (table 1). Statistically significant seasonal variations were seen with more admissions in colder months and less in warmer months. The mean monthly adjusted number of admissions in colder and warmer months for all adults was 413 and 372 ($P < 0.01$), for unemployed adults 218 and 198 ($P < 0.02$) and for pensioners 104 and 82 ($P < 0.05$). There was no statistical difference in admission rates for the working population and children. An exception was the month of December, when an increase in the number of discharges was observed (figure 3).

There was a difference in the discharge rates for all adults and amongst subgroups, with fewer discharges in colder months ($n = 395$) as compared with warmer months ($n = 401$). However, the differences were not statistically significant (table 1).

We found no differences in patterns of hospitalization between rural and urban populations.

Because admissions and discharges are constrained by available hospital capacity, we analysed the ‘running balance’ between admissions and discharges, calculated as the monthly difference between total admissions and total discharges. The periodicity of the running balance between admissions and discharges was explored using Fourier analysis, which showed a seasonal variation with a maximum difference between admissions and discharges in the period October to November and minimum difference in the period April to September (figure 3). The pattern of the running balance mirrors the changes in the temperature (figure 3).

No seasonal variation in notifications of new cases in cold and warm months was observed, and the difference in notification level in cold and warm seasons was not statistically significant (figure 4).

Discussion

We have shown that seasonality and changes in temperature are associated with admission and discharge patterns of patients with tuberculosis in a region of Russia. The number of admissions increases in the winter months from October to March and declines in the warmer months from April to September. As these excess winter admissions are not associated with seasonal

![Figure 1](image-url)  
*Figure 1* The socio-demographic composition of the tuberculosis patients with diagnosis of pulmonary tuberculosis in Samara in the period 1999–2002. Source: Medical Information and Analytical Centre, Regional TB Service, DOH, Samara. M, male; F, female.
changes in notification rates, it seems probable that the periodicity of hospital use and its close association with temperature is as a result of a response by hospital services to meet the social and environmental needs of vulnerable patients without adequate shelter, heating and food supply, notably the unemployed and pensioners.

Whilst advocating a flexible, patient-centred approach to ensuring treatment adherence, the WHO/IUATLD-approved tuberculosis control strategy also recommends management of individuals with tuberculosis outside the hospital setting. 10 Whilst there is a body of evidence showing the effectiveness and cost-effectiveness of community-based care for tuberculosis, from which guidelines are drawn, much of this research comes from Africa, Asia and Latin America, where climatic conditions and social demands are very different from those of the Russian Federation.11 While other studies, from the UK and Spain, have shown seasonal variations in tuberculosis rates and higher levels of notifications over summer months,12–14 to our knowledge, no studies have examined the impact of environmental factors such as climate on hospitalization of patients with tuberculosis. This increase in notification rates in the summer months has been attributed to impaired host defence mechanisms.15

Our analysis of the data on the notification of new cases showed no seasonal pattern and the differences in notification rates in warm and cold months was not statistically significant.

Our analysis suggests that hospitalization patterns can be attributed to not just medical, but also social and environmental factors. In a region where the temperatures frequently fall as low as \(-35^\circ\text{C}\) in winter months, provision of adequate shelter, heating and food are problematic. The Russian tuberculosis control system has developed a sophisticated coping mechanism to mitigate the lack of social care provision for tuberculosis patients.3 Although there was a difference in discharge rates with fewer discharges in colder months as compared with warmer months, the differences were not statistically significant. This may be due to two reasons. First, the length of stay for admitted patients (table 2) is strongly regulated by federal and regional normatives that determine payment to hospitals.16 Hence, there are strong incentives to adhere to these normatives and consequently ensure that once admitted, patients remain in hospital for prescribed periods. Secondly, in December the number of discharges increases (figure 2) in response to administrative and regulatory obligations. December coincides with the end of financial year in Russia, when providers have to submit statistical data to the authorities.
and invoices to insurance companies. Patients are therefore discharged so that invoices can be submitted to the insurance agency, accounts for the year-end finalized and hospital income maximized.

Although our analysis shows a strong association with pattern of admission and discharges with temperature, we cannot discount the potential impact of other influences. A cohort study with detailed follow-up of patients to analyse reasons for admission and discharge would help to confirm or refute our findings.

Our findings have important policy implications for tuberculosis control systems in the Russian Federation, and possibly in the wider former Soviet Union where similar control systems exist. Tuberculosis hospitals shoulder not only the costs of extensive periods of clinical care, but also a substantial burden of non-clinical social support. Financing regulations in Russia prevent a shift of funds from health to social sectors, or pooling of health and social sector budgets, preventing multisectoral policies that might address the social problems of tuberculosis patients, although the recent merger of health and social ministries into the Ministry of health and social Development creates pre-conditions for closer collaboration. Such budgetary restrictions contribute to the inefficiency of the tuberculosis control system and inappropriate use of scarce resources. In planning tuberculosis services the creation of ‘social hostels’ for patients requiring only minimal clinical but substantial social support

Figure 3 Fourier analysis of ‘running balance’ between admission and discharge. Source: Hospitalization Database, 1999–2001, Regional Medical Information Centre

Figure 4 Monthly new tuberculosis notifications for the period 1998–2002. Source: Regional Tuberculosis Register 1999–2002. Regional Medical Information Centre
may be as important as modification of clinical and laboratory practice.

For tuberculosis control to be effective and for changes in line with WHO guidelines to be sustainable in the Russian Federation, the costs and benefits of tuberculosis care delivered in both the community and in institutional settings need to be more clearly understood. It seems likely that a truly multisectoral response to the tuberculosis epidemic can only be mounted if public sector regulations on cross-sectoral budget transfers are relaxed, enabling pooling of social and health sector funds to finance intermediate care for socially vulnerable individuals with tuberculosis.

Further health systems research is needed to provide a more nuanced understanding of organizational, regulatory, economic, clinical and social imperatives if changes to tuberculosis control systems in the Russian Federation are to become concordant with internationally accepted practices and sustained.

Acknowledgement

This work was funded by the UK Department for International Development, London, UK.

Table 2  Average length of stay (LOS) by admission season and patient category

<table>
<thead>
<tr>
<th>Status</th>
<th>LOS when admitted in the cold season (October–March)</th>
<th>LOS when admitted in warm season (April–September)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>All patients (including children)</td>
<td>79.2</td>
<td>80.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Children (&lt;18 years)</td>
<td>119.4</td>
<td>107.1</td>
<td>0.005</td>
</tr>
<tr>
<td>All unemployed</td>
<td>72.9</td>
<td>71.5</td>
<td>0.21</td>
</tr>
<tr>
<td>Pensioners</td>
<td>70.9</td>
<td>69.6</td>
<td>0.43</td>
</tr>
</tbody>
</table>

References


Received 15 October 2003, accepted 11 May 2004