BCG Immunization Age in Urban and Rural Areas of Akita Prefecture, Japan

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Abstract  BCG immunization, utilizing whole-body coordination, is a highly cost-effective means of health intervention for preventing miliary tuberculosis (TB) and TB meningitis. In this study, we investigated the appropriate age by which a child should have completed his or her BCG immunization and discuss the current BCG immunization rate in Akita Prefecture, Japan. BCG immunization rates in urban and rural areas were 90.1% and 80.7%, respectively. Our immunization data were lower than the World Health Organization’s (WHO) recommended rate. Immunization coverage rates in urban settings were higher than those in rural areas among infants four months to fifteen months of age, except for those six months old. We recommend: (1) completing BCG immunization by the age of twelve months, (2) preparing and educating parents for BCG immunization by means of a health policy, and (3) changing BCG immunization methods from group to individual inoculation. Immunization coverage rates may be increased or maintained to prevent miliary TB and TB meningitis.

Introduction

The World Bank (1993) reported that routine immunization programs are among the most cost-effective means of health intervention. Immunization, which utilizes whole-body coordination and adaptability, is the most effective way to prevent a specific infectious disease (Iwanaga, 2005; Kouda, 2005; Yasukouchi, 2005; WHO, 1996a). In Japan and other developed countries, BCG immunization is recognized as the most cost-effective method of preventing miliary tuberculosis (TB) and TB meningitis in children (Trunz et al., 2006). The World Health Organization (WHO) (1996b), recommends that an initial BCG immunization be given at birth or as soon after birth as possible. Consequently, most countries administer the BCG immunization to one-year-olds (WHO, 2004).

The WHO (2004) recommends a BCG coverage rate of at least 90% among children under one year old. In Japan, after a declared state of emergency resulting from TB cases on July 26, 1999, the Ministry of Health, Labor and Welfare (MHLW) of Japan (2001) investigated BCG immunizations in 2000, but the immunization rate was such that some immunization rates were more than 100%. In that investigation, the numerator and denominator represented different populations, so that investigation was not comparable with others. On the other hand, that investigation examined the rate of children’s reactions to tuberculin at six months, twelve months, twenty-four months, and thirty-six months. The rate of tuberculin reaction is about the same as the administration rate of BCG immunization, so we used this rate instead of the BCG immunization rate. This rate is 50% below the expected rate for six-month-olds and 81% below that for one-year-olds. These results have not reached the level of WHO's recommended rate, which is at least 90%.

Although the rate of BCG immunization is low, the MHLW has not discussed shortening the completion time period for BCG immunization. Some studies report that a higher immunization rate is occurring in urban areas than in rural areas (Jamil et al., 1999; Chen and Liu, 2005). Children who live in rural areas have about twice as many opportunities to receive the BCG immunization, so we were worried about reducing the immunization rate as a result of this revision. Moreover, the Japan Pediatric Society (JPS) has reported that BCG immunizations in Japan have started to affect three-month-olds owing to concerns about whether or not they are susceptible to congenital immune deficiency syndrome. As a result, not only will many Japanese children lose the opportunity to be immunized, but this will also decrease the administration rate of BCG immunization. The JPS declared that the BCG immunization should be completed before a
child reaches the age of one. Nevertheless, the MHLW has not investigated the immunization rate, nor has it provided any evidence in support of this claim. Therefore, we felt it necessary to investigate the appropriate age of completion for BCG immunization and to discuss immunization behavior.

The objectives of our study are to investigate: (1) the appropriate age for completing BCG immunization, and (2) the maintenance of BCG immunization coverage in Akita Prefecture, Japan.

Methods

Data Collection
Data were collected from about 1,200 guardians, and their children underwent a health checkup at three years of age from April to December 2004. The data were collected using the Akita Prefectural Immunization Surveillance System (APISS). The structured questionnaire encompassed the children’s characteristics, their history of TB infection, and their BCG immunization history; 92.0% (1094/1189) responded to the questionnaire.

Immunization Record
The date of BCG immunization, status of TB infection, and child’s date of birth were recorded by the guardians using the Parents and Child Health Pocket Book (PCH Pocket Book). Cases in which immunization administration was unclear were excluded from the analysis.

Data Analysis and Statistics
The immunization coverage rate was calculated using the cumulative rate, and is exhibited by the following equation. The cumulative immunization coverage rate was determined first by a plateau, indicating that the practice of immunization was likely to be finished, and, second, by the greatest age of immunization.

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\text{Cumulative \% of age (months)} = \sum \left( \frac{n_i}{N} \right) \times 100
\]

\(n_i\): number of BCG vaccinations administered by age 
\(i (=0, 1, 2, \cdots, 42)\): age in month[s] 
\(N\): number of subjects

We compared the BCG immunization cumulative coverage ratios between urban and rural areas in twelve-month-olds. This comparison was performed with a two-sample test to ensure equal proportions. Municipalities were classified into urban or rural areas according to the vital statistics of Japan, 2003 (Statistics and Information Department, Minister’s Secretariat, MHLW, 2004).

Results
The characteristics of the children examined in this study are shown in Table 1. Boys comprised 50.4% (518/1028) of the population, and girls comprised 49.6% (510/1028). Urban residents comprised 62.0% (641/1034) of the population, while 38.0% (393/1034) of the residents lived in rural areas. Only one child (0.1%) was infected with TB.

The cumulative coverage rates of BCG immunization for all children aged three months, six months, nine months, twelve months, twenty-four months, thirty-six months, and forty-two months were, respectively, 4.9%, 44.0%, 78.3%, 86.5%, 94.6%, 95.7%, and 96.0% (Fig. 1a). In urban areas, the cumulative coverage rates of BCG immunization for children aged three months, six months, nine months, twelve months, twenty-four months, thirty-six months, and forty-two months were, respectively, 5.4%, 45.2%, 84.6%, 90.1%, 94.9%, 96.0%, and 96.0% (Fig. 1b). In rural areas, the cumulative coverage rates of BCG immunization for children aged three months, six months, nine months, twelve months, twenty-four months, thirty-six months, and forty-two months were, respectively, 4.2%, 41.6%, 68.0%, 80.7%, 94.1%, 95.4%, and 96.1% (Fig. 1c). These data indicate that the cumulative immunization rate was significantly higher \((p<0.05)\) in children from urban areas who were aged four months, five months, and from seven to fifteen months. In other age groups, the immunization rates did not differ between urban and rural areas.

Discussion
We investigated the cumulative BCG immunization coverage rates in Akita, Japan. During the nine-month period of data collection, the BCG immunization rates in all areas, urban areas, and rural areas were about 86.5%, 90.1%, and 80.7%, respectively. The BCG immunization coverage rate was lower than the WHO’s recommended rate (90% or more) for children under one year of age (WHO, 2004). The BCG immunization coverage rate of children living in urban areas was significantly higher among four-month-olds, five-month-olds, and seven- to fifteen-month-olds than among those age groups living in rural areas.

APISS was one of the organizations collecting and monitoring routine immunization surveillance data in Japan. Many local governments have not collected continuous cumulative immunization rate data as surveillance data. These

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Table 1  Characteristics of subjects

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<th>Number (%)</th>
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<tr>
<td><strong>Sex</strong></td>
<td></td>
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<tr>
<td>Male</td>
<td>518/1028</td>
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<tr>
<td>Female</td>
<td>510/1028</td>
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<tr>
<td><strong>Residence</strong></td>
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<tr>
<td>Urban</td>
<td>641/1034</td>
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<tr>
<td>Rural</td>
<td>393/1034</td>
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<td><strong>Tuberculosis</strong></td>
<td></td>
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<tr>
<td>Infected</td>
<td>1/1034</td>
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<tr>
<td>Not infected</td>
<td>1033/1034</td>
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surveillance data are used to update the immunization status of children as a basic health service. For example, active surveillance data collected during the 1960s have been important for the implementation of a national poliomyelitis immunization program and were used for a poliomyelitis elimination campaign in the United States (Buehler, 1998). The surveillance data have been useful for monitoring purposes and in the development of a regional strategy to increase routine immunization coverage rates.

BCG immunization is the primary preventive measure against miliary TB and TB meningitis in Japan. The WHO recommends the administration of one dose of the vaccine at birth or at first contact with the health system; this minimizes the harmful effects of complications from military TB and TB meningitis (WHO, 1996b; 2004). Most developing countries follow this recommendation, but no BCG immunization is conducted in the United States and Western European countries because of the low risk of TB infection. In Japan, BCG immunization can be administered after birth, but most Japanese children will receive their BCG immunization after they are three months old. This is because at that time pediatricians generally check whether a child has acquired congenital immune deficiency syndrome. Owing to these circumstances, many Japanese children have not had BCG immunization by the time they visit their local community health center. Moreover, many municipalities administer group BCG immunizations so that small municipalities (i.e., towns or villages) have two chances a year to receive BCG immunization. In reality, however, children living in small municipalities have only one chance per year. The JPS declared that the BCG immunization age should be extended for this reason. Our results showed BCG coverage rates in children under three months old in all areas, urban areas, and rural areas were 4.9%, 5.4%, and 4.2%, respectively. Most Japanese children started BCG immunization at three months old because of a delay to determine whether or not they had contracted congenital immune deficiency syndrome. Nagai (2005) reports that the completion of BCG immunization should be extended to include children younger than one year old. Considering this situation and Nagai’s report, we recommend that the age of completion of BCG immunization should be extended to include one-year-olds.

Immunization creates an artificial defense mechanism for the body (WHO, 1996a). Whole-body coordination consists of not only physiological function but also coordination among the functions of all parts of the body (Kouda, 2005). Therefore, administration of immunization induces whole-body coordination, so that maintaining or improving the immunization rate leads to creating a healthy and comfortable life for humans.

Our results show a lower BCG immunization coverage rate among children in Japan under the age of one than that of the United States (96%), Europe (91%), South-East Asia (92%), and the Western Pacific (95%) (WHO, 2004). A low BCG immunization rate, below 90%, might allow TB infections to increase, as was the case in Japan in 1997 (Inoue and Matoba, 2001) and in the United States from 1985 to 1992 (Navin et al., 2002; Dye et al., 1999). The WHO has reported the importance of support from health policy makers in building health and in educating and advising citizens (WHO, 1986). Social support and health education are needed to increase BCG immunization coverage rates. However, this sort of social and health education system has not been established in Japan. The WHO/UNICEF (1997) recommends the immunization

![Fig. 1 Cumulative coverage rate of BCG immunization.](image)

- a: Cumulative coverage rate of BCG immunization in all areas
- b: Cumulative coverage rate of BCG immunization in urban areas
- c: Cumulative coverage rate of BCG immunization in rural areas
coverage rate be 90% or higher in children younger than one year old. Therefore, we recommend that social support and health education should prepare parents for BCG immunization before lowering the immunization age to less than six months old.

In Akita, all the municipalities have been authorized to administer BCG immunization by means of group inoculation, but it is not easy for children to access a health care center. Nagai (2005) suggests that group inoculations do not provide enough opportunities for children to receive the vaccination. In the United States, Szilagyi et al. (2002) and Santoli et al. (1998) have reported a disparity in immunizations associated with race, access barriers, and cost issues. Several studies (Jamil et al., 1999; Chen and Liu, 2005) have shown that access to immunization provider facilities is associated with the inoculation coverage rate in some countries. Altinkaynak et al. (2004) and Mainous and Hueston (1995) also reported that routine immunization coverage rates were significantly correlated with settlement area, and were higher in urban regions than in suburban and rural regions. Moreover, Jamil et al. (1999) reported that distance to static health centers had a substantial effect on the level of immunization during pregnancy for the most economically disadvantaged group. McCormick et al. (1997) reported that neighborhood immunization sites such as grocery stores or mobile vans might increase the immunization rate. Our data indicated that the immunization rate in rural areas was lower than in urban areas. Therefore, we propose that areas should implement group inoculations rather than individual inoculations, and local governments should facilitate access to immunization provider facilities for children living in rural areas.

Conclusions

We investigated the cumulative BCG immunization coverage rate. At six months of age, the BCG coverage rate was under 50% in both urban and rural areas. The coverage rate reached 90% or more in urban areas and rural areas in, respectively, twelve-month-olds and sixteen-month-olds. The immunization coverage rate in urban areas was significantly higher than in rural areas. Therefore, we recommend: (1) completing BCG immunization by the time a child is twelve months old, (2) preparing and educating parents about BCG immunization before lowering the immunization age to under six months, and (3) changing BCG immunization from group to individual inoculation. Immunization coverage rates may be increased or maintained to prevent the spread of TB.

References

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