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Assessment of Immunization Coverage Using a Computerized System

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Summary. **The major concerns with immunization programs for disease control continue to be improving and sustaining immunization coverage, which can be monitored via the direct or indirect measurement of vaccination levels. We have developed a computerized program to monitor immunization coverage with diphtheria-pertussis-tetanus (DPT) and measles vaccines using registration books of immunization in 7 villages and towns in Niigata Prefecture, Japan, and analyzed 838 children who were born in the calendar year 2000.**

Immunization coverage for the third dose of DPT among infants aged 12 months ranged from 9.3% to 75%. Four places had introduced group immunization programs, and three had individual ones. Good coverage (37.7% to 75.0%) generally resulted when the first dose was given at 3 months of age, but where it was started at 5 or 7 months, values were quite low (9.3% to 28.0%) regardless of whether group or individual immunization programs were employed. However, when the first dose was given at 3 months of age, third dose vaccine coverage at 12 months was higher in the group immunization programs. Locales which arranged many immunization days achieved the best immunization coverage. Measles immunization coverage at 24 months of age was quite high at 86.6% to 94.6%, except in village G (75.5%) with both group and individual immunization programs.

The present study leads us to conclude that this computerized system focusing on immunization activity is an effective tool to evaluate immunization programs.

Key words—vaccine, DPT, measles, immunization coverage, immunization.

INTRODUCTION

Vaccines can prevent death, disease, and disablement among children, and immunization continues to be responsible for dramatic improvements in child health.[1)] In Japan, routine immunization programs target polio, measles, tuberculosis, diphtheria, pertussis, tetanus, rubella, and Japanese encephalitis. The influenza vaccination has also been introduced for people aged over 65 years as well as for high risk groups aged 60 to 65 years.

High and uniform levels of immunization coverage provide a foundation on which specific efforts at disease control can be mounted, and they ensure that control, once achieved, can be maintained.[1,2)] The major concerns of immunization programs thus continue to be improving and sustaining immunization coverage.

Immunizations are recommended for members of the youngest age group at risk of experiencing the disease for whom efficacy, immunogenicity, and safety have been demonstrated.[1)] The ages and interval between doses of the same antigens to provide optimal protection and efficacy have been determined, and in Japan, vaccines are administered to children aged 3-90 months, depending on the individual vaccine.

Vaccine coverage can be monitored via a direct measurement of vaccination levels, or estimated indirectly by several ways including: 1) surveys; 2)

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Abbreviations—DPT, diphtheria-pertussis-tetanus.

reports of the doses of vaccine administered; and 3) reports of doses of vaccine distributed. Coverage is calculated by the total number of immunized children and subject for immunization, but technical problems remain in accurately determining this figure for different target diseases in various areas in Japan. At present, many village and town offices have computerized systems for official work, including immunization registration books. We have focused on diphtheria-pertussis-tetanus (DPT) and measles vaccines because DPT requires three doses under one year of age and measles immunization is given to individuals over one year old. Furthermore, DPT and measles vaccinations are most often used to monitor childhood vaccination coverage rates and trends.[3,4,5] The present study was conducted to monitor actual vaccine coverage at 7 villages and towns in Niigata Prefecture, Japan, for the calendar year 2000 using our original computer system and to clarify the usefulness of the system in the evaluation of vaccination programs.

MATERIALS AND METHODS

Study design

The study was conducted in Niigata Prefecture, located in the middle of the lsland of Honshu of Japan. The total population of Niigata Prefecture is approximately 2.5 million (in the 2000 census). The survey of the calendar year 2000 immunization registry was carried out at 7 villages and towns in a rural farming area covered by the M Public Health Center (Table 1). The total population was 103, 969. The total number of children was 838, excluding these moving in and out, who were born from 1 January to 31 December, 2000, and were inhabitants on 31 March, 2004. We developed a computerized system to calculate the coverage of DPT and measles vaccines for every village and town using commercially available spread sheet software in order to evaluate immunization activity.

We input information for immunization from registration books, such as the date of birth, immunization day for each vaccine, and dates of entering or leaving the area. Coverage was calculated for one day before the birthday date every month. In particular, coverage at 12 months for DPT and at 24 months for measles were specified as the end points.

Statistical analyses

Statistical comparison of mean values was performed with a two-way analysis of variance by adjusting for the effect of residence of the subject. Statistical significance was concluded at $P<0.05$.

RESULTS

Results for the immunization coverage of three doses of DPT for every month of age in the 7 villages and towns are summarized in Table 2. Immunization coverage of a third dose of DPT among infants aged 12 months, the most important marker of immunization activity, ranged from 9.3% to 75%. Five locations (A, B, E, F, and G) where the first dose was administered at 3 months showed good coverage, but the other two (C and D) where it was started at 5 or 7 months showed quite low values regardless of whether group or individual immunization program were in place. Particularly in Town D, immunization coverage of the third dose was very low due to an inadequate immunization schedule; the first dose was given at 9 to 13 months, the second at 10 to 14 months, and the third at 11 to 15 months. The mean age when the first dose was administered was significantly younger in those with the third dose at 12 months of age than in those without (Table 3). When the first dose was given at 3 months of age, immunization coverage of the third dose at 12 months was higher with group immunization programs (Village A and Town B) than with the individual approach (Villages E and F, Town G). Furthermore, even with the first dose given at 3 months of age, immunization coverage of Town B which arranged for 8 immunization days was higher than that of Village A, which arranged for 6 days.

We also monitored the immunization coverage of measles vaccine for every month of age in the 7 villages and towns (Table 4). Measles immunization started after 12 months of age—except in Towns B and D, and coverage at 24 months was quite high, 86.6% to 94.6%, except in Village G (75.5%), independent of the type of immunization program. Among 4 villages and towns (A, B, C, and D) in the group immunization program, immunization coverage increased slowly, whereas among 3 villages and towns (E, F, and G) with individual immunization programs, coverage increased rapidly at 13 to 15 months.

DISCUSSION

Problems with the calculation of immunization coverage persist in Japan, and there is a need to monitor activities for all target age groups. For this purpose, we developed a computerized system to calculate

Table 1. Total number of population and children eligible for immunization at villages and towns in the study

Village and towns	Population[a)]	No. of children eligible for the study[b)]
A	10,042	65
B	15,681	112
C	12,365	82
D	25,136	258
E	29,486	238
F	4,805	30
G	6,454	53

[a)]2000 census; [b)]Date of birth from 1 January to 31 December, 2000.

Table 2. Immunization coverage (%) for DPT at each age

Village or town	Type of immunization program (No. of days)	Doses	Age (Months)									
			3	4	5	6	7	8	9	10	11	12
A	Group (6)	1 st	0.0	9.2	16.9	38.5	55.4	69.2	81.5	92.3	96.9	96.9
		2 nd	0.0	0.0	7.7	13.8	24.6	41.5	55.4	67.7	80.0	86.2
		3 rd	0.0	0.0	0.0	6.2	10.8	20.0	32.3	43.1	50.8	61.5
B	Group (8)	1 st	0.0	9.8	24.1	42.9	53.6	75.0	90.2	94.6	96.4	98.2
		2 nd	0.0	0.0	4.5	17.0	31.3	40.2	57.1	74.1	82.1	87.5
		3 rd	0.0	0.0	0.0	5.4	14.3	25.0	34.8	47.3	64.3	75.0
C	Group (4)	1 st	0.0	0.0	0.0	4.9	9.8	14.6	22.0	31.7	40.2	45.1
		2 nd	0.0	0.0	0.0	0.0	3.7	8.5	14.6	22.0	29.3	34.1
		3 rd	0.0	0.0	0.0	0.0	0.0	6.1	9.8	14.6	20.7	28.0
D	Group (12)	1 st	0.0	0.0	0.0	0.0	0.0	1.6	2.7	21.3	34.1	58.5
		2 nd	0.0	0.0	0.0	0.0	0.0	0.4	1.2	2.7	17.8	35.3
		3 rd	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	2.3	9.3
E	Individual	1 st	0.0	6.3	15.5	26.9	38.7	54.2	66.8	77.7	82.4	86.1
		2 nd	0.0	0.0	5.9	13.0	22.3	31.5	47.5	60.9	72.7	77.7
		3 rd	0.0	0.0	0.0	4.2	12.2	18.1	29.4	43.7	55.9	67.2
F	Individual	1 st	0.0	6.7	10.0	20.0	20.0	30.0	36.7	50.0	63.3	70.0
		2 nd	0.0	3.3	6.7	10.0	16.7	20.0	30.0	36.7	50.0	63.3
		3 rd	0.0	0.0	0.0	6.7	10.0	16.7	20.0	26.7	33.3	40.0
G	Individual	1 st	0.0	5.7	7.5	18.9	24.5	32.1	41.5	52.8	62.3	71.7
		2 nd	0.0	0.0	5.7	5.7	17.0	22.6	32.1	39.6	47.2	52.8
		3 rd	0.0	0.0	0.0	3.8	3.8	13.2	17.0	24.5	30.2	37.7

DPT, diphtheria-pertussis-tetanus, * Recommended age for DPT immunization; 3 to 12 months.

Table 3. Comparison of age when receiving the first dose of DPT by the condition of the third dose at 12 months of age

The third dose of DPT	Age (Months) when receiving the first dose	
	n	m(SD)
Yes	369	6.2 (1.9)*
No	456	11.1 (3.4)

n, No, of subjects for analysis (excepting for infants whose age when the first dose was administered was unclear) m(SD); Average age to receive the first dose (standard deviation); *$p<0.001$, adjusted for the effect of residence of the subject by two-way analysis of variance.

Table 4. Immunization coverage (%) for measles at each age

Village or town	Type of immunization Program (No. of days)	Age (Months)												
		12	13	14	15	16	17	18	19	20	21	22	23	24
A	Group (2)	0.0	13.8	21.5	32.3	52.3	67.7	76.9	81.5	84.6	87.7	89.2	92.3	93.8
B	Group (3)	0.9	0.9	4.5	17.0	33.9	58.9	73.2	87.5	91.1	91.1	92.0	92.9	94.6
C	Group (1)	0.0	3.7	9.8	17.1	29.3	35.4	45.1	61.0	68.3	74.4	81.7	85.4	86.6
D	Group (3)	0.4	3.9	6.2	8.1	16.7	32.2	46.1	68.6	81.0	82.9	84.9	85.7	87.2
E	Individual	0.0	26.1	47.5	58.8	67.6	71.4	76.1	80.3	83.2	84.5	86.1	88.2	88.7
F	Individual	0.0	10.0	13.3	36.7	36.7	46.7	56.7	73.3	80.0	86.7	93.3	93.3	93.3
G	Individual	0.0	15.1	22.6	41.5	47.2	50.9	54.7	58.5	60.4	64.2	67.9	75.5	75.5

*Recommended immunization age: 12 to 24 months; *Recommended immunization age: 12 to 15 months (from 1 January, 2004)

immunization coverage and here have focused on DPT and measles vaccines. Our study indicated that this system allowed the real situation of immunization activities in 7 villages and towns to be determined and is an effective tool for evaluation.

We had no children with diphtheria and tetanus, but there were many children with pertussis even after the introduction of DPT immunization in Japan.[6,7,8] Therefore, an increase in immunization coverage is quite important for prevention of this disease. Our present observations suggest that the first dose of DPT should be given as early as possible after reaching the target age of 3 months. With a group immunization program, locales should provide as many immunization days as possible.

In Japan, individual immunization programs are recommended, but our results indicated that this approach does not simply increase immunization coverage. Thus, the data support our proposal that health education for raising immunization coverage and reducing drop-out rates should be strengthened at the local level, with improvement in the management of health services (providing training/supportive supervision to the health workers who provide immunizations), and informing and motivating the public, specifically recognizing that parents have important health roles to play. Furthermore, a shortage of manpower for immunization is another problem in small villages and towns. Local governments in collaboration with medical associations need to promote broad immunization programs to give individual immunization at several clinics outside the residential areas in Niigata Prefecture.

Measles is the greatest vaccine-preventable killer of young children in the world.[9,10,11] In Japan, routine measles immunization with a single dose of measles vaccine has been performed since 1978. However, measles epidemics still occur, and unvaccinated young adult cases of measles have increased in number.[12,13,14] Furthermore, measles cases have been exported to the United States.[15]

The measles vaccine was shown to be administered

to a wide age range of children aged 12-90 months although the recommended immunization age was 12-24 months[14]. However, routine immunization coverage has been more than 90% by age of 48 months since 1989, and measles have been decreasing in number since 1995 due to a high coverage of more than 60% by the age of 24 months in Niigata.[13,14] In this study, immunization coverage of measles vaccine at 24 months of age was confirmed to be generally high. The recommended age for measles immunization changed again from 12-24 to 12-15 months in 2004. Even in 2000, coverage increased rapidly at 13 to 15 months in our villages and towns in individual immunization programs, and we expect to increase immunization coverage, working with a shift to younger children at the recommended immunization age by enforcing individual immunization program. Thus, we would like to emphasize the necessity for a routine administration of a single dose of measles vaccine to children as soon as possible after their first birthday, as adopted in Canada.[16,17]

However, implementation of a two-dose schedule as a next step might also be required for the elimination of measles in Japan.

At present, office systems are computerized in many local government offices in Japan. We have developed a computerized immunization coverage program linked with computerized registration books which allows monitoring of the coverage of different vaccines, on a monthly basis. The program can be downloaded from our website through the Internet (http://www.med.niigata-u.ac.jp/pub/welcome.htm; however, only a Japanese version is available at the time of the publication of this paper). Registries consolidate vaccination records of children from multiple health-care providers, identify children who are due or late for vaccinations, and can generate reminders and recall notices to ensure that children are vaccinated appropriately. They should also identify provider sites and geographic areas with low immunization coverage.

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