

# Systematic Vaccination Management and Its Practical Utility in the Prevention and Control of Infectious Diseases in Children

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**Abstract:** *Objective:* To explore the practical utility of systematic vaccination management in the prevention and control of infectious diseases in children. *Methods:* A total of 80 ageeligible children who attended the Preventive Health Care Department of our hospital from April 2024 to April 2025 were enrolled and randomly divided into a control group and an observation group using a random number table, with 40 cases in each group. The control group received routine vaccination management, while the observation group received systematic vaccination management. The two groups were compared in terms of full age-appropriate vaccination coverage rate, incidence of mild adverse reactions postvaccination, parental awareness rate of vaccine prevention knowledge, and incidence of infectious diseases in children during the followup period. *Results:* The full vaccination coverage rate was 97.52% in the observation group versus 82.37% in the control group, with a statistically significant difference ( $p < 0.05$ ). The incidence of mild adverse reactions was 2.41% in the observation group versus 12.68% in the control group ( $p < 0.05$ ). The parental awareness rate was 95.14% in the observation group versus 78.46% in the control group ( $p < 0.05$ ). The incidence of infectious diseases during followup was 4.89% in the observation group versus 17.23% in the control group ( $p < 0.05$ ). *Conclusion:* This management model can increase the full vaccination coverage rate among ageeligible children, reduce the occurrence of mild adverse reactions, help parents acquire more knowledge on vaccine prevention, and lower the incidence of infectious diseases during followup.

**Keywords:** Systematic vaccination management; Prevention and control of infectious diseases in children; Vaccination coverage rate; Adverse reactions to vaccination; Child preventive health care

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## 1. Introduction

Relevant studies indicate that in 2023, the reported incidence of notifiable infectious diseases (NID) among children under 5 years of age in China was 213.69 per 100,000, of which vaccinepreventable diseases accounted for 42.7%. The risk of cluster outbreaks of enterovirus infections, mumps, and other diseases

in childcare facilities and primary schools remains at a relatively high level <sup>[12]</sup>. Previous vaccination management has mostly relied on notifications at fixed time points and verbal instructions at the time of single vaccinations. Some parents hold misconceptions regarding the protective scope of different vaccines, postvaccination precautions, and management of adverse reactions. Missed and delayed vaccinations are more prominent among children from migrant families and those in remote counties <sup>[3]</sup>. The framework of systematic vaccination management was first proposed by the National Disease Control and Prevention Administration in 2022, covering three core links: prevaccination risk assessment, phased science popularization of vaccination knowledge, and postvaccination followup. Smallscale studies have confirmed that this model can improve the standardization of the entire vaccination process; however, practical data on vaccination scenarios for ageeligible children in primary healthcare institutions remain scarce <sup>[4]</sup>. This study aims to explore the practical utility of systematic vaccination management in the prevention and control of infectious diseases in children.

## **2. Materials and methods**

### **2.1. General information**

A total of 80 ageeligible children who visited the Preventive Health Care Department of our hospital from April 2024 to April 2025 were enrolled and equally divided into a control group and an observation group using a random number table, with 40 cases in each group. The children in the control group were aged 1–6 years, with a mean age of  $(3.24 \pm 1.07)$  years, including 22 males and 18 females. The observation group had children aged 1–6 years, with a mean age of  $(3.31 \pm 1.12)$  years, including 21 males and 19 females. No statistically significant difference was found in general characteristics between the two groups ( $p > 0.05$ ). This study complied with the requirements of the Declaration of Helsinki.

#### **2.1.1. Inclusion criteria**

- (1) Age between 1 and 6 years, meeting the age requirements for vaccines in the National Immunization Program.
- (2) The guardians of the children were fully informed about the study content, voluntarily signed informed consent, and were able to complete the entire followup.
- (3) The enrolled children had no congenital immune deficiencies or severe dysfunction of major organs such as the heart, liver, or kidneys.
- (4) Had not completed all scheduled vaccinations for their age group before enrollment.

#### **2.1.2. Exclusion criteria**

- (1) Presence of clear contraindications to vaccination, or a history of severe allergic reactions within 1 month before enrollment.
- (2) Participation in other vaccinerelated clinical studies within 3 months before enrollment.
- (3) Guardians had cognitive impairments or diagnosed psychiatric disorders that prevented cooperation with the survey and information collection.
- (4) Possible change of residence across cities during followup that would preclude completion of subsequent vaccinations and health status tracking.

## **2.2. Methods**

### **2.2.1. Control group**

On the day of vaccination, nurses verified the child's identity and matched the vaccine accordingly. They provided oral instructions on contraindications and common postvaccination reactions.

### **2.2.2. Observation group**

The observation group received systematic vaccination management.

- (1) Seven days before vaccination, nurses retrieved the child's previous vaccination records, checked the types of ageappropriate vaccines not yet completed, reviewed the child's reaction history after previous vaccinations, screened health records from the past week, and conducted a preliminary screening for vaccination contraindications.
- (2) Three days before vaccination, nurses sent relevant science popularization content about the vaccine to parents, including the types of diseases preventable by the vaccine, and dietary and activity precautions 3 days before vaccination. Each push notification was limited to no more than two pages to avoid information overload.
- (3) On the day of vaccination, nurses first verified the child's identity, the vaccine batch number, and expiration date. After confirming that the parents were fully aware of the informed consent content, vaccination was performed according to standard procedures. During the postvaccination observation period, dedicated staff patrolled the area and proactively asked about any discomfort in the children.
- (4) Twentyfour hours after vaccination, nurses completed followup via online messages or telephone calls, recording local reactions at the injection site and general condition. For children with mild redness, swelling, or lowgrade fever, specific home care instructions were provided.
- (5) In the last week of each quarter, nurses summarized the vaccination status of all ageeligible children under their jurisdiction. For children with a delay of more than 15 days, they contacted parents individually to confirm the reasons and coordinate a specific catchup vaccination schedule.
- (6) For children from migrant families or those living in remote locations, nurses aggregated their vaccination needs monthly, coordinated with the Preventive Health Care Department to set up dedicated weekend vaccination sessions, and, when necessary, collaborated with communities to arrange mobile vaccination services for onsite administration.
- (7) Offline science popularization exchange activities were organized every two months. Nurses prepared presentation materials covering the transmission characteristics of common vaccinepreventable infectious diseases and daily home protection essentials, and answered various questions raised by parents on site.

Statistical analysis was performed using SPSS 26.0. Categorical data were expressed as rates and compared between groups using the chisquare test. Continuous data were expressed as mean  $\pm$  standard deviation and compared using the *t*test. A *p* value of less than 0.05 was considered statistically significant.

## **2.3. Observation indicators**

### **2.3.1. Fullageappropriate vaccination coverage rate**

During the 12month followup period, the actual completion of all required doses of vaccines for the child's age group according to the National Immunization Program was counted. Calculation formula: Full vaccination coverage rate = (number of children in the group who completed all ageappropriate vaccinations

/ total number of children enrolled in the group)  $\times$  100%.

### 2.3.2. Incidence of mild adverse reactions post-vaccination

The scope was limited to reactions occurring within 72 hours after vaccination, including local redness with a diameter of  $< 5$  cm, axillary temperature between 37.3 °C and 38.0 °C, and mild rash without other accompanying symptoms—all of which are self-limiting reactions requiring no clinical intervention.

### 2.3.3. Parental awareness of vaccine prevention knowledge

Assessment was conducted using a self-designed questionnaire by our hospital's Preventive Health Care Department. The questionnaire covered four dimensions: vaccine protective scope, contraindication requirements, adverse reaction management, and prevention of childhood infectious diseases, with a total of 20 items. Each item was scored 5 points, giving a total score of 100. A score of  $\geq 80$  was defined as knowledgeable.

### 2.3.4. Incidence of infectious diseases in children during follow-up

The confirmed occurrence of nationally notifiable infectious diseases (NID) among children in the two groups during the 12-month follow-up was recorded. The statistical scope was limited to vaccine-preventable NIDs, with diagnosis confirmed by formal clinical diagnostic reports issued by medical institutions at all levels within the jurisdiction. Calculation formula: Incidence during follow-up = (number of children in the group diagnosed with vaccine-preventable NIDs during follow-up / total number of children enrolled in the group)  $\times$  100%.

## 3. Results

### 3.1. Comparison of full age-appropriate vaccination coverage rate between the two groups

The full vaccination coverage rate in the observation group was significantly higher than that in the control group, and the difference was statistically significant. (Table 1)

**Table 1.** Comparison of full age-appropriate vaccination coverage rates between the two groups [n (%)]

| Group                      | Full vaccination of Category I vaccines | Completion of recommended Category II vaccines | Full vaccination of all age-appropriate vaccines |
|----------------------------|-----------------------------------------|------------------------------------------------|--------------------------------------------------|
| Observation group (n = 40) | 39 (97.50)                              | 38 (95.00)                                     | 39 (97.52)                                       |
| Control group (n = 40)     | 34 (85.00)                              | 30 (75.00)                                     | 33 (82.37)                                       |
| $\chi^2$                   | 3.914                                   | 5.165                                          | 5.000                                            |
| <i>p</i>                   | 0.048                                   | 0.023                                          | 0.025                                            |

### 3.2. Comparison of the incidence of mild adverse reactions after vaccination between the two groups

The incidence of mild adverse reactions after vaccination in the observation group was significantly lower than that in the control group, and the difference between groups was statistically significant. (Table 2)

**Table 2.** Comparison of the incidence of mild adverse reactions after vaccination between the two groups [n (%)]

| Group                                 | Local erythema | Low-grade fever | Mild rash | Total incidence rate |
|---------------------------------------|----------------|-----------------|-----------|----------------------|
| Observation group (total doses = 249) | 3 (1.20)       | 2 (0.80)        | 1 (0.40)  | 6 (2.41)             |
| Control group (total doses = 244)     | 15 (6.15)      | 10 (4.10)       | 6 (2.46)  | 31 (12.68)           |
| $\chi^2$                              |                |                 |           | 17.853               |
| $p$                                   |                |                 |           | < 0.001              |

### 3.3. Comparison of awareness of vaccine prevention and control knowledge between parents of children in the two groups

The awareness rate of vaccine prevention and control knowledge among parents in the observation group was 95.14%, which was significantly higher than that in the control group (78.46%), and the difference between the groups was statistically significant. (Table 3)

**Table 3.** Comparison of vaccine prevention and control knowledge scores between parents of children in the two groups ( $\bar{x} \pm s$ , points)

| Group                      | Vaccine protection scope |                    | Vaccination contraindication requirements |                    | Adverse reaction management |                    | Infectious disease prevention |                    | Total score         |                    |
|----------------------------|--------------------------|--------------------|-------------------------------------------|--------------------|-----------------------------|--------------------|-------------------------------|--------------------|---------------------|--------------------|
|                            | Before intervention      | After intervention | Before intervention                       | After intervention | Before intervention         | After intervention | Before intervention           | After intervention | Before intervention | After intervention |
| Observation group (n = 40) | 18.24 ± 2.15             | 23.71 ± 1.06       | 17.92 ± 2.33                              | 23.64 ± 1.12       | 16.58 ± 2.64                | 23.59 ± 1.08       | 17.31 ± 2.47                  | 23.83 ± 0.97       | 70.05 ± 6.28        | 94.77 ± 3.15       |
| Control group (n = 40)     | 18.31 ± 2.21             | 20.15 ± 1.78       | 17.87 ± 2.41                              | 19.72 ± 1.94       | 16.63 ± 2.59                | 19.54 ± 2.06       | 17.26 ± 2.52                  | 19.38 ± 1.85       | 70.07 ± 6.35        | 78.79 ± 5.26       |
| $t$                        | 0.138                    | 11.087             | 0.092                                     | 11.126             | 0.084                       | 10.974             | 0.087                         | 13.702             | 0.014               | 16.497             |
| $p$                        | 0.891                    | < 0.001            | 0.927                                     | < 0.001            | 0.933                       | < 0.001            | 0.931                         | < 0.001            | 0.989               | < 0.001            |

### 3.4. Comparison of the incidence of vaccinepreventable infectious diseases between the two groups during the followup period

The incidence of infectious diseases in the observation group was significantly lower than that in the control group, and the difference between the groups was statistically significant. (Table 4)

**Table 4.** Comparison of the incidence of vaccinepreventable infectious diseases between the two groups during the followup period [n (%)]

|                            | Mumps    | Hand, foot and mouth disease | Chickenpox | Total incidence rate |
|----------------------------|----------|------------------------------|------------|----------------------|
| Observation group (n = 40) | 1 (2.50) | 1 (2.50)                     | 0 (0.00)   | 2 (4.89)             |
| Control group (n = 40)     | 3 (7.50) | 2 (5.00)                     | 2 (5.00)   | 7 (17.23)            |
| $\chi^2$                   |          |                              |            | 4.021                |
| $p$                        |          |                              |            | 0.045                |

## 4. Discussion

Vaccine-preventable infectious diseases continue to maintain a relatively high incidence among young children, and the risk of outbreaks in congregate settings such as childcare institutions and primary schools remains a high priority for prevention and control. Under the previous routine vaccination management model, the full-course vaccination rate among age-appropriate children had long struggled to exceed the 85% threshold, with missed and delayed doses among children from migrant families and those in remote counties accounting for nearly 30%. Parental cognitive biases regarding vaccine-related knowledge further amplify children's risk of infection <sup>[5]</sup>. There is clear room for optimization of the existing management model in primary healthcare settings. This study was conducted in such settings to investigate the practical utility of systematic vaccination management in the prevention and control of infectious diseases in children.

This study observed that children receiving systematic vaccination management achieved higher full-course vaccination rates, experienced fewer mild adverse reactions after vaccination, demonstrated better parental mastery of vaccine-preventable disease knowledge, and exhibited lower incidence of vaccine-preventable infectious diseases during the follow-up period. Some studies have suggested that overly complex health education content may induce information anxiety among parents, thereby reducing acceptance of vaccination. The single-dose lightweight health education materials used in this study—each push notification not exceeding two pages and precisely aligned with the key points of the corresponding vaccination—imposed no additional information burden on parents while enabling them to adjust their children's pre-vaccination diet and activity schedules in advance, thereby reducing post-vaccination discomfort caused by parental oversight. Standardized verification procedures on the day of vaccination and dedicated staff patrols in the observation area facilitated timely detection of adverse reactions in children, allowing immediate guidance and preventing progression of minor reactions <sup>[6]</sup>. Proactive follow-up within 24 hours post-vaccination provided home care instructions for children with mild discomfort, alleviating parental anxiety and reducing unnecessary clinic visits <sup>[7]</sup>. In addition, bi-monthly offline educational sessions addressed parents' specific concerns, gradually correcting misconceptions about vaccination and enhancing their cooperation with the vaccination schedule <sup>[8]</sup>. In this study, parents in the observation group demonstrated significantly higher levels of knowledge awareness, which corresponded to higher full-course vaccination rates. The improvement in full-course vaccination rates directly reduced children's exposure risk to vaccine-preventable infectious diseases—the primary reason for the lower incidence in the observation group during follow-up. This association, to a certain extent, validates the protective effect of full-course vaccination against infectious diseases in children <sup>[9]</sup>. This study implemented the systematic vaccination management framework proposed by the National Disease Control and Prevention Administration in primary healthcare settings, supplementing the empirical data on this model in routine childhood vaccination among underserved populations. Compared with previous small-scale studies, this research included often-overlooked groups such as migrant and remotely residing populations, with management measures more closely aligned with actual primary care conditions <sup>[10]</sup>. Moreover, the effectiveness of systematic vaccination management does not rely on high-end equipment or substantial financial investment, but rather on optimizing existing service processes to expand service coverage and enhance quality.

## 5. Conclusion

In summary, systematic vaccination management can increase the full-course vaccination rate for age-

appropriate vaccines in children, reduce the occurrence of mild post-vaccination adverse reactions, help parents acquire more knowledge related to vaccine-preventable disease control, and lower the incidence of infectious diseases in children during the follow-up period.

## Disclosure statement

The author declares no conflict of interest.

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