# Assessment of Immunization Status in Hospitalized Children Followed by Counseling of Parents and Primary Care Physicians Improves Vaccination Coverage: An Interventional Study

Beda Muehleisen, MD, Gurli Baer, MD, Urs B. Schaad, MD, and Ulrich Heininger, MD

**This prospective, intervention-control study in hospitalized, underimmunized children assessed the effect of vaccination reminders to parents during hospitalization and provides postdischarge rates of catch-up immunizations. One month after hospital discharge, significantly more children in the intervention group (27%) than the controls (8%) had received catch-up immunizations ($P < .001$).** ***(J Pediatr 2007;151:704-6)***

To protect individuals and the population high immunization coverage rates are needed.[1,2] The Swiss standard immunization schedule in childhood comprises protection against nine diseases by administration of the following vaccinations: diphtheria and tetanus toxoids, acellular pertussis component vaccine–inactivated poliomyelitis vaccine–*Haemophilus influenzae* type b conjugate vaccine (DTaP-IPV-Hib) (age 2, 4, 6, and 15 to 24 months), measles, mumps, rubella vaccine (MMR) (age 12 and 15 to 24 months), DTaP-IPV (age 4 to 7 years), and tetanus and diphtheria toxoid vaccine (Td) and hepatitis B vaccine (HBV) (age 11 to 15 years).[3] We recently found significant delays and overall underimmunization in preschool and school-aged children.[4]

Parental recall of a child's immunization status is frequently unreliable.[5-7] However, review of immunization records at the time of hospitalization is an opportunity to identify underimmunized children and to alert patients, parents, and primary care physicians.[8] Consequently, we evaluated the impact of immunization reminders during hospitalization on catch-up immunizations of underimmunized patients after discharge.

## METHODS

Children aged 61 days to 17 years admitted to our institution were eligible for enrollment if they had permanent residence in Switzerland at age 2 months and if they had immunization records available. Children with chronic diseases were excluded. Enrollment was done in a consecutive fashion. The first cohort enrolled (January 1 to March 25, 2003) was the control group; this was followed by an intermediate period of 30 days (March 26 to April 25) before recruitment of the intervention group (April 26 to July 31). The delay until enrollment of the intervention group was done to avoid possible effects of physician reminders on immunization practices for the control group.

After informed consent was obtained, immunization records were assessed. For the control group, missing vaccinations were noted without intervention. In the intervention group, parents were informed about missing immunizations before discharge and were encouraged to contact their primary care physicians for necessary catch-up immunizations. In addition, individual physicians were informed by letter (within 1 week after discharge) about missing vaccinations and were encouraged to administer catch-up immunizations.

Our primary goal was to assess immunizations within 1 month after discharge. We also evaluated immunizations within 9 months of discharge. We performed a follow-up inquiry 9 months after discharge of the last enrolled patient. Follow-up information on all immunizations performed since hospital discharge was requested by mail or phone. If patients had not been seen in private practice since discharge, then information was obtained from parents.

A patient was considered underimmunized if 1 or more immunizations were missing according to the Swiss schedule. Power calculation (NQuery Advisor 4.0; Statistical Solutions, Saugus, MA) revealed that 58 patients would be required in each study

| | | | |
|---|---|---|---|
| DTaP | Diphtheria and tetanus toxoids, acellular pertussis component vaccine | IPV | Inactivated poliomyelitis vaccine |
| HBV | Hepatitis B vaccine | MMR | Measles, mumps, rubella vaccine |
| Hib | *Haemophilus influenzae* type b conjugate vaccine | Td | Tetanus |

From the Division of Pediatric Infectious Diseases, Basel University Children's Hospital, Basel, Switzerland.

Submitted for publication Mar 30, 2007; last revision received Jun 28, 2007; accepted Jul 27, 2007.

Reprint requests: Dr. Ulrich Heininger, Division of Pediatric Infectious Diseases, University Children's Hospital Basel, PO Box 4005, Basel, Switzerland. E-mail: Ulrich.Heininger@ukbb.ch

0022-3476/$ - see front matter



10.1016/j.jpeds.2007.07.051

**Table II. Comparison of underimmunization in control and intervention study groups and proportion of patients with catch-up immunizations performed**

| | Control group, n (%) | Intervention group, n (%) | P* |
|---|---|---|---|
| Underimmunized patients | 111/219 (51) | 98/211 (46) | |
| Missing any MMR | 82/111 (74) | 74/98 (76) | |
| Missing MMR-1 | 26/111 (23) | 38/98 (39) | .016 |
| Missing MMR-2 | 56/111 (51) | 36/98 (37) | .046 |
| Missing combination vaccine immunizations | 56/111 (51) | 46/98 (47) | |
| Catch-up immunizations† | | | |
| Patients with ≥1 CUI within 1 month | 9/106 (8) | 26/95 (27) | < .001 |
| Patients with ≥1 CUI within 9 months | 37/106 (35) | 43/95 (45) | |

*CUI*, catch-up immunizations.
Combination vaccines: Combinations of DTaP ± Hib ± poliomyelitis ± HBV components.
MMR-1 (2): Measles, mumps, rubella combination vaccine, dose 1 (2).
*Only *P* values < .2 are indicated.
†Among 201 patients with follow-up.

group to demonstrate an 30% increase in catch-up immunizations in the intervention group within 9 months of discharge (assuming 20% catch-up immunizations administered in underimmunized individuals in the control group and 50% in the intervention group; 90% power; $P < .05$). Assuming an estimated 70% of patients fulfilling the inclusion criteria, 50% being underimmunized, and 80% completing follow-up, at least 207 patients were required in each study group. The study was approved by the local Ethical Committee.

## RESULTS

During the control and intervention periods, 647 patients were hospitalized (Figure 1; available at www.jpeds.com). Of these, 115 had to be excluded due to vaccinations administered abroad (n = 61), age under 61 days (n = 42), immunosuppression (n = 6), or long-term hospitalization (n = 6). Of the remaining 532 patients, 430 had immunization records (219 in the control group and 211 in the intervention group). The 2 groups had comparable baseline characteristics (Table I; available at www.jpeds.com) as well as admission diagnoses, duration of hospitalization, and nationality (data not shown).

We found underimmunization in 111 patients in the control group (51%) and 98 patients in the intervention group (46%) (Table II). Follow-up information was available from 201 of the 209 total patients (96%) (Table III; available at www.jpeds.com). Of 8 underimmunized children without follow-up data, 5 were in the control group (with 7 missing vaccinations: 2 MMR-1, 2 MMR-2, and 3 other combination vaccines) and 3 were in the intervention group (with 4 missing vaccinations: 1 MMR-1, 1 MMR-2, and 2 other combination vaccines). More patients in the intervention group (27%) compared with the control group (8%) received catch-up immunizations within 1 month of hospital discharge ($P < .001$). Nine months after hospital discharge, 80 patients (40%) had received 1 or more missing catch-up immunizations (Figure 2; Table II), 45% in the intervention group and 35% in the control group. The proportion of parents who opposed immunization was similar in the 2 groups (4.7% in the control group and 6.3% in the intervention group). In the remaining cases, the reasons for lack of catch-up immunizations remained unclear.

## DISCUSSION

Underimmunization was detected in 49% of children in this study. Significantly more catch-up immunizations were administered within 1 month after hospital discharge in the intervention group. Nonetheless, most patients with immunization gaps remained underimmunized 9 months after discharge.

A recent study in England found that providing social services with information on the immunization status of a cohort of 136 "looked-after" children did not improve the children's immunization coverage.[9] The investigators assessed the children's immunization records and reported gaps to the responsible senior social services managers; however, none of the 56 children with missing immunizations was brought up to date. The fact that we approached both the primary care physicians and the parents may explain the effectiveness of our intervention.

Our study has some limitations. Assessment of immunizations was based on written records. Some children may have been classified as underimmunized even though they might have received the respective immunization(s) without documentation. However, this rate would not be expected to be different between groups. Immunization records were missing in some patients. It remains unclear whether documents were lost or whether parents refused participation; immunization gaps may be more pronounced in these patients. Again, this rate was similar in both groups and should not have influenced our findings. Finally, this was a single-center study, and our results may not be generalizable.

There is considerable room for improvement for a sustainable effect. Repeated reminders might be needed if recommended immunizations are not performed shortly after hospital discharge. The proportion of catch-up immunizations was not significantly higher in the intervention group compared with the control group 9 months after discharge. Possibly our intervention influenced the immunization behaviors of physicians and thus interfered with the 9-month follow-up findings, whereas the intermediate period may have preserved our 1-month data.

*We thank all of the patients, their parents, and their primary care physicians for participating in this study. We are grateful to Christian Schindler, Institute for Social and Preventive Medicine, University of Basel and Thomas Erb, University Children's Hospital Basel for*