Do Missed Opportunities Stay Missed? A 6-Month Follow-up of Missed Vaccine Opportunities in Inner City Milwaukee Children

Svapna S. Sabnis, MD; Albert J. Pomeranz, MD; Patricia S. Lye, MD, MS; and Margaret M. Amateau, MD

ABSTRACT. Objectives. To determine 1) the frequency of missed vaccine opportunities (VOs) in inner city children ≤ 3 years of age; 2) whether the recommended vaccine(s) were given within 6 months of the missed opportunity (MO); 3) whether these vaccinations were age-appropriate according to the guidelines of the Advisory Committee on Immunization Practices; and 4) variables associated with MOs.

Design. Retrospective chart review with a nested retrospective cohort of children with MOs.

Setting. Two inner city practice settings in Milwaukee: a community health center and an academic continuity care practice.

Patients/Selection Procedure. A consecutive sample of 710 visits of inner city children ≤ 3 years of age with VOs, seen between January 1 and March 31, 1995. A VO was defined as any encounter when the child was vaccine-eligible according to Advisory Committee on Immunization Practices guidelines.

Results. MOs occurred in 47% (330/710) of the VOs. Only 40% of the children with MOs received age-appropriate immunizations within 6 months; 30% received the vaccinations beyond the age-appropriate time. The remaining 30% either did not return or were not vaccinated on return. The variables significantly associated with MOs were 1) age: children with MOs were older than those without, with a mean age of 15.5 months vs 10.9 months; 2) minor febrile illness; 3) moderate/severe illness; 4) acute illness encounters; and 5) patient's being seen at the community health center. Only 15.5% of all MOs were justified by the presence of moderate/severe illness.

Conclusions. VOs are frequently missed in inner city children. Most of the MOs were not justified by the valid contraindication of moderate/severe illness. Sixty percent of the children with MOs did not receive age-appropriate immunizations within 6 months. These children are vulnerable to vaccine-preventable diseases such as measles and pertussis. Pediatrics 1998;101(5). URL: http://www.pediatrics.org/cgi/content/full/101/5/e5; immunization, vaccination, missed opportunities, children, pre-school.

ABBREVIATIONS. DTP/DTaP, diphtheria, tetanus and pertussis/acellular pertussis vaccines; OPV/IPV, oral polio vaccine/ inactivated polio vaccine; MMR, measles, mumps, and rubella vaccine; VO, vaccine opportunities; MO, missed opportunities; Hib, Haemophilus influenzae type B vaccine; CI, confidence interval; SBI, serious bacterial illness.

Child immunization rates in the United States rose in 1996 to 79% of children between the ages of 19 and 35 months having had a complete series of four diphtheria, tetanus, and pertussis vaccines (DTP), three oral polio vaccines (OPV), and one measles, mumps, and rubella (MMR) vaccine. However, this figure still falls far short of the Healthy People 2000 goal of 90% of children being fully immunized by their second birthday. Of particular concern are urban pockets of underimmunization where the immunization levels fall significantly below national levels. In the city of Milwaukee, only 41% of children in a retrospective school survey in 1995 to 1996 had received the complete vaccination series (four DTP, three OPV, and one MMR) by age 2. In contrast, 70% of children in the Milwaukee suburbs had completed the series.

The National Vaccine Advisory Committee identified several barriers to vaccine delivery, including system barriers (long waiting periods, appointment-only services, prevaccination physical examination requirements) and missed vaccine opportunities (VOs). Missed opportunities (MOs) occur when a vaccine-eligible child does not receive the needed vaccine(s). Although many studies have examined the reasons for MOs, there is little follow-up information on children with missed vaccines. In particular, it is not clear whether the missed vaccines are provided at a follow-up visit but still within an age-appropriate time.

The objective of this study was to examine the frequency of missed VOs among preschool children seen in two urban practices and their possible reasons. We also wanted to determine whether the missed vaccinations were given age-appropriately within the 6 months after the MO. We studied children ≤ 3 years of age because preschool children are more likely to be underimmunized.

METHODS

Setting

The study was conducted at two urban practices in Milwaukee, WI. One was a community health center with patients primarily of Hispanic ethnicity (>70%) and staffed by 13 physicians (pediatricians and family practitioners). The other was an academic pediatric practice with primarily African-American ethnicity (>80%) and staffed by 12 faculty pediatricians, pediatric residents, and medical students. Both clinics allowed immunization only visits and had no policies against immunizing during acute illness visits.
Immunization records were easily available at both clinics. At the academic clinic, a computerized flowsheet was placed in the chart at every visit, with computer-generated reminders about which vaccines were due. At the community clinic, a vaccine flowsheet was clearly visible when the chart was opened.

**Patient Selection**

We retrospectively reviewed 1849 consecutive visits of 1418 children 2 to 36 months of age between January 1 and March 31, 1995, for VOs. We defined a VO as any visit when the child was eligible for one or more of the DTP/DTaP, *Haemophilus influenzae* type B (Hib), OPV/IPV, or MMR vaccines according to the Advisory Committee on Immunization Practices guidelines issued in January 1995 (Table 1), which was adopted at both clinics. The standard was that a child would receive all the vaccine(s) for which s/he was age-eligible regardless of reason for the visit. The MOs associated with true contraindications such as moderate or severe illness (Table 2) were defined as justified MOs.

**Data Collection**

VOs were present in 710 of the 1849 patient visits. These VOs were reviewed for the following:

1. Were the VOs missed?
2. Were the missed vaccines given within the following 6 months and at the appropriate age? An age-appropriate vaccination is one given within the recommended age range for that vaccine (Table 1). The period of 6 months was chosen arbitrarily as a reasonable period within which the child should have received delayed vaccinations. For example, if a 6-month-old with no previous vaccinations is not vaccinated, this is an MO. If the infant returns at 10 months of age and is vaccinated, although s/he will have received vaccinations within the 6-month follow-up period of our study, s/he will not have received them age-appropriately.
3. Which variables were associated with MOs? Inappropriate contraindications include states such as prematurity, current antibiotic therapy, and minor illnesses including low-grade fevers; chronic controlled illness includes conditions such as asthma or seizures. True vaccine contraindications were those defined in the 1994 Red Book and include moderate or severe illness (Table 2). Other variables include visit-type and practice setting, and demographic variables of age, gender, and insurance status.

**Statistical Analysis**

Univariate analysis was performed using Epi-Info. Continuous variables were compared with the student’s *t* test. Categorical variables were compared by chi-square analysis. Results were considered significant at *P* < .05. Logistic regression was performed using SAS. The models were constructed using variables that were significant in the univariate analysis or were thought to be clinically relevant. A stepwise approach with a selection criterion of 0.01 was used to build the models.

**RESULTS**

**Frequency of Missed VOs**

MOs occurred in 330 of 710 (46.5%; 95% confidence interval [CI]: 42.8%, 50.1%) of all visits with VOs. Excluding the justified MOs associated with moderate or severe illness, the frequency was 42.4% (278/656, 95% CI: 38.6%, 46.3%).

**Six-month Follow-up of Missed VOs**

On 6-month follow-up of the cohort with MOs, 40.3% received the missed vaccine in an age-appropriate time and 30.3% received the vaccinations beyond the age-appropriate time. The remaining 29.4% either did not return or were not vaccinated on return (Table 3).

**Variables Associated With MOs**

Logistic regression analysis showed a significant association between MOs and the variables of practice setting, visit type, age, minor febrile illness, and moderate or severe illness (Table 4). The community clinic had more missed VOs than did the academic practice (49% vs 44%; *P* < .001). However, they gave significantly more age-appropriate vaccinations on follow-up (Table 5). Sixty-eight percent of the acute visits versus 35% of all other visits (*P* < .001) had MOs. MOs, however, occurred at all types of visits including 20% of well-child visits, 74% of follow-up visits, 66% of acute illness visits, and 96% of laboratory-only visits. Of the immunization-only visits, 23% (3/13) had MOs when the child received some but not all vaccines for which they were eligible. Older children were more likely to have MOs. The mean age of children with MOs was 15.5 months versus 10.9 months in those without MOs (*P* < .001). There was a statistically significant difference between the mean ages of children at the community clinic (11.4 months) and the continuity clinic (14.7 months) that was controlled for on regression analysis. There was no significant difference between clinics with regard to gender distribution (55% male, 45% female) and payer type (7% private insurance; 10% no insurance; 83% Medicaid or Medicaid–HMO).

Minor febrile illnesses were significantly associ-

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**TABLE 1.** Definitions of Vaccine Opportunity and Age-appropriate Vaccination

<table>
<thead>
<tr>
<th>Vaccine(s) Due</th>
<th>Vaccine Opportunity Present</th>
<th>Vaccine Age Appropriate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st DTP, Hib, OPV</td>
<td>Age &gt; 2 mo</td>
<td>Age ≤ 4 mo</td>
</tr>
<tr>
<td>2nd DTP, Hib, OPV</td>
<td>No previous DTP, Hib, OPV</td>
<td>Age ≤ 6 mo</td>
</tr>
<tr>
<td>3rd DTP, Hib, OPV</td>
<td>Age &gt; 4 mo</td>
<td>Age ≤ 8 mo</td>
</tr>
<tr>
<td>4th DTP</td>
<td>2 mo since 1st set</td>
<td>Age ≤ 12 mo</td>
</tr>
<tr>
<td>4th Hib</td>
<td>Age &gt; 6 mo</td>
<td>Age ≤ 18 mo</td>
</tr>
<tr>
<td>MMR</td>
<td>2 mo since 2nd set</td>
<td></td>
</tr>
</tbody>
</table>

*For the first three sets, vaccines given within a 2-month grace period were considered age-appropriate. For the others, the outer age limits defined by the ACIP schedule were considered age-appropriate.

* Although the 4th Hib may be given at >12 months with an interval of 2 months, it was considered due at the same time as the 4th DTP because a combined DTP/Hib was in use. In children in whom initial Hib vaccination was delayed until ≥7 months, the schedule recommended in the 1994 Red Book (Table 3.9) was used.*
TABLE 5. Comparing 6-Month Follow-up of the MOs at Both Were Children With MOs Vaccinated Within 6 Months? Follow-up of the MOs

<table>
<thead>
<tr>
<th>Description</th>
<th>Frequency</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Received missed vaccine, age appropriate</td>
<td>40.3%</td>
<td>35%–45.8%</td>
</tr>
<tr>
<td>Received missed vaccine, not age appropriate</td>
<td>30.3%</td>
<td>25.5%–35.6%</td>
</tr>
<tr>
<td>Returned but did not receive vaccine</td>
<td>17.3%</td>
<td>13.4%–21.9%</td>
</tr>
<tr>
<td>Did not return</td>
<td>12.1%</td>
<td>8.9%–16.3%</td>
</tr>
</tbody>
</table>

TABLE 3. Were Children With MOs Vaccinated Within 6 Months? Follow-up of the MOs

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds Ratio</th>
<th>95% CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinic type, community clinic</td>
<td>3.496</td>
<td>2.33–5.24</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Age, older</td>
<td>1.091</td>
<td>1.07–1.12</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Visit type, acute</td>
<td>3.681</td>
<td>2.43–5.59</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Moderate or severe illness</td>
<td>43.019</td>
<td>9.92–186.5</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Minor febrile illness</td>
<td>2.066</td>
<td>1.16–3.67</td>
<td>.0133</td>
</tr>
</tbody>
</table>

TABLE 4. Risks for MOs: Significant Variables in Logistic Regression Models

<table>
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<tr>
<th>Variable</th>
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<th>95% CI</th>
<th>P</th>
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</table>

TABLE 5. Comparing 6-Month Follow-up of the MOs at Both Clinical Practices (P < .001)

<table>
<thead>
<tr>
<th>Description</th>
<th>Academic Practice</th>
<th>Community Health Center</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age-appropriate vaccinations given</td>
<td>21% (33/157)</td>
<td>57.8% (100/173)</td>
</tr>
<tr>
<td>Vaccinations given beyond age-appropriate period</td>
<td>36.3% (57/157)</td>
<td>24.9% (43/173)</td>
</tr>
<tr>
<td>Returned within 6 months but not immunized</td>
<td>21.7% (34/151)</td>
<td>13.3% (23/173)</td>
</tr>
<tr>
<td>Did not return</td>
<td>21.2% (33/157)</td>
<td>4% (7/173)</td>
</tr>
</tbody>
</table>

DISCUSSION

Our study of two central city clinics found that MOs occurred frequently (46.5% of visits with VOs). A study of seven primary care clinics in Rochester, NY, found MOs ranging from 2.1% to 30% of all office visits.8

Our study found that MOs were significantly associated with acute visits, younger age, minor febrile illness, and moderate or severe illness. Justified MOs associated with moderate or severe illness accounted for only 15.5% of all MOs. MOs may be attributable to deficits in the provider’s knowledge of the immunization schedule and true vaccine contraindications or overcautious interpretation of the contraindications. Minor illness, although not a true contraindication, often is associated with MOs.8,10,11 Although MOs occur most often at acute illness visits,8,12,13 they also occur at age-appropriate preventive visits.4,8,10,15 Other reasons cited for MOs are failure to review vaccine status,14 incomplete vaccine records,15 and vaccine shortages.16 Physicians may be reluctant to give multiple vaccines simultaneously14,15,17 and often are concerned that vaccinating during acute visits might decrease well-child care attendance.18 It is likely that there may be more than one reason for a missed VO.

On 6-month follow-up of patients with MOs, only 40.3% received age-appropriate vaccinations. The remaining 59.7% either received delayed (later than 6 months) or no vaccinations, or were lost to follow-up. In 14.5% of children, some but not all of the vaccines due were given. The reason for not giving all vaccines simultaneously was not documented clearly. However, 4 of these 48 MOs were OPVs that do not require injections. This indicates that reluctance to give too many shots may not be the only reason why some vaccinations are not given when multiple vaccines are due. Other reasons may include deficits in knowledge of vaccine schedules or errors in screening vaccine status. School immunization laws ensure that school children are immunized, but there usually are no similar laws protecting preschoolers. MOs in this group may result in delayed vaccinations, underimmunization, and inadequate protection against preventable diseases like pertussis and measles.19,20 Our results demonstrate the impor-
tance of screening for and providing all vaccines for which the child is eligible, provided there are no true contraindications.

This study has several limitations. Differentiating between a minor and a more severe illness is not simple; thus, our definition of moderate or severe illness is not comprehensive or absolute. In this study, there were patients immunized with no adverse effects, although they met our definition of moderate or severe illness. The individual physician can make a case-by-case decision about the severity of illness. A review of the literature yielded no guidelines on moderate or severe illness. The development of such guidelines might be helpful to the busy practitioner in deciding when to withhold vaccinations in case of illness. This study was performed at an academic practice and a community health center and may not be generalizable to private practices. Also, a prospective study is needed to determine the precise reasons for MOs. Our chart review did not address whether children with MOs had return visits scheduled to receive their immunizations. We also cannot comment on whether the children who did not return for follow-up actually were immunized at other centers. The time of the study, from January through March, was chosen for convenience, but it might have been associated with greater number of acute care visits.

Reasons for the statistically significant differences between the two practices are unclear and may not be clinically relevant. The lower number of MOs at the academic practice may be attributable to an emphasis on teaching. The community health center provided more age-appropriate immunizations on follow-up. This may be attributable to better continuity of care with the same physician or possible differences in patient populations and their compliance with earlier return.

CONCLUSIONS AND RECOMMENDATIONS

The results of our study support the National Vaccine Advisory Committee recommendations to use all clinical encounters to vaccinate, simultaneously administer all vaccines needed, and observe only true contraindications for withholding vaccinations. If these recommendations had been followed, all but the justified MOs could have been avoided. In an urban population in whom medical care may occur only at acute visits, it is imperative not to miss VOs. Our study shows that most of the children with MOs will have either delayed or no follow-up immunizations and that many MOs stayed missed.

We speculate that education and feedback to vaccine providers may be important in decreasing MOs. Feedback could include information on clinic-specific immunization rates and MO rates. A study in Georgia public clinics demonstrated an increase in vaccine coverage with feedback to practitioners.21 We also suggest regular review of immunization schedules with updates from the American Academy of Pediatrics or Advisory Committee on Immunization Practices, reviewing true and false contraindications for immunization and developing clinic guidelines on appropriate reasons to withhold immunizations.
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