



Frequent Vaccination Missed Opportunities at Primary Care Encounters Contribute to Underimmunization

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Objective To examine missed opportunities to administer an eligible vaccination (MOs) and their contribution to underimmunization in contemporary pediatric practices.

Study design This study was a retrospective analysis from 42 diverse pediatric practices located throughout the US. Medical records of 50 randomly selected children 3-18 months of age per practice were reviewed in Spring 2013. Immunization status for age and MOs were assessed as of each encounter and as of March 1, 2013.

Results Of 2076 eligible patients, 72.7% (95% CI 67.6-77.9) were up-to-date with receipt of standard vaccines. Most children (82.4%; 95% CI 78.3-85.9) had at least 1 MO, and 37.8% (95% CI 30.0-46.2) had at least one MO to administer an overdue vaccination. After adjustment, risk of underimmunization was 3.5 times greater for patients who had ever experienced an MO for an overdue vaccination compared with those who had not (adjusted relative risk = 3.5; 95% CI 2.8-4.3). If all age-appropriate vaccinations had been administered at the last recorded encounter, 45.5% (95% CI 36.8-54.5) of the underimmunized patients would have been up to date at the time of assessment.

Conclusion MOs were common and contributed substantially to underimmunization in this contemporary sample of diverse primary care practice settings. (*J Pediatr* 2015;166:412-7).

Although rates of immunization have increased in recent years in the US, coverage varies widely by geographic region, practice, and patient demographic factors.¹ In 2013, only 70.4% of American children ages 19-35 months of age had received all recommended vaccinations.¹ Vaccination delay leaves children vulnerable to vaccine-preventable illnesses in the interim.²⁻⁵ Moreover, failure to receive vaccines on schedule early in life predicts future underimmunization.⁶⁻⁸ Since 1996, the National Vaccine Advisory Committee (NVAC) has recommended strategies for health care practitioners to reduce the incidence of missed opportunities to administer an eligible vaccination (MO) to children when they are brought for care.⁹ For instance, NVAC standards call for practitioners to review the vaccination status of children and administer all due and overdue vaccines at every encounter rather than exclusively at health maintenance visits.¹⁰ They also recommend administering all vaccines unless there is a valid medical contraindication¹⁰ and giving all age-appropriate vaccines simultaneously.¹¹ Furthermore, the Centers for Disease Control and Prevention (CDC) advises against vaccination postponement for mild acute illnesses, including diarrhea, minor upper respiratory tract infections with or without fever, otitis media, mild-to-moderate local reactions to a previous vaccine dose, and current antibiotic therapy.¹¹ Thus, in most cases, children should receive all indicated vaccinations at any health care encounter. In the mid-1990s, several studies demonstrated that pediatric practice missed opportunities to administer indicated vaccines at roughly 50% of the encounters.^{6,12-14} Our literature search did not yield any studies describing the frequency of vaccination MOs subsequent to the wide dissemination of the NVAC and CDC recommendations.

In the present study, we describe the frequency of MOs among a contemporary sample of pediatric primary care practices as well as the association of various patient and medical-practice factors with MOs. In addition, we quantify the relationship between MOs and vaccination status during the first 18 months of life.

ACIP	Advisory Committee on Immunization Practices
aRR	Adjusted risk ratio
CDC	Centers for Disease Control and Prevention
HepB	Hepatitis B vaccine
MO	Missed opportunity to administer an eligible vaccination
MO-OD	Missed opportunity to administer an overdue vaccination
NVAC	National Vaccine Advisory Committee
QI	Quality improvement
RR	Relative risk
UTD	Up-to-date

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Methods

The present analysis uses baseline data collected as part of a year-long immunization quality improvement (QI) dissemination study. This study was approved by the Institutional Review Board of Children's National Health System in Washington, DC. The collection of all data in the present analysis was included in the Institutional Review Board–approved protocol.

Study advertisements for the QI project were placed in 4 pediatric journals and e-mailed to members of 2 national pediatric professional associations (American Academy of Pediatrics, Academic Pediatric Association), as well as 52 different state and regional primary care, immunization, or QI networks. Study invitations also were sent to members of an online physician networking site (Doximity). All advertisements directed interested individuals to an online eligibility survey created using the REDCap application.¹⁵ The survey embedded stop action logic such that the ability to proceed to any subsequent item was predicated on an acceptable response—based on eligibility criteria—to all previous items.

To be eligible for the study, an individual had to spend the majority of his/her clinical time in general pediatrics; not currently be in training; be able to generate a complete listing of ages of patients in the practice; and have access to high-speed internet (required for QI study activities). Additional eligibility criteria stipulated that the participating practice must immunize 5 or more children ages 0-18 months per week; have estimated immunization rates of less than 86% for children ages 3-18 months old; and be able to commit the participation of at least one physician, one clinical support staff, and one administrative staff member to a QI project. Of the 300 individuals who started the eligibility survey, 42 respondents and their practices met all the aforementioned eligibility criteria and consented to participate. These respondents served as project leaders in the study on behalf of the 42 enrolled practices from 23 states. Data for the present analysis were collected at baseline before the start of any QI interventions.

At each participating practice, records of 50 randomly selected patients aged 3-18 months old were reviewed onsite and specified data were extracted by 1 of 3 pediatrician researchers or a pediatric registered nurse researcher using the Comprehensive Clinical Assessment Software Application for immunizations.¹⁶ To ensure uniformity of the process, all aspects of data collection were codified into a standardized, written protocol. Before their first site visit, all research team members received training in the protocol, which included a requirement to enter mock data from 25 simulated patient records with 100% accuracy.

At each site, patients were stratified by age at the time of assessment into 4 groups whose boundaries coincide with the minimum and maximum recommended ages for routine receipt of vaccine doses.¹⁷ Patients in each stratum were sorted randomly for sample selection. The sampling strategy

was designed to oversample the larger age strata according to the following distribution: 3-4 months, $n = 10$; 5-6 months, $n = 10$; 7-15 months, $n = 16$; 16-18 months, $n = 14$. A medical record was excluded if there was documentation that the child had moved or gone elsewhere for routine primary care, had not had any contact with the practice in at least 12 months, or had fewer than 2 encounters at the practice before the assessment date. Records of patients who met exclusion criteria were replaced by the next patient record in the corresponding age-specific randomly ordered list. When no additional eligible patient records were available for replacement in the corresponding age stratum, a patient record from an adjacent age stratum was selected. At the 3 practices in which the total eligible patient population aged 3-18 months old was less than 50 ($n = 37, 42, \text{ and } 47$, respectively), all eligible records of patients aged 3-18 months on the date of assessment were included.

Data extracted from patient records included sex, insurance status (Medicaid or non-Medicaid), documentation of any reason a vaccination was not administered, and documentation of vaccinations administered by an outside provider. The following dates also were extracted: date of birth and dates of all encounters and vaccinations from birth to March 1, 2013 (arbitrarily selected assessment date for all records reviewed). The following areas of the medical record were searched for reasons why vaccinations were withheld: all vaccination administration records, the problem list, and treatment records for all well-child encounters and any encounter on which simultaneous vaccinations could have been administered but were not. Project leaders at each site also completed an online survey via the REDCap application¹⁵ from which the following variables were obtained: total number of practitioners, estimated racial and ethnic composition of patient population, practice setting, practice type (free-standing independent practice; federally qualified or community health center; or other, including academic practice, health maintenance organization, and integrated delivery system), and use of an electronic medical record system.

Patient vaccination status was determined according to the 2011 Advisory Committee on Immunization Practices (ACIP) routine and catch-up schedules.¹⁸ We assessed for the following vaccines: hepatitis B (HepB); diphtheria and tetanus toxoids and pertussis; *Haemophilus influenzae* type b; pneumococcal conjugate; inactivated poliovirus; measles, mumps, rubella; and varicella (Table I). As per ACIP, doses were considered valid if given within 4 days of the minimum recommended ages and/or intervals.¹¹ Per ACIP, the first dose of HepB should be administered to all newborns before hospital discharge; however, no maximum age for compliance is specified. For our analysis, we assigned an upper limit of 4 days of age.

Vaccination status was determined for each patient as of the assessment date and as of the conclusion of each patient encounter. A child who had not yet received a recommended vaccination and was older than the lower limit of the recommended age range with a sufficient interval from a previous

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