Improving Immunization Rates at 18 Months of Age: Implications for Individual Practices

James T. McElligott, MD, MSCR[a]
James R. Roberts, MD, MPH[a]
Elizabeth S. O'Brien, RN[a]
Katherine D. Freeland, BS[a]
Maureen S. Kolasa, RN, MPH[b]
John Stevenson, MA[b]
Paul M. Darden, MD[c]

ABSTRACT

Objective. We sought to model the effect that a targeted immunization visit at 18 months of age could have on immunization rates of preschool-aged children in a sample of pediatric practices.

Methods. We conducted retrospective chart reviews in six practices of all active patients aged 18–30 months. Up-to-date (UTD) status was defined as receipt of four diphtheria-tetanus-acellular pertussis, three polio, one measles-mumps-rubella, three hepatitis B, and one varicella vaccines. *Haemophilus influenza* tybe b vaccine was not included due to a shortage in vaccine supply during the time of the study. Practice vaccination rates were determined at 17 months, 18 months, and the age at assessment. Of those not UTD at 17 months, the percentage of children who could be brought UTD with one visit was calculated for each practice. This calculated rate was compared with the measured rate at 18 months of age and at the age of assessment.

Results. At each practice, we reviewed 183–616 charts (median = 382). Observed UTD immunization rates at 17 months ranged from 26% to 64% (median = 38%) and increased 3 to 27 percentage points (median = 6) from age 17 months to 18 months and 9 to 39 percentage points (median = 17) from age 17 months to the age at assessment. A simulated vaccination visit at 18 months of age could improve the UTD rates from 27 to 61 percentage points (median = 44).

Conclusion. Practice-based interventions aimed at encouraging an 18-month well-child visit that emphasizes delivery of vaccines have the potential to substantially increase timely vaccination rates among individual practices.

[a]Medical University of South Carolina, Charleston, SC

[b]Centers for Disease Control and Prevention, Immunization Services Division, Atlanta, GA

[c]University of Oklahoma Health Sciences Center, General & Community Pediatrics, Oklahoma City, OK

Address correspondence to: James T. McElligott, MD, MSCR, Medical University of South Carolina, 135 Rutledge Ave., Charleston, SC 29425; tel. 843-876-8512; fax 843-876-8709; e-mail <mcellig@musc.edu>.

©2011 Association of Schools of Public Health

Immunizations are among the most effective medical interventions affecting the health of children when coverage is adequate.[1,2] Recognizing this importance, the health community has made much progress in improving vaccine delivery to children, and overall coverage is now greater than 95% among U.S. children at school entry.[3] However, many children do not receive all vaccinations according to the recommended vaccination schedule, with one-third of all children being undervaccinated for more than six months during the first two years of life.[4] This vaccination gap is important because children of this age are vulnerable to vaccine-preventable diseases and can serve as vectors for disease transmission.[5–8] Addressing this vaccination gap requires an increased focus on the immunization opportunities in the second year of life.

The 18-month well-child visit, as recommended by the American Academy of Pediatrics,[9,10] is an excellent opportunity to improve the vaccine series completion rates for children prior to school entry.[11] A study by Shimabukuro et al. utilized the 2004 National Immunization Survey to perform a simulation in which children not already up-to-date (UTD) received all eligible vaccinations at an 18-month visit to demonstrate whether one visit would have improved the immunization rate. Using a series definition of four diphtheria-tetanus-acellular pertussis (DTaP), three polio (IPV), one measles-mumps-rubella (MMR), three *Haemophilus influenzae* type b (Hib), three hepatitis B (Hep B), and one varicella (VAR) vaccines, the authors reported an increase in the series completion rate from the true rate of 61% to a potential rate of 87% at 18 months of age if all eligible doses were administered at an 18-month visit.[12] The results indicated that there was significant opportunity to impact immunization rates both at 18 months of age and overall with interventions targeted at the 18-month well-child visit.

This study sought to demonstrate, at the practice level, the potential of an immunization visit targeted at 18 months of age to improve vaccination completion rates.

METHODS

This study was part of an overall quality improvement effort to increase immunization rates among pediatric practices in the South Carolina Pediatric Practice Research Network (SCPPRN). The Institutional Review Board of the Medical University of South Carolina reviewed and approved the study.

Setting

The SCPPRN consists of pediatric practices throughout South Carolina organized and administered by the Division of General Pediatrics at the Medical University of South Carolina to collaborate on pediatric research projects. At the time the study was initiated, the network included nine practices, six of which chose to participate. The practices varied by geographic location, patient population, vaccine schedules, and record-keeping methods. None of the practices in the study utilized a statewide immunization registry.

Procedures and definitions

Immunization rates for each pediatric practice were obtained through retrospective chart reviews performed for active patients who were 18–30 months of age at the time of assessment. Active patients were defined as children aged 18–30 months as of May 31, 2008, who had visited a participating practice on or after their first birthday. The practices provided all of the charts for every eligible child, and trained study personnel reviewed each chart.

The date of assessment varied for each practice, though all children assessed would have been at least 18 months of age if included in the study and no older than 30 months of age. Age of 18 months was defined as having completed the full 18th month of life.

Study data were extracted from clinical sources by manual chart review for two practices and electronic data download for the remaining four practices. Of these four practices, three used an electronic medical record. The fourth used paper charting with a practice electronic immunization registry updated through billing and manual data entry. The electronic medical records systems were put in place prior to the study period. All practices reported use of a similar vaccination schedule for the antigens assessed. Practice characteristics of percentage of patients with Medicaid, gender distribution, and use of an electronic medical record were obtained through surveys sent to the practices. Vaccination schedule used was determined through site visit.

Active patients were considered UTD for immunizations if they had received the following number of doses and vaccines: four DTaP, three IPV, one MMR, three Hep B, and one VAR. The Hib vaccine was not included due to a shortage in vaccine supply during the time of the study, which is consistent with Centers for Disease Control and Prevention (CDC) reporting of vaccination rates for the time period.[13] With the exception of the Hib vaccination, these antigens are consistent with the model used in the previous study by Shimabukuro et al.[12]

Calculations were performed using the Comprehensive Clinic Assessment Software Application (CoCASA) 3.3.80, a tool for assessing immunization practices within a clinic.[14] CoCASA performs a tally count of the antigens received that are in accordance with the Advisory Committee on Immunization Practices guidelines published by CDC.[15,16] We used SAS® version 9.2 to confirm the results and perform the modeled calculation at 18 months of age.[17]

Analysis

We determined the immunization rate for each practice for children at age 17 months and used this rate as the basis for comparison of subsequent rates within each practice. Practice performance for children at age 18 months was defined as the percentage of children UTD by 18 months of age. Practice performance for children at the time of assessment was defined as the percentage of children UTD when the charts were reviewed and includes vaccines given after age 18 months through age 30 months. The practice potential immunization coverage rate at age 18 months was calculated by adding one more, maximally utilized vaccination visit (all vaccines the patient was eligible to receive) at age 18 months to each child's immunization record at age 17 months.[15] Summary comparisons for the practice network as a group were reported with ranges and the median value.

RESULTS

For each practice, we reviewed 183–616 charts (median = 382, total n=2,386). Two of the practices were urban, two were suburban, and two were rural. For this analysis, we identified the six practices as Practices A–F. One of the participating practices was based at an academic institution and was staffed with pediatric residents and medical students as well as supervising attending physicians. Among all the practices, the percentage of patients insured through Medicaid ranged from 6% to 91%, the percentage of black patients ranged from 30% to 85%, and the percentage of patients of Hispanic race/ethnicity ranged from 4% to 52%. Selected characteristics by practice are shown in Table 1.

The percentage of children UTD for their immunizations at age 17 months ranged from 26% to 64% (median = 38%). At age 18 months, 37% to 70% (median = 49%) of children were UTD, an increase of 3 to 27 percentage points (median = 6 percentage points) (Figure).

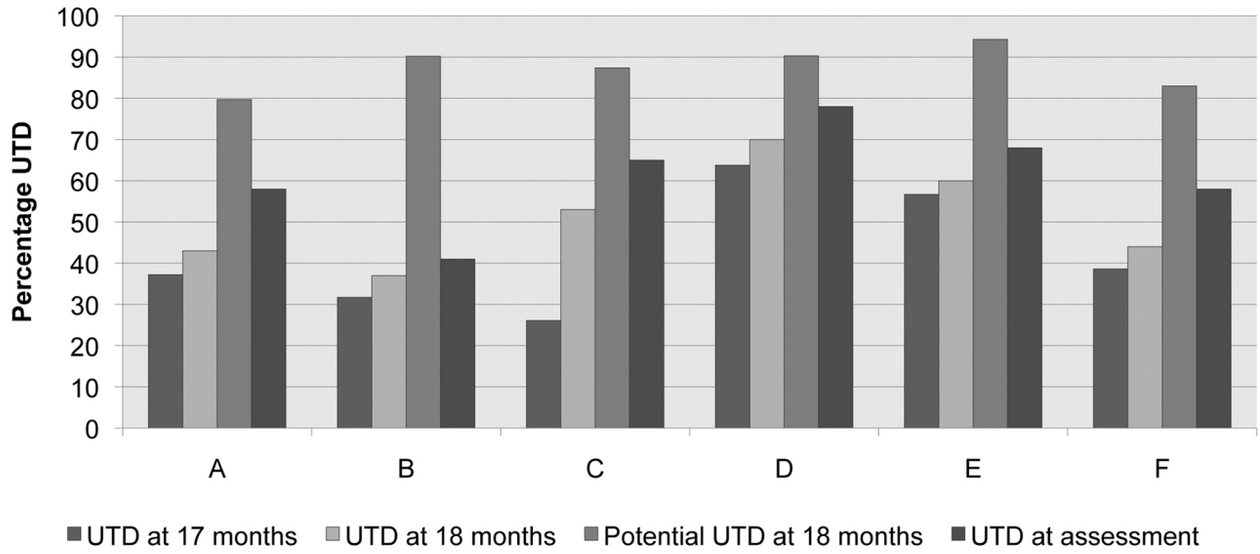
The potential UTD immunization coverage level for each practice, with the inclusion of a fully utilized immunization visit for patients at age 18 months, ranged from 80% to 94% (median = 89%). This estimate represented a calculated increase among the practices of 27 to 61 percentage points (median = 44) over the observed UTD immunization coverage level of patients at age 17 months within each practice. For all practices, the observed UTD immunization coverage level at age 18 months was less than the practice potential UTD coverage if an 18-month well-child visit would have occurred and been fully utilized for all children. Indeed, the highest practice UTD coverage rate was 20 percentage points less than the potential UTD coverage rate: Practice D's patients were 64% UTD at age 17 months and 70% UTD at age 18 months, with a potential UTD of 90% if a fully utilized well-child visit were to occur at age 18 months.

When vaccinations given after age 18 months were included in the coverage assessment (until assessment date), observed immunization coverage rates still lagged behind the potential coverage rates if a fully utilized well-child visit would have occurred at age 18 months for all of the practices. The percentage of children UTD at the date of assessment ranged from 41% to 78% (median = 62%), an increase from baseline coverage of 9 to 39 percentage points (median = 17 percentage points) within each practice. Practice C was notable for having the lowest baseline UTD coverage percentages relative to the other practices, although after 18 months of age, the UTD rate in this practice (53%) surpassed the median coverage (49%) for all practices.

Table 1. Selected characteristics of six practices participating in a study on improving immunization rates of children at age 18 months: South Carolina Pediatric Practice Research Network, 2008

	Practice					
Characteristic	*A*	*B*	*C*	*D*	*E*	*F*
Number of charts reviewed	616	183	207	381	616	383
Percent of patients enrolled in Medicaid	83	6	35	67	91	75
Electronic medical record used	Yes	No	No	No	Yes	Yes

Figure. Observed percentage of patients UTD for vaccinations at age 17 months and 18 months, and potential percentage UTD at 18 months, by practice (A–F), in a study on improving immunization rates of children at age 18 months: South Carolina Pediatric Practice Research Network, 2008[a,b,c]



[a]UTD immunization coverage was defined as the following number of doses and types of vaccines: four diptheria-tetanus-acellular pertussis, three polio, one measles-mumps-rubella, three *Haemophilus influenzae* type b, three hepatitis B, and one varicella.

[b]Date of assessment = age range of 18–30 months

[c]UTD percentage potential at 18 months = UTD percentage at 17-month immunization record plus one additional, maximally utilized well visit at age 18 months

UTD = up-to-date

Table 2 displays the percentage UTD by individual vaccine for each practice. The series that was most frequently incomplete was DTaP (UTD ranged from 48% to 73%, median = 69%). Two practices deviated from this pattern, with Practice B having a low rate of UTD for Hep B vaccine (50%) and Practice C having a low rate of UTD for IPV (66%). Hib antigen (two-vaccine series) was included in Table 2 for comparison, although it was not included in the overall assessment of UTD.

DISCUSSION

Practices can optimize vaccination coverage among young children by emphasizing a well-child visit at 18 months of age. After age 18 months, well-child visits become less frequent, decreasing the number of interactions with health-care providers and, thus, opportunities to address lapses in vaccination coverage. If not UTD at age 18 months, children may go through several years of incomplete vaccination coverage before school vaccination laws would promote receipt of recommended vaccinations. The results of this study suggest that many children aged 18–30 months are underimmunized and, therefore, at risk for contracting vaccine-preventable diseases. The variability in coverage by practice indicates that the practice's performance does influence the immunization rates of its active patients.

Modeling the potential impact of an 18-month well-child visit among these individual practices demonstrates that practices can improve their immunization rates. Our results provide additional evidence to support Shimabukuro et al.'s study demonstrating the value of the 18-month visit in improving vaccination rates of preschool-aged children. Among the SCPPRN practices, the potential percentage point increase (47 percentage points) was greater than the data presented by Shimabukuro et al. (26 percentage points).[12] Additionally, other investigators have documented the benefits of the 18-month well-child visit when it is used as a target for structured interventions regarding screening efforts to identify and manage children with developmental delays.[18,19]

The Standards for Child and Adolescent Immunization practices maintain that all opportunities to

vaccinate should be utilized, including vaccinating during sick visits.[20] These results indicate that a targeted visit at age 18 months has the potential to exceed the practice performance that was seen for children at age 18–30 months, suggesting that not all opportunities for immunization are being adequately utilized by these practices. As a result of this finding, further studies will be conducted with these practices to explore the impact of missed opportunities on vaccination coverage in the second year of life.

To encourage the well-child visit at age 18 months, during which all eligible vaccines are administered, practices would do well to identify children due for vaccinations and then contact their parents to schedule a visit. These tasks can be accomplished on a practice level through routinely sending out reminders to parents of children approaching 18 months of age. Immunization information systems (IISs) can also be utilized on a practice or population level to accomplish this task. Practices and IISs need to ensure that this technical function is easily available within the practice record-keeping system and/or within the IIS and that these reminders are systematically generated for the practice's clients. It is worth noting that none of the practices in this study employed a consistent patient reminder technique or an IIS.

The removal of the Hib antigen as a component of the definition of UTD may have led to an overestimation of the practice rates. Hib vaccination requirements differ by brand of vaccine, and the number of Hib antigens required would differ among practices. To maintain consistency among practices and with CDC assessments for the Hib shortage time period, we removed the antigen from this analysis. To estimate the impact of this omission, the assessment was also performed with the inclusion of two Hib antigens required. No difference in overall UTD was seen in this alternate assessment.

Limitations

This study was limited by practice inconsistencies in vaccine documentation, which could have lowered the calculated practice immunization rates. This limitation was of particular concern for practices that had no electronic medical record. Chart reviewers noted that these practices often had multiple locations in which immunizations were recorded, making it difficult to find records of all administered immunizations. A second concern was for those vaccines given outside of the clinic. All practices attempted to capture all vaccines given, regardless of location, and the study results reflect this charting. However, any vaccinations given but not charted would have the effect of lowering the immunization rate and raising the potential for improvement with an 18-month well-child visit.

Another limitation was that an immunization registry is not widely used in South Carolina, which may limit the generalizability of these results. Such a registry would add validity to the calculated improvement if an 18-month well-child visit were available, though practice charting errors may persist despite the existence of a widely used registry.

Also limiting study interpretation was a lack of knowledge of parental compliance with bringing children to the provider for a scheduled 18-month well visit. Existing literature[19] on well-visit compliance allows for the inference that compliance is lower for well visits in the second year of life relative to the first year. Compliance also varies by patient characteristics, particularly for payer type and income.[21] Future studies

Table 2. Percentage of six participating practices UTD by vaccine type in a study on improving immunization rates of children at age 18 months: South Carolina Pediatric Practice Research Network, 2008

Number of doses and vaccine type (equal to UTD coverage at age 18 months)	*Percent UTD*					
	Practice A	*Practice B*	*Practice C*	*Practice D*	*Practice E*	*Practice F*
4 DTaP	48	68	73	70	69	48
3 Polio	85	70	66	94	95	60
1 MMR	74	75	85	90	87	74
3 Hepatitis B	88	50	72	97	96	87
1 Varicella	64	84	85	88	77	62
2 Hib[a]	90	95	97	98	99	92

[a]Not included in overall assessment of UTD due to shortage of vaccine supply during the study time period

UTD = up-to-date

DTaP = diptheria-tetanus-acellular pertussis

MMR = measles-mumps-rubella

Hib = *Haemophilus influenzae* type b

would be strengthened with the addition of visit rates for visits at 18 months of age. It should also be noted that this study relied on retrospective chart reviews, and the children were of differing ages at the time of assessment. While the point-of-assessment analysis allows valuable insight into catch-up vaccination patterns of the practices, comparisons among practices should be interpreted with caution.

CONCLUSION

This study demonstrated that vaccine coverage among preschool-aged children could be improved with a well-child visit at age 18 months that is maximally utilized for catch-up immunizations. The results reported are consistent with previous evidence[11] and strengthen the argument that the potential for improvement exists in individual pediatric practices. Practices should consider the 18-month well-child visit as a point of focus for practice-specific immunization efforts.

This study was funded by Centers for Disease Control and Prevention (CDC) grant #U01IP0001146. This study was originally presented in February 2009 at the South Eastern Regional Meeting of the Academic Pediatric Society in New Orleans, Louisiana. Paul Darden has acted as a consultant to Pfizer in 2010 and Sanofi Pasteur in 2009; he has no ongoing relationship with either company.

The findings and conclusions presented in this article are those of the authors and do not necessarily represent the views of CDC.

REFERENCES

1. Centers for Disease Control and Prevention (US). Impact of vaccines universally recommended for children—United States, 1900–1998. JAMA 1999;281:1482-3.
2. Plotkin SL, Plotkin SA. A short history of vaccination. In: Plotkin SA, Orenstein WA, editors. Vaccines. 4th ed. New York: Saunders; 2004. p. 1-16.
3. National, state, and local area vaccination coverage among children aged 19–35 months—United States, 2008. MMWR Morb Mortal Wkly Rep 2009;58(33):921-6.
4. Luman ET, McCauley MM, Stokley S, Chu SY, Pickering LK. Timeliness of childhood immunizations. Pediatrics 2002;110:935-9.
5. Dombkowski KJ, Lantz PM, Freed GL. The need for surveillance of delay in age-appropriate immunization. Am J Prev Med 2002;23:36-42.
6. Schlenker TL, Bain C, Baughman AL, Hadler SC. Measles herd immunity. The association of attack rates with immunization rates in preschool children. JAMA 1992;267:823-6.
7. Hutchins SS, Escolan J, Markowitz LE, Hawkins C, Kimbler A, Morgan RA, et al. Measles outbreak among unvaccinated preschool-aged children: opportunities missed by health care providers to administer measles vaccine. Pediatrics 1989;83:369-74.
8. Bisgard KM, Rhodes P, Connelly BL, Bi D, Hahn C, Patrick S, et al. Pertussis vaccine effectiveness among children 6 to 59 months of age in the United States, 1998–2001. Pediatrics 2005;116:e285-94.
9. U.S. Congress, Office of Technology Assessment. Healthy children: investing in the future [OTA-H-345]. Washington: Government Printing Office (US); 1988. Also available from: URL: http://www.fas.org/ota/reports/8819.pdf [cited 2010 May 28].
10. American Academy of Pediatrics. Recommendations for preventive pediatric health care (periodicity schedule). 2008 [cited 2010 May 28]. Available from: URL: http://practice.aap.org/content.aspx?aid=1599
11. Luman ET, Stokley S, Daniels D, Klevens RM. Vaccination visits in early childhood: just one more visit to be fully vaccinated. Am J Prev Med 2001;20(4 Suppl):32-40.
12. Shimabukuro TT, Luman ET, Winston CA, Schieber RA. Potential for improving age-appropriate vaccination coverage by maximizing the 18-month well-child visit. J Public Health Manag Pract 2007;13:572-7.
13. National, state, and local vaccine coverage among children aged 19–35 months—United States, 2009. MMWR Morb Mortal Wkly Rep 2010;59(36):1171-7.
14. Centers for Disease Control and Prevention (US). Comprehensive Clinic Assessment Software Application (CoCASA): Version 3.3.80. Atlanta: CDC; June 2009. Also available from: URL: http://www.cdc.gov/vaccines/programs/cocasa/default.htm [cited 2010 May 28].
15. Centers for Disease Control and Prevention (US), Advisory Committee on Immunization Practices. ACIP recommendations. 2009 [cited 2010 May 28]. Available from: URL: http://www.cdc.gov/vaccines/pubs/ACIP-list.htm
16. Centers for Disease Control and Prevention (US). Vaccines & immunizations: programs and tools: CoCASA: users guide. 2009 [cited 2010 May 28]. Available from: URL: http://www.cdc.gov/vaccines/programs/cocasa/users-guide.htm
17. SAS Institute, Inc. SAS®: Version 9.2. Cary (NC): SAS Institute, Inc.; 2010.
18. Mousmanis P, Watson WJ. The 18-month well-child visit in primary care: clinical strategies for early intervention. Paediatr Child Health 2008;13:845-9.
19. Williams R, Clinton J, Biscaro A. Ontario and the enhanced 18-month well-baby visit: trying new approaches. Paediatr Child Health 2008;13:850-6.
20. National Vaccine Advisory Committee. Standards for child and adolescent immunization practices [published erratum appears in Pediatrics 2004;113:184]. Pediatrics 2003;112:958-63.
21. Selden TM. Compliance with well-child visit recommendations: evidence from the Medical Expenditure Panel Survey, 2000–2002. Pediatrics 2006;118:e1766-78.