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On-time Vaccine Receipt in the First Year Does Not Adversely Affect Neuropsychological Outcomes

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On-time Vaccine Receipt in the First Year Does Not Adversely Affect Neuropsychological Outcomes

WHAT'S KNOWN ON THIS SUBJECT: An increasing number of parents are concerned that children receive too many vaccines too soon, and some are requesting alternative immunization schedules. This practice is not evidence-based and may lead to increased incidence of vaccine-preventable diseases.

WHAT THIS STUDY ADDS: This is the first study to compare long-term neuropsychological outcomes between children with timely vaccination and those with delayed or incomplete vaccination. These data suggest that there is no benefit in delaying immunizations during the first year of life.

abstract

FREE

OBJECTIVES: To determine whether children who received recommended vaccines on time during the first year of life had different neuropsychological outcomes at 7 to 10 years of age as compared with children with delayed receipt or nonreceipt of these vaccines.

METHODS: Publicly available data, including age at vaccination, from a previous VaccineSafety Datalink study of thimerosal exposure and 42 neuropsychological outcomes were analyzed. Vaccine receipt was defined as timely when each vaccine was received within 30 days of the recommended age. Associations between timeliness and each outcome were tested in univariate analyses. Multivariable regression models were constructed for further assessment of the impact of timeliness on neuropsychological outcomes after adjustment for potential confounders. Secondary analyses were performed on a subset of children with the highest and lowest vaccine exposures during the first 7 months of life.

RESULTS: Timely vaccination was associated with better performance on 12 outcomes in univariate testing and remained associated with better performance for 2 outcomes in multivariable analyses. No statistically significant differences favored delayed receipt. In secondary analyses, children with the greatest vaccine exposure during the first 7 months of life performed better than children with the least vaccine exposure on 15 outcomes in univariate testing; these differences did not persist in multivariable analyses. No statistically significant differences favored the less vaccinated children.

CONCLUSIONS: Timely vaccination during infancy has no adverse effect on neuropsychological outcomes 7 to 10 years later. These data may reassure parents who are concerned that children receive too many vaccines too soon. *Pediatrics* 2010;125:1134–1141

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KEY WORDS

vaccines, vaccine safety, neurodevelopmental, public health

ABBREVIATIONS

VSD—Vaccine Safety Datalink
DT—diphtheria-tetanus-pertussis
Hib—*Haemophilus influenzae* type B

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Childhood vaccines have led to remarkable reductions in child mortality and disease-related injury during the past 60 years[1]; however, as the visible threats of vaccine-preventable diseases have decreased, parental concerns about vaccine safety have increased.[2] Most recently, these concerns have focused on the now debunked links between autism and the measles-mumps-rubella vaccine as well as concerns about the ethyl mercury–containing preservative thimerosal, which is no longer present in routine childhood immunizations except for some influenza vaccines.[3]

Another area of parental angst relates to potential overburdening of the infant immune system or other harms as a result of administration of multiple vaccines at an early age.[4] Although the number of parents who completely refuse vaccines remains low,[5] many families are requesting alternative immunization schedules that space out and delay receipt of the recommended childhood vaccines.[6] There is no evidence that timely receipt of all recommended vaccines during infancy causes harm of any type. Vaccine delay, conversely, may lead to potentially severe negative consequences as a result of prolonged susceptibility to vaccine-preventable diseases.[7] Nonetheless, misinformation in the media and on the Internet may increase parental demand for immunization schedules that vary substantially from national recommendations.

Because undervaccinated children in the United States have higher rates of some vaccine-preventable disease than vaccinated children,[8] randomized, controlled trials designed to assess the safety of recommended versus alternative immunization schedules cannot be conducted on ethical grounds; however, the National Vaccine Advisory Committee Vaccine Safety Working Group has suggested that retrospective observational studies of populations with natural variation in vaccination schedules may provide useful information on this issue.[9]

The Vaccine Safety Datalink (VSD) project has provided important safety information for a number of childhood vaccines[10–12] and has also been used to assess vaccine timeliness.[13,14] One recent VSD study found no evidence to support a causal association between thimerosal exposure during the first 7 months of life and neuropsychological outcomes at 7 to 10 years of age.[15] We used publicly available data from this study to evaluate whether children who received all recommended vaccines on time in the first year of life had different neuropsychological outcomes as compared with children with delayed receipt or nonreceipt of these vaccines.

METHODS

Data Source

A publicly available cohort of 1047 children from a previous study of thimerosal exposure and neuropsychological outcomes at 7 to 10 years was analyzed.[15] Children in the cohort were born between 1993 and 1997 and underwent 42 in-depth neuropsychological tests between 2003 and 2004. The public-use data set contains age in days for all vaccines administered during the first year of life. These data were used to construct timeliness variables. In addition to immunization history, the data set contains detailed sociodemographic and medical history data, which were used as covariates. The study was granted exempt status by the institutional review board at the University of Louisville.

Study Definitions

On the basis of the 1993–1997 immunization schedules,[16,17] children were required to have received at least 2 hepatitis B, 3 diphtheria-tetanus-pertussis (DTP), 3 *Haemophilus influenzae* type B (Hib), and 2 polio vaccines (2:3:3:2 series) to be considered up-to-date during the first year of life. For our primary analyses which used data from all children in the data set, vaccine receipt was defined as timely when each of these vaccine doses was received within 30 days of the recommended age, consistent with previous studies of vaccine timeliness.[18] Children who did not meet this definition were classified as having untimely vaccine receipt. Although receipt of 2 doses of 1 specific Hib vaccine (PRP-OMP) could complete the primary series, we required 3 doses of Hib vaccine for definitions of timeliness and up-to-date status to maximize the vaccine exposure, because both the number and the timeliness of vaccines received were components of dosage exposure for our analyses.

A second set of analyses were performed to measure more precisely the association between density of vaccine receipt and neuropsychological outcomes. In these analyses, we first stratified children by age in quintiles at completion of the 2:3:3:2 series. Children in the first 2 quintiles were considered to be the "most timely vaccinated" having received a minimum of 10 vaccines in the first 7 months of life. A "least vaccinated" group was defined as those in the cohort who received $\leq$6 vaccine doses of any type during the first 7 months of life (defined as $\leq$209 days). Although a small number of these children may have gone on to complete the 2:3:3:2 series before their first birthday, we included them in the least vaccinated group because they had the lowest density of vaccine receipt in the first 7 months of life.

Outcomes

The 42 specific neuropsychological tests have been previously described in detail.[15,19] In summary, these include assessments of speech and language,

verbal memory, achievement, fine motor coordination, visuospatial ability, attention and executive-functioning tasks, behavior regulation, tics, and general intellectual functioning. These tests were chosen on the basis of previous studies of neurodevelopmental outcomes associated with methylmercury exposure.[20,21]

Statistical Analyses

Associations between timeliness and each of the 42 outcomes were tested in univariate analysis by using *t* tests. Multivariable regression models were constructed to assess further the impact of timeliness on neuropsychological outcomes after adjustment for potential confounders. All analyses controlled for age, gender, birth weight, poverty status, maternal IQ, maternal education, study site, cumulative ethyl mercury exposure during the first 7 months of life, and Home Observation for Measurement of the Environment score (an objective assessment of stimulation and emotional support in the home environment, which has been associated with developmental outcomes).[22,23] Additional covariates that were associated with specific outcomes in the original study were included where appropriate (Supplemental Appendix, which is published as supporting information at www.pediatrics.org/content/full/125/6/1134).[19] In the secondary analyses, outcomes were compared between the most timely and least timely vaccinated children by using *t* tests. Multivariable analyses were performed by using the same covariates as in the primary analyses. All statistical analyses were performed by using Stata 9.0 (Stata Corp, College Station, TX) and SPSS 17 (SPSS, Inc, Chicago, IL).

RESULTS

A total of 491 (47%) of 1047 children met the study definition for timely receipt. An additional 235 (23%) received all recommended vaccines during the study period but not on time. The remaining 311 (20%) did not receive all recommended vaccines during the study period. Timely receipt of individual vaccine series was highest for hepatitis B (83%) and polio (79%) vaccines and lowest for DTP (65%) and Hib (53%) vaccines. Type of vaccine could be verified for 2636 (93%) of 2834 Hib doses. Of these, only 15 (0.6%) were PRP-OMP. Nine (0.86%) children received no vaccines at all during the study period.

Selected characteristics of children in each group are presented in Table 1. Consistent with the study definitions, children in the untimely and least timely groups received fewer vaccines, both during the first year of life and the first 7 months of life. Children with later vaccine receipt had lower family household incomes in both analyses, although all groups averaged well above the poverty level. They also had lower percentages of mothers with college degrees. Finally, there were greater proportions of male children and single-parent households in the less timely groups. These differences did not reach statistical significance in the primary analyses of timely versus untimely receipt but did in the secondary analyses of most timely versus least timely receipt. There were no

TABLE 1 Selected Sociodemographic and Clinical Characteristics by Timeliness Status

Characteristic	Total Cohort ($N = 1047$)	Primary Analysis			Secondary Analysis		
		Untimely ($n = 556$)	Timely ($n = 491$)	P[a]	Least Timely ($n = 112$)	Most Timely ($n = 310$)	P[a]
Total no. of vaccines during first year of life, mean ± SD	10.90 ± 1.94	10.10 ± 2.34	11.80 ± 0.60	<.001	7.40 ± 3.49	11.80 ± 0.64	<.001
Total no. of hepatitis B vaccines during first year of life, mean ± SD	2.71 ± 0.77	2.46 ± 0.96	2.99 ± 0.27	<.001	1.68 ± 1.28	2.98 ± 0.30	<.001
Total no. of Hib vaccines during first year of life, mean ± SD	2.71 ± 0.64	2.42 ± 0.75	3.02 ± 0.17	<.001	1.88 ± 1.05	3.04 ± 0.21	<.001
Total no. of DTP/DTaP vaccines during first year of life, mean ± SD	2.85 ± 0.53	2.71 ± 0.69	3.01 ± 0.10	<.001	1.96 ± 0.98	3.01 ± 0.11	<.001
Total no. of polio vaccines during first year of life, mean ± SD	2.62 ± 0.61	2.51 ± 0.70	2.73 ± 0.46	<.001	1.86 ± 1.00	2.74 ± 0.46	<.001
Total no. of vaccines during first 7 mo of life, mean ± SD	9.4 ± 2.44	8.00 ± 2.41	11.10 ± 1.01	<.001	4.20 ± 1.96	11.20 ± 0.79	<.001
Age at assessment, mean ± SD, y	9.30 ± 1.08	9.40 ± 1.04	9.20 ± 1.11	<.001	9.20 ± 1.02	9.20 ± 1.15	.808
Male gender, %	48.6	51.0	45.8	.090	58.0	46.5	.036
Household income, mean ± SD[b]	412 ± 260	380 ± 241	448 ± 275	<.001	334 ± 217	448 ± 288	<.001
Maternal college degree, %	51.5	46.8	56.8	.001	42.9	58.4	.005
Single-parent household, %	19.5	21.5	17.1	.068	29.5	18.1	.011
HOME score, mean ± SD	12.00 ± 1.95	11.90 ± 1.98	12.10 ± 1.90	.070	11.90 ± 2.00	12.10 ± 1.95	.297

HOME indicates Home Observation for Measurement of the Environment.

[a] Calculated by using *t* tests.

[b] Reported as percentage above poverty level.

significant differences between the groups in the average Home Observation for Measurement of the Environment score.

In the primary analyses, timely receipt was significantly associated with better performance on 12 of 42 outcomes in univariate analyses (Table 2). Specifically, children with timely receipt scored statistically better on the Boston Naming Test, grooved pegboard, metacognition, and teacher Connor's ratings for hyperactivity and inattentiveness. They also had higher verbal, performance, and full-scale IQs and were reported by parents to stutter less than children with untimely receipt. Children with untimely receipt did not perform better (no clinically or statistically significant differences) on any of the outcomes.

Timely receipt remained independently associated with 2 outcomes in multivariable analysis (Table 3). Children who received their vaccines on time scored 1 point higher on the Developmental Neuropsychological Assessment (NEPSY) speeded naming test (mean: 27.4 [SD: 8.12]), which requires rapid access to and production of recurring colors, sizes, and shapes. They also scored 2.7 points higher on the Wechsler Abbreviated Scale of Intelligence performance IQ (standardized mean: 100 [SD: 15]), which assesses block design and matrix reasoning.

In the secondary analyses, children were separated into 3 groups (Fig 1). The most timely group ($n = 310$) completed the 2:3:3:2 series between 154 and 191 days (<6.4 months). The least timely group ($n = 112$) included 93 children who did not complete the series during the first year of life and 19 children who completed the series between 263 and 363 days. All children who were not categorized into the most or least timely group ($n = 625$) were excluded from the secondary analyses. Univariate comparisons between the most and least timely vaccinated children are presented in Table 2. Children in the most timely group performed statistically better than children in the least timely group for 15 of the 42 outcomes, including 10 of the 12 outcomes associated with better outcome in the primary analysis. No test differences favoring the least timely group reached statistical significance. There were no significant differences between the 2 groups for any of the outcomes in multivariable analysis.

DISCUSSION

Receipt of all recommended childhood vaccines on time in the first year of life in 1993–1997 had no negative impact on neuropsychological outcomes at 7 to 10 years of age, compared with delayed receipt or nonreceipt of ≥1 dose during infancy. In fact, children who received each dose of each vaccine on time performed better on 2 of the 42 outcomes tested after adjustment for multiple familial and socioeconomic factors. Those with delayed receipt or nonreceipt of ≥1 infant dose did not perform better on any measure.

We initially analyzed vaccine dose exposure as a simple dichotomous timeliness variable on the basis of the Centers for Disease Control and Prevention's immunization schedule: receipt of each recommended dose on time versus ≥1 dose being delayed or missing. This definition of timeliness, however, was initially developed to identify factors that are associated with undervaccination and ongoing susceptibility to vaccine-preventable diseases.[18] Use of this strict definition classified children who completed the 2:3:3:2 series within the first 7 or 8 months of life as untimely when any of the doses were given outside of the 30-day window from earliest date of eligibility. This accounts for the relatively small differences in the mean number of vaccine doses received in the first 7 months of life between the timely and untimely groups (11 vs 8), which might have masked small but important differences on ≥1 test outcome.

To address more precisely the issue of density of vaccine exposure in the first 7 months of life as a potential risk factor for poorer neurodevelopmental outcomes, we identified a subset of children who had maximum receipt of vaccines during the first 7 months of life (mean: 11.2 doses) and a subset of children who had least timely vaccination and far less exposure to vaccines during the first 7 months of life (mean: 4.2 doses). The least timely vaccinated children did not perform better than the most timely vaccinated children for any of the 42 assessments. The most timely children performed better on 15 of 42 measures in univariate analyses, but these differences did not persist in multivariable analyses. Differences in familial and socioeconomic factors between the 2 groups likely accounted for the univariate results.

This comparison of the subsets of most and least vaccine exposed confirmed the findings of the timely versus nontimely analyses of the full cohort. In both analyses, the comparison groups received multiple patterns of vaccination receipt, some of which were delayed but ultimately complete and others that were only partially to minimally complete. The lack of any statistically significant results that favored delayed receipt of vaccines in the first year of life sends a clear public health message that should be comforting to many parents with vaccine safety concerns: children can receive their immunizations on time and expect to have the same neurodevelopmental outcomes as children with any other pattern of vaccine receipt.

This is important because vaccine delay in the first year of life, regardless of whether it is intentional, can have neg-

TABLE 2 Neuropsychological Outcomes Associated With Timely Vaccination in Univariate Analysis

Domain	Specific Outcome	Primary Analysis		Secondary Analysis	
		Untimely ($n = 556$)	Timely ($n = 491$)	Least Timely ($n = 112$)	Most Timely ($n = 310$)
Speech and language	Boston Naming Test[a,b]	39.1	40.1	37.4	40.3
	NEPSY				
	Speeded naming[b]	26.9	27.9	26.0	27.8
	Comprehension of instructions	23.5	23.6	23.6	23.7
	Clinical Evaluation of Language Fundamentals				
	Formulated sentences	32.7	32.9	32.2	33.1
	Recalling sentences	44.2	45.0	43.6	44.9
	Goldman-Fristoe Test of Articulation (lower = better)	1.58	1.56	1.66	1.51
	Stuttering, %				
	Rating by evaluator	3.24	3.48	2.70	3.24
	Rating by parent[a]	3.62	1.04	2.70	0.65
	Rating by teacher	9.36	8.47	7.69	9.32
Verbal memory	California Verbal Learning Test				
	Free recall				
	No delay	46.60	46.30	45.50	46.70
	Short delay	9.81	9.64	9.66	9.62
	Long delay	10.40	10.40	9.90	10.40
	Cued recall				
	Short delay	10.3	10.3	9.7	10.3
	Long delay[b]	10.6	10.7	10.1	10.7
	Children's Memory Scale				
	Immediate recall	48.2	46.4	45.3	46.5
	Delayed recall	45.2	43.7	41.4	43.7
Achievement	Woodcock-Johnson III (letter and word identification)[b]	50.9	50.9	47.8	51.2
Fine motor coordination	Grooved pegboard (lower = better)				
	Dominant hand[a,b]	69.1	62.2	67.7	60.7
	Nondominant hand[a,b]	77.5	69.3	77.8	67.4
	Finger tapping				
	Dominant hand	38.9	38.7	37.5	38.6
	Nondominant hand	34.8	34.1	33.2	34.2
Visuospatial ability	Stanford-Binet copying test	18.1	18.3	17.8	18.4
Attention/executive functioning	Gordon Diagnostic System (vigilance task)				
	Correct responses	40.4	40.5	39.7	40.5
	Errors (lower = better)	8.3	6.7	8.3	7.0
	Wechsler Intelligence Scale (digit span)				
	Forward recall	8.09	8.01	8.05	7.99
	Backward recall[b]	4.52	4.54	4.16	4.56
	Combined	12.6	12.5	12.2	12.5
	Behavior Rating Inventory of Executive Function (metacognition index, lower = better)				
	Rating by parent[a,b]	75.4	73.0	76.9	73.0
	Rating by teacher[a,b]	69.3	64.9	72.7	65.4
Behavior regulation (lower = better)	Connor's Rating Scales				
	Hyperactive or impulsive				
	Rating by parent	5.46	5.38	5.80	5.05
	Rating by teacher[a,b]	4.40	3.47	5.38	3.42
	Inattentive				
	Rating by parent[b]	6.58	5.98	7.46	5.95
	Rating by teacher[a,b]	7.40	5.95	8.28	6.13
	Behavior Rating Inventory of Executive Function (behavioral regulation index)				
	Rating by parent	42.4	42.1	43.3	41.8
	Rating by teacher	39.5	38.0	40.4	37.7
Tics (lower = better)	Rating by evaluator, %				
	Motor tics	8.99	8.81	6.25	10.39
	Phonic tics	6.65	7.99	7.14	9.09
	Rating by parent, %				
	Motor tics	10.49	7.47	10.71	7.82
	Phonic tics	11.39	8.68	14.29	10.39
General intellectual functioning	Wechsler Abbreviated Scale of Intelligence				
	Verbal IQ[a,b]	106.0	108.9	105.1	108.7
	Performance IQ[a,b]	103.0	107.3	102.2	107.6
	Full-Scale IQ[a,b]	105.3	109.2	104.1	109.2

Average scores for continuous variables are summarized as means. The 7 dichotomous outcomes are summarized as percentages and are indicated as such in the table. Except where noted, higher score indicates better performance.

[a] $P < .05$ for an association between timely receipt and better outcome in primary analysis.

[b] $P < .05$ for an association between most timely receipt and better outcome in secondary analysis.

TABLE 3 Neuropsychological Outcomes Associated With Timely Vaccination in Multivariable Analysis

Outcome	Coefficient	95% CI	*P*
NEPSY speeded naming test	1.08	0.16–2.00	.022
WISC performance IQ	2.72	0.91–4.52	.003

Both analyses controlled for age, gender, birth weight, poverty status, Home Observation for Measurement of the Environment score, maternal IQ, maternal education, study site, computer experience, presence of siblings, use of English as primary language, duration of breastfeeding, prenatal fish exposure, iron deficiency, use of attention-deficit/hyperactivity disorder (ADHD) stimulants, and cumulative ethyl mercury exposure during the first 7 months of life. Additional covariates in the speeded naming test model include maternal age, participation in home-based child care, history of intrauterine growth restriction, prenatal exposure to nicotine, prenatal exposure to alcohol, prenatal exposure to tuna, prenatal exposure to organic mercury, maternal speech delay, maternal language delay, and maternal ADHD. CI indicates confidence interval; NEPSY, Developmental Neuropsychological Assessment; WISC, Wechsler Intelligence Scale for Children.

ative consequences. This is particularly true for pertussis, because disease incidence and mortality are highest in children who are younger than 6 months.[24] Furthermore, delayed receipt may lead to series noncompletion. For example, it is known that children who receive the third dose of diphtheria-tetanus-acellular pertussis (DTaP) late are less likely to receive a fourth dose of DTaP.[25]

We used individual vaccine doses as the unit of dosage exposure rather than estimating total or cumulative antigenic exposure. Some antigens are more reactogenic than others in the first day or 2 after injection, but how such "short-term" differences may or may not translate or relate to any differences in neurologic or immunologic development are unknown. However, our most timely group had the maximum possible vaccine antigen exposures during their infancies, whereas the least vaccinated comparison group had <40% (on the basis of vaccine doses) of this exposure.

Delays in receipt of childhood vaccines may be nonintentional (eg, poor access to care, accession of care) or attributable to parental request. Nonintentional delays are known to be associated with maternal marital status (single), lower maternal education, and family socioeconomic status.[5,18] We found similar associations between timeliness of vaccine receipt and these factors in this health maintenance organization–based population, although <2% of the children in the cohort had family incomes below the federal poverty level. In contrast, only 1 of the 9 children who had not received any vaccines resided in a single-parent household, and 6 had mothers with college degrees. This is consistent with a previous study that demonstrated that children who received no vaccines are more likely to come from affluent, well-educated families.[5] This cohort did not have enough children who were fully unvaccinated in the first year of life to form robust estimates of neuropsychological outcomes as compared with children with other patterns of receipt. This is an inherent limitation of any VSD-based study given the generally high immunization rates of children within the member health maintenance organizations.[26] We did not attempt to control statistically for potential differences between completely unvaccinated children and those with late receipt.

A notable strength of this analysis is that the initial study ascertained many important familial and socioeconomic covariates for the neurodevelopmental outcomes. The outcomes also were measured with blinding to the vaccine histories of the children. In addition, the sample size of the initial study was substantial, allowing us ample power to detect small but meaningful differences, even in our subgroup analyses. For example, we had 86% power (posthoc analysis) to detect a 5-point difference in IQ measures as statistically significant (2-sided $\alpha = .05$). Such results, even a 3-point difference (in favor of on-time vaccination), were detected as significantly different in univariate testing. Thus, it is unlikely that a protective effect of delayed vaccination truly exists but was undetected in these analyses. Nevertheless, as with any nonrandomized study, it is possible that we did not fully adjust for confounders that were not present in the original study and may have biased the association between timely vaccination and the outcomes of interest. Given the favorable associations between timely vaccination and most outcomes in the univariate analyses, it seems unlikely that true net adverse effects have been masked by unmea-

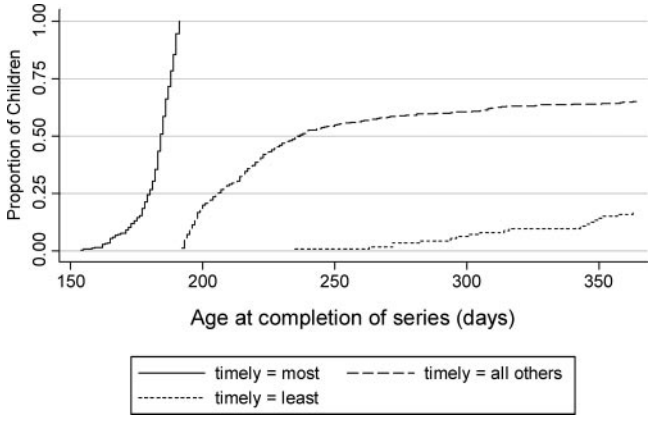

FIGURE 1
Up-to-date status in the study cohort. Only children in the most and least timely vaccinated groups were included in the secondary analyses.

sured or unevaluated confounders; however, there may be alternative study designs that more accurately assess associations between time-dependent exposures and outcomes in retrospective studies. We are exploring the use of other methods, including survival and propensity-adjusted analyses, for future studies of outcomes associated with vaccine timeliness.

Because the children in this study were born between 1993 and 1997, these results may not be generalizable to the current infant immunization schedule, which now includes 3 doses of heptavalent pneumococcal conjugate vaccine, 3 doses of oral rotavirus vaccine, and 1 or 2 doses of influenza vaccine in the first year of life (earliest eligibility at 6 months of age). This limitation is presently unavoidable in any vaccine safety study with long-term follow-up. However, most of the children in this study received DTP rather than DTaP, so the total antigenic burden to which children in this study cohort were exposed was actually higher than that encountered by children today.[27] Finally, our analyses were limited to publicly available data from the original study. Future VSD studies without this restriction would be able to assess a wider range of outcomes. These include putative vaccine adverse effects such as neurodevelopmental delay, autism, and autoimmune disorders. The association between vaccine timeliness and the incidence of vaccine-preventable diseases could also be measured.

CONCLUSIONS

This study provides the strongest clinical outcomes evidence to date that on-time receipt of vaccines during infancy has no adverse effect on neurodevelopmental outcomes 7 to 10 years later. These results offer reassuring information that physicians and public health officials may use to communicate with parents who are concerned that children receive too many vaccines too soon.

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BPA Controversy Continues: *While there has been much in the news recently about the potential dangers of bisphenol A (BPA) resulting in recommendations to avoid products such as baby bottles and canned goods lined with it, the Food and Drug Administration continues to note that this chemical does not pose a risk at low levels of human exposure. Those against BPA argue that we don't know what a low level really is, and those who don't see it as a problem are calling for more research to disprove the fears. According to an editorial in the* The Wall Street Journal *(January 30, 2010), the National Toxicology Program filed a report in 2008 noting some concern for effects of BPA on the brain, behavior, and prostate glands in fetuses, infants, and children. The other 320 pages to this report have largely been overlooked, despite their noting that these studies are controversial because they have not been successfully reproduced by independent investigators, study designs are questionable, the relevance of animal models for human risks is not clear, and we lack understanding of just what the potential adverse nature of reported effects are. While BPA has been called an "endocrine disruptor" because it binds to estrogen receptors, the National Toxicology study states, "there is currently no evidence that estrogen receptor signaling plays an essential role in male-typical brain and behavioral sexual differentiation" in humans. The National Institute of Environmental Health Sciences is currently investing $30 million in further BPA research. Hopefully the findings will allow us to put the cap on the bottle in terms of whether or not we really need to worry about BPA.*

Noted by JFL, MD

On-time Vaccine Receipt in the First Year Does Not Adversely Affect Neuropsychological Outcomes

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