Effect of Compliance With Health Supervision Guidelines Among US Infants on Emergency Department Visits

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Background: There are few studies that demonstrate the health benefit of compliance with early periodic health supervision.

Objective: To examine the association between emergency department (ED) use and compliance with prevailing guidelines for periodic health supervision for conditions that potentially could be avoided among a national cohort of US children.

Design: This was a historic cohort study that combined maternal and primary care physician reports of the use of preventive care services for infants during the first 7 months of life from the 1988 National Maternal and Infant Health Survey and its 1991 Longitudinal Follow-up study. A preventive care scale used in Cox proportional hazards survival regression predicted the time to the first ED visit for selected diagnoses and all-cause visits controlling for illness severity.

Results: Among children with incomplete well-child care in the first 6 months of life, there was an increased risk of having an ED visit for an upper respiratory tract infection (hazard ratio, 2.3; 95% confidence interval, 1.6-3.2), gastroenteritis (hazard ratio, 1.8; 95% confidence interval, 1.0-3.0), asthma (hazard ratio, 2.1; 95% confidence interval, 1.0-4.3), and all-cause ED visits (hazard ratio, 1.6; 95% confidence interval, 1.4-1.98).

Conclusions: Because of the positive effect compliance with national guidelines for early well-child care has on lowering the risk of experiencing ED use, national efforts to improve the quality of child health services for young children should focus on increasing compliance with periodic preventive care for young children.

Arch Pediatr Adolesc Med. 2002;156:1015-1020
The mothers were asked extensive questions about their pregnancy and pregnancy history, behavioral risk factors, prenatal care, infant feeding, socioeconomic level, and use of pediatric health care services.

The 1991 LF interviewed the mothers of the live born infants from the 1988 NMISI to obtain longitudinal data on child development, effects of low-birth-weight, child care, and pediatric health care services use since the earlier survey. It resurveyed 8285 (88%) of the mothers interviewed in the 1988 NMISI when the surviving children were 3 years old.14 When merged, 1991 LF and the 1988 NMISI data provided a rich longitudinal database for our analysis of the relationship of ED visits and compliance with recommended well-child care visits. Mothers were asked to provide the names of all medical providers and hospitals where the child's condition was diagnosed, treated, and/or where the child was admitted. Each health care provider was asked to supply information about the type of service provided and diagnosis for each visit and/or hospitalization. Specific information about ED visits came from the hospitals that responded to the survey. Responses were received from 6606 primary care physicians (73% of those contacted) and 3183 hospitals (89% of those contacted). The 1991 LF sample was then reweighted to be representative of all children aged 3 years in the United States. Emergency department visits were ascertained from the hospitals that responded to the 1991 LF.

LEVEL OF WELL-CHILD CARE COMPLIANCE WITH RECOMMENDED GUIDELINES

The goal of the analysis was to examine the effect of compliance with accepted guidelines for well-child care on use of emergency services adjusting for elements that could also be related to use of the ED. To do this, we created a variable to represent compliance with the 1988 American Academy of Pediatrics schedule of well-child care visits and immunizations during the first 7 months of an infant's life, which was the period about which mothers were asked to recall their child's physician visits and immunizations during the 1988 NMISI. In that year, the American Academy of Pediatrics recommended 4 well-child care visits for that age group (1 soon after birth, then every 2 months thereafter) and 5 immunizations (3 diphtheria and tetanus toxoids and pertussis vaccines and 2 oral polio vaccines).11 To improve the responses of the mothers during the 1988 NMISI, we combined the information provided by the mothers during the earlier survey with that supplied by the health care providers from the 1991 LF. We restricted the health care provider information to the first 7 months of the child's life, which was the period reported on by the mothers.

We classified sick visits during which an immunization or screening was given as well-care visits to capture opportunistic well care. The 1988 NMISI contained the month but not day of birth to protect respondent confidentiality, limiting our ability to determine the exact timing of child well-care visits in relation to the date of birth. Instead, we arbitrarily assigned age to be the 15th day of the birth month. Because we did not know the date of the first well-child care visit relative to the child's age, we set a lenient deadline of 2 months for the first visit to occur and required only 3 total visits in 7 months instead of the recommended 4 for an child to be categorized as having complete well-child care visits. We totaled maternal and primary care physician counts of well-care visits and immunizations separately, using the greater of the 2 to determine the number of visits and immunizations during the first 7 months of the child's life. We excluded cases with no information from either source. A thorough explanation of the combination of these 2 sources is given in a previous article.16

We categorized the variable that indicated compliance into 3 levels based on the relative completeness of well-child care visits and immunizations. Compliance was complete if there were maternal or primary care physician reports of 3 or more well-child care visits with the first occurring by age 2 months, with the requisite number of immunizations (3 diphtheria and tetanus toxoids and pertussis vaccines and 2 oral polio vaccines) by age 7 months. The intermediate level, which we termed “adequate,” was defined as 3 or more well-child care visits that began by age 2 months but with fewer than the above-mentioned immunizations. This situation suggested that while well-child care visits appeared up-to-date, there were missed opportunities to immunize the child. Inadequate compliance was no well-child care visits in the first 2 months or fewer than 3 visits by age 7 months, regardless of the number of immunizations, implying that there were barriers to accessing preventive care visits that could potentially affect the child's health.

ED VISITS

Previous studies have used the concept of avoidable hospitalizations as an indication of adequate well-child care.9,17 The concept of having an avoidable ED visit has not been used as an indicator of quality pediatric preventive care, to our knowledge, with the exception of a study that found that a higher level of ED use to be related to poor continuity of care.18 Because of this, we hypothesized that ED use would be related to compliance with well-child care visits. We selected 3 diagnoses from those commonly used to indicate hospital admission is potentially avoidable and that would be common reasons for visiting an ED: upper respiratory tract infection, gastroenteritis, and asthma.9 We also examined the effect of compliance with early well-child care on ED visits for all diagnoses.

To maintain a temporal chain of events, we defined our outcome to be an ED visit that occurred after the first 7 months of each child's life, which was the period about which we had maternal information about well-child care. Emergency department visits that occurred before the age of 7 months were excluded from the analysis.

STATISTICAL ANALYSIS

We used SUDAAN statistical software for the analysis to consider the sampling framework when computing national estimates and SEs in regression models.19 Survival time in days until the first ED visit after the seventh month of life was the outcome variable in a Cox proportional hazards model for acute upper respiratory tract disease and for all-cause ED visits. The major independent variable was the level of well-child care compliance in the first 7 months of life. To account for general health, we counted the number of ambulatory visits for sick care using the maximum number of sick care visits reported by the mother or primary care physician and categorized them into 3 levels (≤1, 2-6, and ≥7). We computed separate Cox proportional hazards models for upper respiratory tract infections, gastroenteritis, asthma, and all diagnoses.

We tested many potential variables that have been found to be related to use of infant services by other researchers including maternal depression, number of children in the family, use of prenatal care,20 whether the mother wanted the pregnancy, alcohol consumption, where the infant's care was obtained, race, marital status, parental educational level, maternal age, number of children in the household, and household income. We also adjusted for maternal smoking and infant's birth weight.

RESULTS

Beginning with the sample of 8285 mothers who responded to both the 1988 NMISI and the 1991 LF, we
The characteristics of the analytic sample differed somewhat from the subsample not selected for analysis (Table 1). The mothers in the analytic sample were more likely to be white (72.7% vs 62.1%) and less likely to be Hispanic (11.1% vs 15.5%). They were more likely to be married (71.4% vs 68.7%), less likely to have a household income less than the federal poverty level (28.7% vs 33.3%), and more likely to be privately insured (52.8% vs 49.5%).

More than half (55.5%) of the children in the sample experienced complete early well-child care visits (≥3 well-child care visits, the first occurring by age 2 months, and 3 diphtheria and tetanus toxoids and pertussis vaccines and 2 oral polio vaccines) by age 6 months; 26.7% had adequate well-child care visits (3 well-child care visits and ≥5 immunizations) and 17.8% of the children had inadequate early well-child care visits (no well-child care visit in the first 2 months or <3 well-child care visits by age 7 months) (Table 2). Approximately 30% of the children had 0 or 1 sick visit by age 7 months, and 53.6% had 2 or 6 sick visits during that time. Infants with a birth weight less that 1500 g (n=864) had a different pattern of compliance: 36.6% had complete compliance, 38.2% had adequate compliance, and 25.2% had incomplete compliance. For this reason we conducted separate analyses for the infants who weighted less than 1500 g and those who weighted 1500 g and more.

Emergency department visits were common among children between the ages of 7 months and 3 years (Table 3). Emergency department visits were even more common for children born with a birth weight less than 1500 g. Rates of ED visits for upper respiratory tract infection, asthma, and all-causes diagnoses were associated with level of well-child care compliance, increasing as compliance became poorer. For example, those children with a birth weight of 1500 g or more with complete well-child care compliance had 40.0 of 1000 ED visits for upper respiratory tract infection compared with 87.0 of 1000 among those with an inadequate level of compliance. The rate of ED visits for asthma among the larger-birth-weight infants rose from 6.4 per 1000 among those with complete care to 13 per 1000 for those with inadequate care. The very low-birth-weight children with inadequate compliance experienced 551.7 per 1000 ED visits for any diagnosis compared with 339 per 1000 among those with complete care and 76.5 per 1000 ED visits for asthma among those with inadequate care compared with 36.0 of 1000 among those with complete compliance. For ED visits for gastroenteritis, the pattern was less clear. Among infants weighting more than 1500 g at birth, ED visits rose from 6.4 per 1000 to 17.5 per 1000 for those with complete well-child care to 30.5 per 1000 and 30 per 1000 for those with adequate and inadequate well-child care.

The results of the Cox proportional hazards regression analysis revealed a 60% increase in risk of experiencing an ED visit for any reason among the sample of children who weighed 1500 g (hazard ratio [HR], 1.6; 95%
confidence interval [CI], 1.4-1.9) when early well-child care was inadequate compared with those with complete early well-child care after adjustment for sick visits (Table 4). Similarly, the children with inadequate well-child care had a 40% increase in risk of having an ED visit (HR, 1.4; 95% CI, 1.2-1.6). This relationship between ED visits and the level of well-child care compliance was similar for visits for upper respiratory tract infections, gastroenteritis, and asthma, with an approximate doubling in risk (HR, 2.3; 95% CI, 1.6-3.2; HR, 1.8; 95% CI, 1.0-3.0; and HR, 2.1; 95% CI, 1.0-4.3, respectively). With the exception of gastroenteritis, a similar pattern of an approximate doubling of risk of experiencing an ED visit for any reason or for upper respiratory tract infections or asthma was seen among the very low-birth-weight children. Sick visits were related to ED visits among the children with a birth weight greater than 1500 g, a relationship that was less clear among the very low-birth-weight children.

A second regression model that adjusted for race, marital status, parental education, maternal age, number of children in the household, use of prenatal care, maternal depression score, maternal smoking, whether the pregnancy was wanted, household income, insurance, and birth weight in grams did not change the relationship between well-child care compliance and ED visits. In this model (not shown), there were few consistent relationship associations between any of the variables and ED visits except for insurance status. Receiving Medicaid was associated with a 60% increase in likelihood of having any ED visit for children weighing more than 1500 g at birth (HR, 1.6; 95% CI, 1.1-2.3) and a 30% increase among the very low-birth-weight children (HR, 1.3; 95% CI, 1.1-1.6).

Since well-child care became institutionalized, pediatric policy-makers have hypothesized that comprehensive primary care consisting of examination, immunization, monitoring of growth and development, and anticipatory guidance and counseling of parents reduces childhood morbidity and mortality. Indirect evidence suggests that this is so. For example, during the first full decade of Medicaid (1970-1980), which was associated with increased use of health services, infant mortality dropped 35%, the most rapid decline of the century. In addition, deaths in early childhood (ages 1-4 years) declined 24%; for school-aged children (5-14 years), 26%; and for older adolescents and young adults, 25%.21 Research shows that poor children are less likely to use preventive services and that among poor children there is a greater likelihood that they will use ED services for conditions that could be treated in a physician's office.22,23 The results of this and other studies suggest that children in the United States are underusing preventive care services.11,18 But, there has been little direct evidence of a link between the level of compliance with well-child care and ED visits.

Researchers have used the concept of avoidable hospitalizations and nonurgent ED visits to measure access to and the quality of primary care.9,20 The class of hospitalizations considered by researchers to be potentially avoidable has been found to be associated with indicators of poverty, such as minority status and low educational level.8 Similarly, ED visits for nonurgent reasons have been found to be associated with the same factors.10,25,26 A recent study found that among Medicaid-covered children, compliance with recommended guidelines for well-child care was related to as much as a 50% decrease in avoidable hospitalizations.11 Another study of the relationship between continuity of care and ED use found that with poor continuity of care there was more than a 50% increase in the risk of an ED visit.18 Several studies have found an association between more frequent primary care visits and fewer ED visits.10,18,27 However, using ED use as a health outcome indicator is nonspecific—it includes many visits that are unavoidable, such as acute illness that occurs after hours. The time of the ED visit was unavailable to us.

Use of health care services is a multidimensional phenomenon. Individual circumstances; family dynamics; social, cultural, political, and economic factors; health care provider characteristics; and the characteristics of health care systems may affect health care behaviors that might improve use of pediatric child health care.9,28-30 Because the 1988 NMHS and its 1991 LF conducted a comprehensive survey that included a large number of questions, a long list of potential risk factors were tested in our regression models as independent risk factors for ED vis-

### Table 3. Incidence Rates of Having an Emergency Department Visit for Selected Conditions Between the Ages of 6 Months and 3 Years by Well-Child Care in the First 6 Months

<table>
<thead>
<tr>
<th>Well-Child Care Compliance †</th>
<th>Rates of Emergency Department Visits per 1000</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Any Diagnosis</td>
</tr>
<tr>
<td>Birth weight ≥1500 g</td>
<td></td>
</tr>
<tr>
<td>Complete</td>
<td>241.0</td>
</tr>
<tr>
<td>Adequate</td>
<td>313.2</td>
</tr>
<tr>
<td>Inadequate</td>
<td>356.0</td>
</tr>
<tr>
<td>Birth weight &lt;1500 g</td>
<td></td>
</tr>
<tr>
<td>Complete</td>
<td>339.0</td>
</tr>
<tr>
<td>Adequate</td>
<td>405.4</td>
</tr>
<tr>
<td>Inadequate</td>
<td>551.7</td>
</tr>
</tbody>
</table>

*Incidence rates are based on data collected as part of the 1988 National Maternal and Infant Health Survey and its 1991 Longitudinal Follow up. † Complete indicates all 3 recommended well-child care visits on schedule and 5 immunizations (3 diphtheria and tetanus toxoids and pertussis vaccines and 2 oral polio vaccines) in the first 3 months of life; adequate, all 3 well-child care visits, but fewer than 5 immunizations; and inadequate, fewer than 3 well-child care visits or well care begun after age 2 months. The emergency department visits occurred from month 7 through approximately age 3 years.
its. These included indicators of social status (marital status, income, and educational level), family dynamics (whether the index pregnancy was wanted, number of children, and birth order), health care access (prenatal care attendance and usual source of care), and other indicators (ie, depression score, use of alcohol, and others). None of these was consistently associated with the dependent variables (with the exception of insurance status) suggesting that the notion of compliance with well-child care and fewer ED visits is independent of race, socioeconomic indicators, and other variables thought to be causally associated with use of ED services.

A limitation of this study is that more than one quarter of the original sample was eliminated because of incomplete survey information. Because the excluded sample was more frequently of those in a lower socioeconomic level, the analytic sample had a higher level of complete compliance compared with the full sample analyzed in our previous study (53.5% vs 31.7%). Had we had ED visit information on the whole sample, the incidence rates given in Table 3 may have been higher. However, because our results remained robust after adjustment for socioeconomic factors, they are generalizable to all US children.

Other limitations of this study include the potential for incomplete or inaccurate data from the health care providers, discrepancies between maternal and health care provider reports, or problems with maternal recall of use of services. The fact that neither the maternal nor the health care provider reports were complete suggests that our estimates of health services use may have been low because of underreporting. Conversely, the estimated rates of early well-child care may be inflated because mothers excluded from the study were disproportionately from high-risk groups. Although mothers reported more early well-child care than did their health care providers, the health care providers reported more sick visits than mothers, suggesting that visits mothers considered to be for well-child care may have been recorded as sick visits by physicians. Counting well-child care visits and immunizations is only a proxy for the concept of complete preventive care and does not provide a measure of the quality of that care. However, with the exception of immunizations, no study has yet found that any particular component of the well-child care visit is effective. The results of this analysis suggest that it is the act of compliance with a scheduled series of primary care encounters that is related to the outcome. We speculate that once continuity is established between the mother and physician, a mutually trusting relationship forms that facilitates treatment.

Despite these limitations, the results of our study strongly suggest that compliance with guidelines for care may establish a physician-family relationship that may prevent the use of ED for nonurgent care. This suggests that children with poor compliance should be targeted for intervention. Moreover, children without adequate health coverage should be assured of adequate pediatric care. Nationally, the Children’s Health Insurance Program, enacted by the 1997 Balanced Budget Act, is improving coverage of children of the working- and near-poor who have been ineligible for Medicaid.

### Table 4. Results of Cox Regression for Risk of an Emergency Department Visit Between the Ages of 6 Months and 3 Years for Infants With a Birth Weight $\geq 1500$ g*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Any Diagnosis</th>
<th>Acute Upper Respiratory Tract Infection</th>
<th>Gastroenteritis</th>
<th>Asthma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth weight $\geq 1500$ g</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Well-child care compliance in first 6 mo‡</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Complete</td>
<td>1.4 (1.2-1.6)‡</td>
<td>1.7 (1.2-2.4)‡</td>
<td>2.0 (1.2-3.2)‡</td>
<td>2.1 (1.0-4.5)</td>
</tr>
<tr>
<td>Adequate</td>
<td>1.6 (1.4-1.9)‡</td>
<td>2.3 (1.6-3.2)‡</td>
<td>1.8 (1.0-3.0)‡</td>
<td>2.1 (1.0-4.3)</td>
</tr>
<tr>
<td>Inadequate</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Sick visits in first 6 mo</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>0-1</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>2-6</td>
<td>1.2 (1.0-1.4)§</td>
<td>1.8 (1.3-2.6)‡</td>
<td>2.0 (1.2-3.5)§</td>
<td>1.7 (0.8-3.9)</td>
</tr>
<tr>
<td>7+</td>
<td>1.8 (1.5-2.1)†</td>
<td>3.4 (2.3-5.1)‡</td>
<td>3.0 (1.6-5.5)†</td>
<td>3.8 (1.7-9.0)§</td>
</tr>
<tr>
<td>Birth weight &lt;1500 g</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Well-child care compliance in first 6 mo</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Complete</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Adequate</td>
<td>1.3 (1.0-1.8)</td>
<td>1.4 (0.8-2.4)</td>
<td>0.9 (0.3-2.6)</td>
<td>1.6 (0.7-3.8)</td>
</tr>
<tr>
<td>Inadequate</td>
<td>1.9 (1.4-2.6)‡</td>
<td>2.2 (1.2-3.7)§</td>
<td>1.2 (0.4-3.5)</td>
<td>2.1 (0.9-4.9)</td>
</tr>
<tr>
<td>Sick visits in first 6 mo</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>0-1</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>2-6</td>
<td>1.1 (0.8-1.4)</td>
<td>1.3 (0.8-2.3)</td>
<td>3.0 (0.6-14.1)</td>
<td>0.7 (0.3-1.5)</td>
</tr>
<tr>
<td>7+</td>
<td>1.7 (1.2-2.4)‡</td>
<td>1.4 (0.7-2.6)</td>
<td>3.9 (0.8-18.6)</td>
<td>1.8 (0.8-4.2)</td>
</tr>
</tbody>
</table>

*These data are based on data collected as part of the 1988 National Maternal and Infant Health Survey and its 1991 Longitudinal Follow up.

†Complete indicates all 3 recommended well-child care visits on schedule and 5 immunizations (3 diphtheria and tetanus toxoids and pertussis vaccines and 2 oral polio vaccines) in the first 3 months of life; adequate, all 3 well-child care visits, but fewer than 5 immunizations; and inadequate, fewer than 3 well-child care visits or well care begun after age 2 months. The emergency department visits occurred from month 7 through approximately age 3 years.

‡P<.001.
§P<.01.
||P<.05.
Only a few studies have shown a correlation between well-child care visits and indicators of health such as avoidable hospitalizations or ED use. Even fewer studies have shown a positive health benefit of compliance with the recommended pediatric guidelines for health supervision. This study provides evidence that compliance with health supervision guidelines during infancy is associated with a decrease in incidence of ED visits in general. The results of this study provide further support of the role of early health supervision in preventing unnecessary morbidity. The implication is that no child in the United States should be without preventive care.

Accepted for publication May 9, 2002.

The views expressed in this study are those of the authors and do not reflect those of the Department of Health and Human Services or the Centers for Medicare & Medicaid Services.

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REFERENCES