Trends in the Management of Viral Meningitis at United States Children’s Hospitals

WHAT’S KNOWN ON THIS SUBJECT: In the era of widespread conjugate vaccine use, the prevalence of bacterial meningitis has declined. However, the impact of this decline on the rate of emergency department visits for viral meningitis and cost of caring for these children is unknown.

WHAT THIS STUDY ADDS: There was a decline in the rate of diagnosis of viral meningitis in US children’s hospitals between 2005 and 2011. Most children diagnosed with viral meningitis are treated with antibiotics and are hospitalized, accounting for considerable health care costs.

abstract

OBJECTIVE: To determine trends in the diagnosis and management of children with viral meningitis at US children’s hospitals.

METHODS: We performed a multicenter cross sectional study of children presenting to the emergency department (ED) across the 41 pediatric tertiary-care hospitals participating in the Pediatric Health Information System between January 1, 2005, and December 31, 2011. A case of viral meningitis was defined by International Classification of Diseases, Ninth Revision, discharge diagnosis, and required performance of a lumbar puncture. We examined trends in diagnosis, antibiotic use, and resource utilization for children with viral meningitis over the study period.

RESULTS: We identified 7618 children with viral meningitis (0.05% of ED visits during the study period). Fifty-two percent of patients were <1 year of age, and 43% were female. The absolute number and the proportion of ED visits for children with viral meningitis declined from 0.98 cases per 1000 ED visits in 2005 to 0.25 cases in 2011 (P < .001). Most children with viral meningitis received a parenteral antibiotic (85%), and were hospitalized (91%). Overall costs for children with viral meningitis remain substantial (median cost per case $5056, interquartile range $3572–$7141).

CONCLUSIONS: Between 2005 and 2011, viral meningitis diagnoses at US children’s hospitals declined. However, most of these children are hospitalized, and the cost for caring for these children remains considerable. Pediatrics 2013;131:670–676

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KEY WORDS: viral meningitis, lumbar puncture, resource utilization

ABBREVIATIONS: CSF—cerebrospinal fluid ED—emergency department ICD-9—International Classification of Disease, Ninth Revision IQR—interquartile range LP—lumbar puncture PHIS—Pediatric Health Information System

Dr Nigrovic conceived and designed the study, interpreted the data, and drafted the manuscript; Drs Fine, Shah, and Neuman conceived and designed the study, interpreted the data, and critically reviewed the manuscript; and Dr Monuteaux acquired data, conducted the data analysis, interpreted the data, and critically reviewed the manuscript.


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PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275). Copyright © 2013 by the American Academy of Pediatrics

FINANCIAL DISCLOSURE: The authors have indicated they have no financial relationships relevant to this article to disclose.

FUNDING: No external funding.
In the era of widespread conjugate vaccines, most children with meningitis have a viral rather than a bacterial infection. Although children with bacterial meningitis require prompt initiation of parenteral antibiotics and hospitalization, those with viral meningitis, a self-limited condition, require only supportive care. Until recently, a reliable and accurate method to distinguish children with viral from bacterial meningitis based on clinical and laboratory predictors available at presentation was not available. The Bacterial Meningitis Score, a validated clinical prediction rule, accurately identifies children at low risk for bacterial meningitis. However, the impact of this clinical decision-making tool on the diagnosis and management of children with viral meningitis in the setting of a substantial decline in the prevalence of bacterial meningitis has not been evaluated.

Patients with viral meningitis are commonly hospitalized to receive antimicrobial therapy while awaiting results of bacterial cultures. However, recent information regarding rates of hospitalization for children with viral meningitis are limited. Although the number of emergency department (ED) visits for meningitis in children and adults combined remained stable over the past decade, the rate of hospitalizations for pneumococcal meningitis decreased substantially.

We sought to determine whether the rate of diagnosis and management of children with viral meningitis at children’s hospitals has changed in recent years. We examined patients presenting to the ED of a Pediatric Health Information System (PHIS) participating children’s hospital between 2005 and 2011 to examine trends in diagnosis and management of viral meningitis.

**METHODS**

**Setting**

Data for this study were obtained from PHIS, an administrative database that contains inpatient, ED, ambulatory surgery, and observation data from tertiary care pediatric hospitals in the United States. These hospitals are affiliated with the Children’s Hospital Association (Overland Park, KS). The data warehouse function for the PHIS database is managed by Truven Health Analytics (Ann Arbor, MI). For the purposes of external benchmarking, participating hospitals provide discharge/encounter data including demographics, diagnoses, and procedures as well as resource utilization data (eg, pharmaceuticals, imaging, laboratory). Data are deidentified at the time of submission and are subjected to a number of reliability and validity checks before being included in the database. We excluded 2 PHIS hospitals due to incomplete ED visit data. For this study, the number of hospitals contributing complete ED data increased from 37 to 41 over the study period. This study was approved by the Institutional Review Board at Boston Children’s Hospital.

**Study Population**

Children <18 years of age who presented to the pediatric ED of a participating PHIS institution between January 1, 2005, and December 31, 2011, with viral meningitis were eligible for inclusion. Using a previously reported classification scheme, children were excluded if they were transferred to the receiving institution, had a chronic comorbid condition (eg, cystic fibrosis, malignancy, sickle cell disease, epilepsy, cerebral palsy), or a diagnosis of cerebrospinal fluid (CSF) ventricular shunt.

**Classification of viral meningitis**

Patients with “suspected” viral meningitis were defined by the following 6 International Classification of Diseases, Ninth Revision (ICD-9) discharge diagnosis codes: meningitis due to Coxsackie viruses (047.0), meningitis due to echoviruses (047.1), meningitis due to other specified enteroviruses (047.8), unspecified viral meningitis (047.9), meningitis due to adenovirus (049.1), and meningitis due to viruses not elsewhere classified (321.2). We used diagnosis codes similar to those used by previous investigators, although we chose to not include herpes infections in our case definition. Among a subset of patients with suspected viral meningitis, we considered a patient to have viral meningitis if he or she had 1 of the 6 ICD-9 diagnosis codes and also had a lumbar puncture (LP) performed. We defined an LP by the presence of either an LP procedure code or a billing code for a CSF culture on the day of hospital presentation.

**Measured Exposures and Outcomes**

We evaluated diagnostic testing, resource utilization, and costs for children with viral meningitis. Diagnostic and laboratory testing were identified by using clinical tabular codes. We identified the performance of an LP using these codes and medication delivery using the National Drug Code Directory. We evaluated admission rate and hospital length of stay for children who were hospitalized. The admission rate included inpatient hospitalization or admission to “observation status” to account for the variable use of observation status, “virtual” inpatient admission, and availability of inpatient beds among institutions. For patients discharged from the ED with viral meningitis, we identified all return visits to the ED within 3 days of index visit, as well as return visits resulting in admission.

Costs were based on the ratio of cost-to-charges submitted by the hospitals on their respective Medicare cost reports.
and were adjusted by the Centers for Medicare and Medicaid price/wage index. We further adjusted all patient costs to 2011 dollars by using the annual Consumer Price Index inflation rate for the “Hospital and related services” expenditure category as published by the US Department of Labor.

Statistical Analysis

We summarized demographic characteristics among patients with “suspected” viral meningitis and the subset meeting our case definition of viral meningitis. We then stratified our case series by age and compared the resulting groups on clinical management and outcome factors using a series of logistic regression models. To test for changes over time in the rates of viral meningitis cases, we conducted a test for trend using a logistic regression with case status as the dependent variable and time in calendar year as the independent variable. To test for changes over time in patient costs, we conducted a test for trend using a Poisson regression model. Given that our data were taken from several hospitals, the assumption of independent observations may not hold. To accommodate these data, our regression models used clustered sandwich standard error estimates, which allow for intrahospital correlation, relaxing the assumption that observations from the same hospital are independent.

Because the decision to hospitalize a child with viral meningitis might be balanced against return visits, we tested the correlation between hospital-specific rate of admission and 72-hour return ED visit rate resulting in admission. Using the Spearman’s correlation coefficient, we measured the hospital-specific correlation between initial admission rate and the rate of return visits to the ED resulting in admission within 3 days weighted by the hospital-specific number of meningitis visits.

All analyses were performed by using Stata 12.1 (College Station, TX). All statistical tests were 2-tailed, and α was set at .05.

RESULTS

Over the study period, 15,293,012 children were seen in the EDs of the 41 participating study institutions. After applying the exclusion criteria, we identified 130,334 children (0.85% of all ED visits) who had an LP performed. Of these, we identified 10,329 visits for suspected viral meningitis (0.07% of ED visits) and 7618 with viral meningitis (0.05% of ED visits). The median proportion of visits for viral meningitis among all ED visits across the participating institutions was 0.05% (range 0.01%–0.57%), and the median hospital admission rate was 94% (range 64%–100%). Institutions with lower admission rates for children with viral meningitis did not have higher rates of ED return visits within 3 days resulting in admission (P = .10).

The demographic characteristics of patients with suspected viral meningitis and those with viral meningitis are presented in Table 1. A greater proportion of children with viral meningitis than suspected viral meningitis were <1 year of age, implying that younger children were more likely to have an LP performed for suspected viral meningitis. A similar proportion of children with suspected viral meningitis and viral meningitis presented during the peak enteroviral season (June 1 through October 31).

Clinical management differed by patient age (Table 2). Of the children ≤60 days of age, the most common ED admitting diagnosis was fever (22%) followed by unspecified viral meningitis (17%). Of the children >60 days of age, the most common ED admitting was unspecified viral meningitis (29%) followed by headache (19%). Older children with viral meningitis had a lower admission rate (82% for children ≥3 years of age vs 99% for children <3 years, P < .001) as well as shorter length of stay (median 2 days interquartile range [IQR] 1–3 days for children ≥3 years of age vs median 2 days IQR 2–3 days for children <3 years of age, P = .01). Older children were more likely to have a cranial CT performed as part of their diagnostic evaluation (43% for children ≥3 years vs 9% for 672

<table>
<thead>
<tr>
<th>TABLE 1 Demographic Characteristics of Patients With Suspected Viral Meningitis Presenting to the ED of Participating US Children’s Hospitals From 2005 Through 2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographic Characteristic</td>
</tr>
<tr>
<td>Gender (female)</td>
</tr>
<tr>
<td>Age</td>
</tr>
<tr>
<td>&lt;1 y</td>
</tr>
<tr>
<td>≥1 y</td>
</tr>
<tr>
<td>Census region</td>
</tr>
<tr>
<td>Northeast</td>
</tr>
<tr>
<td>South</td>
</tr>
<tr>
<td>Midwest</td>
</tr>
<tr>
<td>West</td>
</tr>
<tr>
<td>Enteroviral season&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Insurance payer</td>
</tr>
<tr>
<td>Private</td>
</tr>
<tr>
<td>Public</td>
</tr>
<tr>
<td>Other</td>
</tr>
<tr>
<td>Missing</td>
</tr>
</tbody>
</table>

<sup>a</sup> Suspected viral meningitis defined by ICD-9 discharge code.

<sup>b</sup> Viral meningitis defined by ICD-9 discharge code plus an LP performed.

<sup>c</sup> Enteroviral season defined as June 1 through October 31.
children < 3 years, P < .001), although we were unable to determine whether the imaging was performed before or after the diagnostic LP. Of the 7618 children with viral meningitis, 6472 children (85%) were treated with parenteral antibiotics. Among these patients, the most commonly prescribed parenteral antibiotics were as follows: third-generation cephalosporin (n = 6141, 95%), ampicillin (n = 2569, 40%), and vancomycin (n = 1539, 24%). The most frequent antibiotic combinations were a third-generation cephalosporin with ampicillin (n = 2325, 38%), third-generation cephalosporin with vancomycin (n = 1496, 23%), and ampicillin with gentamicin (n = 526, 8%). The youngest infants were the most likely to receive acyclovir (37% for ≤60 days vs 12% for >60 days of age, P < .0001). Only a minority of patients received corticosteroids.

While the overall number of ED visits increased from 2005 to 2011, both the absolute number and proportion of ED visits for children with either suspected viral meningitis or viral meningitis decreased (Table 3). For the children with viral meningitis, the proportion of ED visits for children ≤60 days of age similarly declined during the study period. The number and proportion of ED visits with an LP performed declined as well as the proportion of those diagnosed with viral meningitis.

Most children diagnosed with viral meningitis in the ED setting were hospitalized (91%). Over the study period, admission rates declined only slightly (94% in 2005 vs 91% in 2011), although the test for trend was statistically significant (odds ratio = 0.89, 95% confidence interval 0.82–0.96). The median duration of hospital stay for admitted patients remained constant (2 days in 2005, IQR 2–3 vs 2 days in 2011, IQR 2–3). After adjusting for health care inflation and hospital location, the median cost for a child hospitalized with viral meningitis remained stable over the study period (overall cost per child $5363, IQR $3967–$7444). The median cost per child with viral meningitis was $4000 higher for hospitalized children compared with those discharged from the ED ($1371, IQR $984–$1825 for discharged patients, P < .001).

### Table 2: Clinical Management for 7618 Patients With Viral Meningitis Presenting to ED of Participating US Children’s Hospitals Stratified by Patient Age

<table>
<thead>
<tr>
<th>Clinical Management</th>
<th>≤60 d N = 2830, n (%)</th>
<th>61–3 y N = 1382, n (%)</th>
<th>&gt;3 y N = 3406, n (%)</th>
<th>Overall n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital admission rate</td>
<td>2822 (99)</td>
<td>1344 (97)</td>
<td>2796 (82)</td>
<td>6962 (91)</td>
</tr>
<tr>
<td>Length of stay (admitted patients)</td>
<td>1 d 364 (13) 205 (15) 954 (34) 1523 (22)</td>
<td>2 d 1344 (48) 586 (44) 995 (36) 2925 (42)</td>
<td>3 d 699 (25) 306 (23) 421 (15) 1426 (20)</td>
<td>≥4 d 415 (15) 247 (18) 426 (15) 1088 (16)</td>
</tr>
<tr>
<td>Repeat ED visits within 3 d</td>
<td>54 (2) 49 (4) 302 (9) 405 (5)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cranial computed tomography</td>
<td>113 (4) 267 (19) 1457 (43) 1837 (24)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parenteral antibiotics</td>
<td>2814 (99) 1329 (96) 2529 (78) 6472 (85)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acyclovir</td>
<td>1043 (37) 242 (18) 326 (10) 1611 (21)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corticosteroids</td>
<td>35 (1) 58 (4) 248 (7) 341 (4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Viral testing</td>
<td>899 (31) 375 (27) 751 (22) 1825 (24)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Viral testing included any of the following laboratory codes: viral antibody unspecified; other specified viral culture; other specified meningitis bacteria; or viruses, unspecified.

### Table 3: The Number and Proportion of ED Patients Who Had an LP Performed, Suspected Viral Meningitis, and Viral Meningitis Diagnoses Over the Study Period

<table>
<thead>
<tr>
<th>Year</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of hospitals</td>
<td>37</td>
<td>40</td>
<td>41</td>
<td>41</td>
<td>41</td>
<td>41</td>
<td>41</td>
</tr>
<tr>
<td>Suspected viral meningitis</td>
<td>1886</td>
<td>1488</td>
<td>1515</td>
<td>1654</td>
<td>1444</td>
<td>1382</td>
<td>980</td>
</tr>
<tr>
<td>Percent of all ED visits</td>
<td>0.13</td>
<td>0.09</td>
<td>0.08</td>
<td>0.08</td>
<td>0.05</td>
<td>0.05</td>
<td>0.04</td>
</tr>
<tr>
<td>Admission</td>
<td>1694 (90)</td>
<td>1325 (90)</td>
<td>1344 (88)</td>
<td>1379 (83)</td>
<td>1188 (82)</td>
<td>1109 (80)</td>
<td>824 (84)</td>
</tr>
<tr>
<td>Viral meningitis</td>
<td>1457</td>
<td>1185</td>
<td>1147</td>
<td>1191</td>
<td>1014</td>
<td>970</td>
<td>674</td>
</tr>
<tr>
<td>Percent of all ED visits</td>
<td>0.10</td>
<td>0.07</td>
<td>0.06</td>
<td>0.05</td>
<td>0.04</td>
<td>0.04</td>
<td>0.03</td>
</tr>
<tr>
<td>Admission</td>
<td>1364 (84)</td>
<td>1084 (84)</td>
<td>1073 (84)</td>
<td>1085 (89)</td>
<td>901 (89)</td>
<td>862 (83)</td>
<td>813 (91)</td>
</tr>
<tr>
<td>Age ≤60 d</td>
<td>550 (33)</td>
<td>440 (38)</td>
<td>457 (40)</td>
<td>409 (34)</td>
<td>403 (40)</td>
<td>329 (34)</td>
<td>242 (36)</td>
</tr>
<tr>
<td>LPs performed in the ED (n)</td>
<td>17 878</td>
<td>18 052</td>
<td>20 817</td>
<td>19 901</td>
<td>19 538</td>
<td>17 248</td>
<td>16 900</td>
</tr>
<tr>
<td>No. of cases</td>
<td>1.20</td>
<td>1.09</td>
<td>1.04</td>
<td>0.91</td>
<td>0.72</td>
<td>0.67</td>
<td>0.63</td>
</tr>
<tr>
<td>Percent with viral meningitis</td>
<td>8.1</td>
<td>6.5</td>
<td>5.5</td>
<td>6.0</td>
<td>5.2</td>
<td>5.6</td>
<td>4.0</td>
</tr>
</tbody>
</table>

* Suspected viral meningitis defined by ICD-9 discharge code.

* Test for linear trend using logistic regression: P < .05.

* Viral meningitis defined by ICD-9 discharge code plus a lumbar puncture performed.
and viral meningitis were based on the estimates of the rates of bacterial meningitis over the 15-year study period.\(^7\) In a second study of hospitalizations for meningitis, the median length of hospital stay for admitted patients was 2 days, similar to a previous Canadian study of aseptic meningitis in children.\(^{14}\) However, our observed length of hospital stay was considerably shorter than the 4.1 days observed in the study of hospitalized patients with meningitis.\(^6\) This difference may be attributed to the fact that the latter study included patients of all ages, and hospital stays for adults were considerably longer.

In the era of widespread conjugate vaccines, most children with meningitis have viral rather than bacterial infections.\(^2,5\) The current availability of the new 13-valent \textit{Streptococcus pneumoniae} and 4-valent \textit{Neisseria meningitidis} conjugate vaccines in the developed world will further decrease the incidence of childhood bacterial meningitis. Although children with bacterial meningitis require prompt initiation of parenteral antibiotics, most children with viral meningitis require only supportive care.\(^{14}\) Because bacterial cultures take several days to exclude bacterial growth reliably, clinicians must make management decisions before definitive test results are available.\(^{15,16}\) Meningitis clinical prediction rules combine readily available clinical and laboratory factors to estimate the risk of bacterial meningitis. One model, the Bacterial Meningitis Score, has been validated in 8 published studies and performs with a high degree of diagnostic accuracy in a wide variety of clinical settings.\(^{17}\) We would expect that an application of a clinical decision rule would reduce the rate of hospitalization and antibiotic use for children determined to be at low risk of bacterial meningitis. Additionally, available polymerase chain reaction tests may rapidly identify enteroviruses, the most common viral cause of meningitis.\(^{18-20}\) Children with a positive enteroviral polymerase chain reaction test are at low risk of bacterial meningitis\(^{21}\) and could be safely managed as outpatients.

In our study population, overall >90% of the children diagnosed with viral meningitis were hospitalized with some variability across study sites. Although some children may require hospitalization for hydration, pain control, or to ensure adequate follow-up, most children at low risk for bacterial meningitis can be appropriately managed as outpatients.\(^5\) Administration of a single dose of a long-acting parenteral antibiotic such as ceftriaxone can provide coverage in the unlikely case of bacterial infection. The absence of national evidence-based guidelines for the management of children with meningitis may have led to overhospitalization of children at low risk of bacterial meningitis. Even modest reductions in hospitalization would substantially reduce the costs to care for these children. Importantly, the measured costs of inpatient care do not completely capture the unintended consequences for the patient (eg, nosocomial infections or adverse events) and for their caretakers (eg, missed workdays).

We were surprised to observe the substantial decline in the number and the proportion of patients with viral meningitis over the 7-year study period. Although conjugated vaccines have dramatically reduced the prevalence of bacterial meningitis, we would presume that the rates of viral meningitis would not have been affected. We observed a decline in the number of LPs performed, consistent with a previously observed long-term secular trend in the number of LPs performed in the ED setting.\(^22\) However, the decline in viral meningitis cases cannot be explained solely by the decrease in the number of LPs performed because the proportion of children who had an LP
performed and were diagnosed with viral meningitis also declined. We hypothesize that this reflects changes in referral patterns as well as discharge diagnosis coding. Pediatricians and community hospitals may now feel more comfortable managing children with suspected viral meningitis and may refer fewer of these children to pediatric centers for evaluation. Additionally, visits for suspected meningitis may be coded as viral illness rather than meningitis, particularly when the LP is not performed.

Our study has the following limitations. First, because we were limited to ED visits to children’s hospitals included in the PHIS database, we are unable to make population-based estimates about the overall burden of viral meningitis in children. However, our direct rather than proportional sampling allowed us to make more precise conclusions about the care each child received. Second, we selected a specific viral meningitis case definition that required both a discharge diagnosis code and either an LP procedure code or a CSF culture. Although we may not have identified all potential patients, we also identified children with suspected meningitis based on discharge diagnosis alone. The trends in diagnosis and management in children with suspected viral meningitis and viral meningitis were similar. Third, we were unable to obtain specific clinical and laboratory information because the PHIS database relies primarily on administrative data. Therefore, we were unable to exclude children who were pretreated with antibiotics, which may require hospitalization because bacterial cultures may be falsely negative and CSF profiles affected. Fourth, we only captured return visits to PHIS hospitals. However, we believe that the majority of meningitis follow-up care occurred at the institution where the patient had the LP performed. Last, we were unable to determine the reason some children with viral meningitis were hospitalized; presumably, some children may have required interventions such as intravenous hydration or pain control. Future studies should investigate patient management decisions to inform the development of effective clinical practice guidelines for children with viral meningitis.

CONCLUSIONS

Bacterial meningitis has become a rare disease, especially for pediatric patients. Over the 7-year study period, the number and the proportion of children diagnosed with viral meningitis and suspected viral meningitis at US children’s hospitals has declined. However, admission rates, antibiotic use, and costs for caring for children diagnosed with viral meningitis remain high. Evidence-based clinical guidelines for the management of children with meningitis should be developed to guide clinical decision-making by safely reducing hospitalization and antibiotic use for children with viral meningitis.

REFERENCES

aseptic meningitis. BMC Infect Dis. 2006;6:68


**BOUTIQUE WORMING:** When I see the word “boutique,” I tend to think of a small shop that sells fashionable (and usually expensive) clothes or jewelry. Rarely do I associate the word with the digestive powers of earthworms. However, I may need to change my thinking. As reported in The New York Times (Science: December 31, 2012), earthworm farming can be big business. The worms’ value lies in their ability to reduce an incredible array of rotting organic material (including manure) into a wonder supplement for plants. The product of worm digestion, called vermicompost, helps plants mature faster and assists in preventing a variety of plant diseases. Vermicompost production most often begins with mounds of composted cow manure. This initial composting step generates heat that kills seeds and unwanted bacteria (such as Escherichia coli) in the manure. Next, in a controlled environment, thousands of worms (most often Eisenia fetida) are added to the composted manure. Over the next six months, the worms turn the cow manure into a fine loose material that resembles peat moss and is teeming with valuable microorganisms. Scientists believe that the bacteria from the worms’ digestive systems help generate nitrogen for the growing plants and prevent disease by other virulent organisms. Many growers swear by the product—which costs far more than usual soil additives. Vermicompost has a wide variety of uses and can restore richness to soil depleted by synthetic fertilizers and pesticides. Interestingly, some plants seem to respond better to different types of vermicompost. For example, some plants respond best to vermicompost made from dairy manure, while others respond better to vermicompost made from food waste or cardboard. Vermicompost made from cardboard seems particularly good for nut and stone fruit farmers and helps control nut gall, a fungal disease that affects walnut trees. This has led to the development of “boutique” vermiculture producers that specialize in vermicompost for specific types of plants or trees. While I doubt we will eventually see the same number of “boutiques” as we do at the local shopping mall, the process seems fantastic. Not only do the worms help get rid of mounds of waste, but the end product of the breakdown improves the environment.

Noted by WVR, MD
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Pediatrics 2013;131:670
DOI: 10.1542/peds.2012-3077 originally published online March 25, 2013;

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