Influenza-Associated Pediatric Deaths in the United States, 2004–2012
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Influenza-Associated Pediatric Deaths in the United States, 2004–2012

WHAT'S KNOWN ON THIS SUBJECT: Influenza-associated deaths in children occur every year among children of all ages. Young children and those with high-risk medical conditions are at higher risk of influenza-related complications.

WHAT THIS STUDY ADDS: This study describes influenza-associated pediatric deaths over 8 influenza seasons in the United States and compares characteristics of deaths in children with high-risk medical conditions with those in children without high-risk medical conditions.

BACKGROUND: Influenza-associated deaths in children occur annually. We describe the epidemiology of influenza-associated pediatric deaths from the 2004–2005 through the 2011–2012 influenza seasons.

METHODS: Deaths in children <18 years of age with laboratory-confirmed influenza virus infection were reported to the Centers for Disease Control and Prevention by using a standard case report form to collect data on demographic characteristics, medical conditions, clinical course, and laboratory results. Characteristics of children with no high-risk medical conditions were compared with those of children with high-risk medical conditions.

RESULTS: From October 2004 through September 2012, 830 pediatric influenza–associated deaths were reported. The median age was 7 years (interquartile range: 1–12 years). Thirty-five percent of children died before hospital admission. Of 794 children with a known medical history, 43% had no high-risk medical conditions, 33% had neurologic disorders, and 12% had genetic or chromosomal disorders. Children without high-risk medical conditions were more likely to die before hospital admission (relative risk: 1.9; 95% confidence interval: 1.6–2.4) and within 3 days of symptom onset (relative risk: 1.6; 95% confidence interval: 1.3–2.0) than those with high-risk medical conditions.

CONCLUSIONS: Influenza can be fatal in children with and without high-risk medical conditions. These findings highlight the importance of recommendations that all children should receive annual influenza vaccination to prevent influenza, and children who are hospitalized, who have severe illness, or who are at high risk of complications (age <2 years or with medical conditions) should receive antiviral treatment as early as possible. Pediatrics 2013;132:796–804

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KEY WORDS
influenza, mortality, pediatric, surveillance

ABBREVIATIONS
AdP—Advisory Committee on Immunization Practices
ci—confidence interval
pH1N1—influenza A (H1N1) pdm09
RR—relative risk

Dr Wong conceptualized and designed the study, performed the statistical analysis, interpreted the data, and drafted the initial manuscript; Drs Jain and Fry conceptualized and designed the study, interpreted the data, and reviewed and revised the manuscript; Ms Blanton acquired, analyzed, and interpreted the data and reviewed and revised the manuscript; Ms Dhara acquired the data and reviewed and revised the manuscript; Ms Brammer acquired and interpreted the data and reviewed and revised the manuscript; Dr Finelli conceptualized and designed the study, supervised data collection, interpreted the data, and reviewed and revised the manuscript; and all authors approved the final manuscript as submitted.

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

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Influenza is associated with an estimated 54,000 to 430,000 hospitalizations and 3000 to 49,000 deaths annually,\(^1\) and influenza infection rates in the community are highest among children.\(^3\)–\(^6\) Influenza is usually a self-limited illness, but severe complications, including pneumonia, encephalitis, myocarditis, and death, can occur in children.\(^7\)–\(^9\)

Since October 2004, influenza-associated pediatric deaths have been a nationally notifiable condition in the National Notifiable Diseases Surveillance System. This system has enabled characterization of severe influenza-associated disease, identification of at-risk groups for targeting prevention and treatment strategies, and evaluation of trends in influenza-associated pediatric mortality over time.\(^7\)–\(^8\),\(^10\)–\(^15\) These data have contributed to changes in the Advisory Committee on Immunization Practices (ACIP) recommendations for influenza vaccination.\(^16\)–\(^21\) Previous studies of influenza-associated pediatric deaths have described deaths over 1 or a few seasons,\(^7\)–\(^8\),\(^13\)–\(^15\) pandemic influenza A (H1N1) pdm09 (pH1N1) deaths,\(^12\),\(^14\) or deaths among children with certain risk factors.\(^22\) We describe influenza-associated pediatric deaths reported since the national influenza-associated pediatric mortality surveillance system began in 2004 and compare characteristics of children with and without high-risk medical conditions who died.

**METHODS**

**Influenza-Associated Pediatric Death Surveillance**

An influenza-associated pediatric death is defined as a death in a US resident <18 years of age with laboratory-confirmed influenza virus infection. The confirmation of influenza virus infection can occur before or after death by any of the following laboratory methods: rapid diagnostic test, viral culture, fluorescent antibody, enzyme immunoassay, reverse transcription polymerase chain reaction, or immunohistochemical staining of tissue. Diagnostic testing is performed according to routine clinical care and/or postmortem examination if available. State and local health departments report influenza-associated pediatric deaths to the Centers for Disease Control and Prevention by using a standardized case report form that includes information about demographic characteristics, laboratory results, clinical course, medical conditions, and influenza vaccination status. Health departments verify vaccination status by reviewing medical records, contacting the child's health care provider, or checking the state vaccine registry, if available. Bacterial coinfection is defined as bacteria cultured from a normally sterile site (blood, cerebrospinal fluid, pleural fluid) after illness onset or from postmortem lung tissue if the specimen was collected <24 hours after death.

An influenza season was defined as October 1 through September 30 with the exception of the pH1N1 period, during which seasons were defined as October 1, 2008, through August 29, 2009, and August 30, 2009, through September 30, 2010. Rates of influenza-associated death were reported with respect to census estimates of the population <18 years of age during the same influenza season.\(^23\) The ACIP high-risk medical conditions include the following: asthma, neurologic/neurodevelopmental disorders, chronic lung disease, heart disease including congenital heart disease, blood disorders, endocrine disorders, kidney disorders, liver disorders, metabolic disorders, immunosuppression, and pregnancy.\(^24\) In this analysis, children with neurologic/neurodevelopmental disorders were considered to have a high-risk medical condition for all influenza seasons. Analyses of influenza antiviral treatment data were limited to seasons in which they were consistently collected (2010–2011 and 2011–2012).

Groups recommended for influenza vaccination by the ACIP changed during the study period. During the 2004–2005 and 2005–2006 seasons, all children 6 to 23 months of age and children <18 years of age with high-risk medical conditions were recommended for vaccination.\(^16\),\(^17\) Neurologic disorders were added to the ACIP high-risk medical conditions in 2005.\(^17\) In the 2006–2007 and 2007–2008 seasons, vaccination recommendations were expanded to all children 6 to 59 months of age.\(^18\) This recommendation was expanded further to all children 6 months to 18 years of age in the 2008–2009 season.\(^19\)–\(^21\) All children ≥6 months of age were considered eligible for influenza vaccination in this analysis, even if they were not specifically recommended for vaccination by the ACIP on the basis of age, medical conditions, or household contacts during the season of their death, because vaccine formulations approved by the Food and Drug Administration for persons ≥6 months of age were available during the entire study period. During the 2009–2010 season, the group eligible for the pH1N1 monovalent vaccine was limited in this analysis to those who died on or after November 1, 2009, to account for timing of vaccine distribution. Children were considered fully vaccinated if they received the recommended number of doses of influenza vaccine ≥14 days before illness onset that season. Selected characteristics were compared between children with and without high-risk medical conditions.

**Analysis**

Data were analyzed by using SAS, version 9.3 (SAS Institute, Cary, NC). A Wilcoxon rank-sum test was used to
evaluate differences between non-normally distributed data. A t test was used to evaluate differences between means, and a χ² test was used to evaluate differences between proportions. Asymptotic 95% confidence intervals (CIs) are reported for relative risks (RRs) where the natural log of the RR is assumed to be approximately normally distributed. All P values are 2-sided, and P < .05 was considered significant.

RESULTS

Characteristics of Influenza-Associated Deaths in Children

As of August 2, 2013, a total of 830 laboratory-confirmed influenza-associated pediatric deaths occurring from October 1, 2004, through September 30, 2012, were reported from all 50 states and Guam. The most deaths reported in 1 season, 282 (3.8 deaths per 1 million children), occurred during the 2009–2010 season, and the fewest deaths, 35 (0.5 deaths per 1 million children), occurred during the 2011–2012 season (Fig 1). Deaths for most seasons peaked in February or March (Fig 2). After the pH1N1 virus was identified in the United States in April 2009, an early wave of pediatric deaths occurred during June 2009 followed by a larger peak in October 2009.

Of children who died, 53% were male (Table 1). The median age of children was 7 years. Children who died during the 2005–2006 season had the youngest median age of 3 years, and children who died during the 2009–2010 season had the oldest median age of 8.5 years (Table 2). Overall, 649 (78%) children with influenza-associated death had influenza A virus infection, 165 (20%) had influenza B virus infection, and 1 (<1%) was coinfected with influenza A and B viruses; 15 (2%) children had influenza virus infection for which the type was not distinguished. Except for the 2009–2010 season during which only 1% of viruses identified were influenza B, influenza B virus infection was identified in 23% to 38% of deaths each season (Table 2).

Of 794 children with influenza-associated death and a reported medical history, 453 (57%) had ≥1 high-risk medical condition. Neurologic disorders were the most commonly reported high-risk medical condition (33%). Overall, 26% had a pulmonary disorder, including 16% with asthma; 12% had a chromosome or genetic abnormality associated with a high-risk condition; and 11% had congenital heart disease or other cardiac disease (Table 1). Approximately one-third or more of children who died each season had no known high-risk medical conditions, and during the 2006–2007 season the majority (62%) of children had no high-risk medical conditions (Table 2).

Among children with influenza-associated death, the proportion without high-risk medical conditions varied by the type and subtype of influenza virus identified (P < .001). Among 323 deaths associated with pH1N1 virus, 115 (36%) occurred in children with no high-risk medical conditions. For deaths associated with seasonal influenza A (H1N1), influenza A (H3N2), and influenza B viruses, the proportions occurring in children without high-risk medical conditions were 20 of 32 (63%), 41 of 57 (72%), and 72 of 150 (48%) children, respectively.

More than one-third of children died before hospital admission, including 18% who died in the emergency department and 16% who died outside the hospital (Table 1). The median duration of illness was 5 days (interquartile range: 3–12 days). Of children who had a bacterial culture obtained from a normally sterile site, 154 (40%) had ≥1 bacterial coinfection. Almost half of those with bacterial coinfections had Staphylococcus aureus infection, and 22 (14%) had Streptococcus pneumoniae infection. Other bacterial coinfections identified included Streptococcus species other than S. pneumoniae (n = 38), of which the most common was Streptococcus...
pyogenes (n = 20), Enterococcus species (n = 5), and Gram-negative organisms such as Pseudomonas aeruginosa (n = 6), Enterobacter cloacae (n = 4), and Klebsiella pneumoniae (n = 3). Among 769 children with information on complications, the most common complication was radiographically confirmed pneumonia (51%); other complications included seizures (11%), encephalopathy/encephalitis (9%), and coinfection with noninfluenza viruses (5%) (Table 1).

Among 126 children who died during the 2010–2011 and 2011–2012 seasons whose treatment status was known, 56 (44%) received influenza antiviral treatment. When limiting those deaths to the 74 that occurred after hospital admission, 48 (62%) received antiviral treatment; and when limiting further to the 65 children ≥1 year of age, 43 (66%) received antiviral treatment. Of 511 children ≥6 months of age whose vaccination status was known, 84 (16%) had been fully vaccinated with seasonal influenza vaccine. During the 2009–2010 season, of 66 children ≥6 months of age whose vaccination status was known and who died on or after November 1, 2009, 2 (3%) had been fully vaccinated with pH1N1 monovalent vaccine.

**Comparison of Influenza-Associated Deaths in Children Without and With High-Risk Medical Conditions**

There were 341 (43%) children without high-risk medical conditions and 453 (57%) children with ≥1 high-risk medical condition who died; medical history was unknown for 36 children. Children without high-risk medical conditions were more likely to be <5 years old than those with high-risk medical conditions (RR: 1.3; 95% CI: 1.1–1.6) (Table 3). Those without high-risk medical conditions were more likely to die outside the hospital or in the emergency department (RR: 1.9; 95% CI: 1.6–2.4) and ≤3 days after illness onset (RR: 1.6; 95% CI: 1.3–2.0). Among children who were tested, bacterial coinfection was more common among children without high-risk medical conditions (RR: 2.0; 95% CI: 1.5–2.5). Among those who were ≥6 months of age whose high-risk medical conditions had been fully vaccinated with seasonal influenza vaccine. During the 2010–2011 and 2011–2012 seasons, children without high-risk medical conditions were less likely to receive influenza antiviral treatment than those with high-risk medical conditions, although the difference was not statistically significant (35% vs 54%; RR: 0.7; 95% CI: 0.4–1.0).

**DISCUSSION**

This study describes 830 deaths among children reported to the national influenza-associated pediatric mortality surveillance system from the 2004–2005 through the 2011–2012 influenza seasons and reveals the importance of current strategies for the prevention and treatment of influenza in children. Deaths occurred in children of all ages and regardless of high-risk medical conditions. However, children with neurologic disorders, chromosome abnormalities, and genetic disorders were highly represented among those who died compared with the prevalence of these disorders in the general pediatric population. Influenza-associated pediatric deaths often occurred within days of symptom onset. Bacterial coinfections and pneumonia were commonly reported among children who died. Efforts to prevent influenza and its complications in children by ensuring annual influenza vaccination and appropriate early access to antiviral medications should remain a priority for the medical and public health communities. Children with high-risk medical conditions are vulnerable to severe influenza-associated complications, including death.24 These conditions include common childhood conditions, such as asthma. Some conditions, such as neurologic disorders and conditions associated...
TABLE 1 Selected Characteristics Among Children With Influenza-Associated Death: United States, October 2004 Through September 2012

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male gender</td>
<td>442 (53)</td>
</tr>
<tr>
<td>Age, median (IQR), y</td>
<td>7 (1–12)</td>
</tr>
<tr>
<td>&lt;6 months</td>
<td>94 (11)</td>
</tr>
<tr>
<td>6 to 23 months</td>
<td>114 (14)</td>
</tr>
<tr>
<td>24 to 59 months</td>
<td>117 (14)</td>
</tr>
<tr>
<td>5 to 8 years</td>
<td>167 (20)</td>
</tr>
<tr>
<td>9 to 12 years</td>
<td>112 (13)</td>
</tr>
<tr>
<td>13 to 17 years</td>
<td>226 (27)</td>
</tr>
<tr>
<td>Race/ethnicity&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>373 (45)</td>
</tr>
<tr>
<td>Hispanic or Latino</td>
<td>194 (23)</td>
</tr>
<tr>
<td>Black</td>
<td>149 (18)</td>
</tr>
<tr>
<td>Asian</td>
<td>35 (4)</td>
</tr>
<tr>
<td>American Indian/Alaska Native</td>
<td>17 (2)</td>
</tr>
<tr>
<td>Native Hawaiian/Pacific Islander</td>
<td>7 (1)</td>
</tr>
<tr>
<td>Identified by ≥2 races</td>
<td>5 (1)</td>
</tr>
<tr>
<td>Unknown</td>
<td>50 (6)</td>
</tr>
<tr>
<td>High-risk medical conditions&lt;sup&gt;b&lt;/sup&gt; (n = 794)</td>
<td></td>
</tr>
<tr>
<td>No high-risk medical conditions</td>
<td>341 (43)</td>
</tr>
<tr>
<td>One or more high-risk medical condition&lt;sup&gt;c&lt;/sup&gt;</td>
<td>453 (57)</td>
</tr>
<tr>
<td>Pulmonary disease</td>
<td>206 (26)</td>
</tr>
<tr>
<td>Asthma</td>
<td>127 (16)</td>
</tr>
<tr>
<td>Neurologic disorder</td>
<td>290 (33)</td>
</tr>
<tr>
<td>Neurodevelopmental disorder</td>
<td>212 (27)</td>
</tr>
<tr>
<td>Cerebral palsy</td>
<td>78 (10)</td>
</tr>
<tr>
<td>Neuromuscular disorder</td>
<td>25 (3)</td>
</tr>
<tr>
<td>Seizure disorder</td>
<td>126 (16)</td>
</tr>
<tr>
<td>Chromosome abnormality/genetic syndrome</td>
<td>98 (12)</td>
</tr>
<tr>
<td>Congenital heart disease or other cardiac disease</td>
<td>87 (11)</td>
</tr>
<tr>
<td>Immunosuppressive condition</td>
<td>57 (7)</td>
</tr>
<tr>
<td>Cancer (received chemotherapy or radiation)</td>
<td>31 (4)</td>
</tr>
<tr>
<td>Endocrine disorder</td>
<td>45 (6)</td>
</tr>
<tr>
<td>Other conditions&lt;sup&gt;d&lt;/sup&gt;</td>
<td>30 (4)</td>
</tr>
<tr>
<td>Location of death (n = 823&lt;sup&gt;e&lt;/sup&gt;)</td>
<td></td>
</tr>
<tr>
<td>Admitted to hospital</td>
<td>537 (65)</td>
</tr>
<tr>
<td>Emergency department</td>
<td>151 (18)</td>
</tr>
<tr>
<td>Outside hospital</td>
<td>135 (16)</td>
</tr>
<tr>
<td>Duration of illness, median (IQR) (n = 798&lt;sup&gt;f&lt;/sup&gt;)</td>
<td></td>
</tr>
<tr>
<td>≤3 days</td>
<td>5 (3–12)</td>
</tr>
<tr>
<td>≤7 days</td>
<td>296 (33)</td>
</tr>
<tr>
<td>One or more bacterial pathogen identified from normally sterile site (n = 387&lt;sup&gt;F&lt;/sup&gt;)</td>
<td>500 (63)</td>
</tr>
<tr>
<td>Staphylococcus aureus&lt;sup&gt;f&lt;/sup&gt;</td>
<td>154 (40)</td>
</tr>
<tr>
<td>Methicillin-resistant S aureus</td>
<td>76 (49)</td>
</tr>
<tr>
<td>Methicillin-sensitive S aureus</td>
<td>48 (31)</td>
</tr>
<tr>
<td>Sensitivity testing not performed</td>
<td>23 (15)</td>
</tr>
<tr>
<td>Streptococcus pneumonia</td>
<td>5 (3)</td>
</tr>
<tr>
<td>Complications during acute illness (n = 769&lt;sup&gt;g&lt;/sup&gt;)</td>
<td></td>
</tr>
<tr>
<td>Pneumonia</td>
<td>389 (51)</td>
</tr>
<tr>
<td>Acute respiratory distress syndrome</td>
<td>235 (31)</td>
</tr>
<tr>
<td>Seizures</td>
<td>83 (11)</td>
</tr>
<tr>
<td>Encephalopathy/encephalitis</td>
<td>68 (9)</td>
</tr>
<tr>
<td>Viral coinfection</td>
<td>39 (5)</td>
</tr>
</tbody>
</table>

Data are presented as n (%) unless otherwise indicated; N = 830. IQR, interquartile range.

<sup>a</sup> Hispanic or Latino ethnicity includes persons of any race. Data for other race categories do not include Hispanics.

<sup>b</sup> Information was available on the presence or absence of high-risk conditions for 794 children, on location of death for 823 children, on duration of illness for 788 children, on results of bacterial testing for 387 children who were tested, and on the presence or absence of complications for 769 children.

<sup>c</sup> More than 1 medical condition could be reported for each child.

<sup>d</sup> Other conditions include renal disease (n = 20), hemoglobinopathy (n = 8), and pregnancy (n = 2).

<sup>e</sup> Percentages reported out of 154 children with a bacterial coinfection.

with underlying chromosome and genetic abnormalities, were over-represented in our data compared with the prevalence of these disorders in the general pediatric population. Cerebral palsy, which affects <1% of children in the United States<sup>25</sup> was reported among 10% of children with influenza-associated death in this analysis. The high prevalence of cerebral palsy among the fatalities is consistent with studies highlighting the vulnerability of these children to poor outcomes after influenza virus infection<sup>22,24,26</sup>. It is especially important that children with neurologic disorders and other high-risk conditions, who often have more regular access to health care than otherwise healthy children<sup>27</sup>, receive influenza vaccination before the influenza season begins and early antiviral treatment of suspected influenza<sup>21,28</sup>. Clinicians should maintain a high index of suspicion for influenza virus infection in children with high-risk conditions when influenza is circulating in their communities.

Previously healthy children of all ages are also at risk of influenza-associated death. In this study, >40% of children who died had no high-risk medical conditions. Among children hospitalized with laboratory-confirmed influenza in the United States, the percentage with no high-risk medical conditions ranged from 47% to 59% over the same period as this study<sup>20</sup>. Healthy children are often perceived as not being at risk of serious influenza illness. A 2003 survey of parents of healthy children found that more than half believed that influenza infections are more serious in healthy 70-year-olds than in healthy 1-year-olds<sup>30</sup>; however, the risk of influenza-associated hospitalization in young children is similar to that of older adults<sup>2,31</sup>. Parents and clinicians should be aware that influenza can be...
associated with severe complications in otherwise healthy children, especially in those who are <2 years of age.13

Influenza-associated deaths often occurred quickly, and some ill children were not admitted to a hospital before they died. More than one-third of children died outside the hospital or in the emergency department, and most children died within 1 week of symptom onset. Previously healthy children appeared to have a shorter interval between symptom onset and death compared with children with high-risk medical conditions. The reasons for this observation are unknown, and the clinical course of influenza in these 2 populations has not been directly compared previously. Immune dysregulation may lead to severe illness in some previously healthy children.32 In this study, previously healthy children were more likely than those with high-risk medical conditions to have a bacterial coinfection, which may contribute to the difference in clinical course observed between the 2 groups. The potential for rapid clinical decline in children with influenza virus infection emphasizes the importance of reducing the risk of influenza infection and related complications through prevention and early treatment.

### TABLE 3


<table>
<thead>
<tr>
<th>Characteristic</th>
<th>No High-Risk Medical Conditions, (n = 341)</th>
<th>One or More High-Risk Medical Condition, (n = 453)</th>
<th>P</th>
<th>RR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, median (IQR), y</td>
<td>5 (1–11)</td>
<td>8 (3–13)</td>
<td>&lt;.001</td>
<td></td>
</tr>
<tr>
<td>Age &lt;5 years</td>
<td>152/341 (45)</td>
<td>154/453 (34)</td>
<td>1.3</td>
<td>1.1–1.6</td>
</tr>
<tr>
<td>Died before being admitted to hospital</td>
<td>156/339 (46)</td>
<td>106/449 (24)</td>
<td>1.9</td>
<td>1.6–2.4</td>
</tr>
<tr>
<td>Duration of illness ≤3 days</td>
<td>136/326 (42)</td>
<td>113/438 (26)</td>
<td>1.6</td>
<td>1.3–2.0</td>
</tr>
<tr>
<td>One or more bacterial pathogen</td>
<td>89/155 (55)</td>
<td>63/222 (26)</td>
<td>2.0</td>
<td>1.5–2.5</td>
</tr>
<tr>
<td>identified from normally sterile site</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of complication</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pneumonia</td>
<td>130/320 (41)</td>
<td>249/426 (58)</td>
<td>0.7</td>
<td>0.6–0.8</td>
</tr>
<tr>
<td>Acute respiratory distress syndrome</td>
<td>82/320 (26)</td>
<td>148/426 (35)</td>
<td>0.7</td>
<td>0.6–0.9</td>
</tr>
<tr>
<td>Shock or sepsis</td>
<td>104/320 (33)</td>
<td>97/426 (23)</td>
<td>1.4</td>
<td>1.1–1.8</td>
</tr>
</tbody>
</table>

Data are presented as n (%) unless otherwise indicated. IQR, interquartile range.

* Died in emergency department or outside of hospital.
conditions, support the recommenda-
tion that all children ≥6 months of age 
receive annual influenza vaccination.21 
Few children who died were vacci-
nated. National influenza vaccine cov-
erage among children 6 months to 17 
years of age increased40,41 from 24% in 
2008–2009 to 52% in 2011–2012 but 
remained well below the Healthy Peo-
ple 2020 target of 80%.42 Infants <6 
months of age are at higher risk of 
influenza-related complications but 
are too young to be vaccinated; to 
protect them, pregnant women and 
close contacts of infants are recom-
manded for vaccination.20,43,44 Children 
with high-risk medical conditions, who 
were overrepresented among the fa-
talities in this report, as well as their 
close contacts, are important target 
groups for influenza prevention stra-
geties. Studies in adult nursing facility 
staff suggest that vaccinating contacts 
of high-risk persons can reduce in-
fluenza morbidity and mortality among 
residents at high risk.45–47 
In addition to influenza vaccination, in-
fluenza antiviral medications can reduce 
the severity of illness and complications 
associated with influenza virus in-
fec tion.28 Antiviral treatment can shorten 
illness duration in children with un-
complicated influenza,48–50 decrease the 
need for mechanical ventilation in chil-
dren hospitalized with influenza,51 and 
lower the odds of death in critically ill 
children with pH1N1 virus infection52; 
however, antiviral treatment was re-
ported in less than half of the children 
who died during the 2010–2011 and 
2011–2012 seasons in this study. Previous 

studies have shown that antiviral treat-
ment among children hospitalized with 
influenza increased sharply during the 
2009 pandemic compared with prepan-
demic seasons,53 but it decreased from 
77% during the pandemic to 56% during 
the 2010–2011 season,54 even though 
children hospitalized with suspected in-
fluenza are recommended to receive 
early empirical antiviral treatment.55 
Children with signs or symptoms of se-
vere or progressive illness and those 
who are hospitalized should be treated 
empirically for influenza with antiviral 
medications such as oseltamivir, which 
is approved by the Food and Drug Ad-
ministration for treatment of influenza 
in persons ≥2 weeks of age, or zana-
ivir without waiting for laboratory 
results, even if they have no other risk 

factors for influenza-associated compli-
cations. In addition, children <2 years of 
age or those with high-risk medical 
conditions are recommended to receive 
antiviral medication for treatment no 
matter the severity of illness.26,55 

This report is subject to limitations. The 
national influenza-associated pediatric 
mortality surveillance system requires 
laboratory diagnosis of influenza virus 
fection and will miss deaths for which 
influenza testing is not available or 
routinely performed. Testing practices 
and patterns of health care use are 
likely to differ between children with 
and without high-risk medical con-
ditions; those with high-risk medical 
conditions may be more likely to be 
tested for influenza and therefore more 
likely to be reported in the surveillance 
system. Influenza testing was more 

prevalent during the pH1N1 influenza 
pandemic, leading to increased case 
reporting during that time period. In-
formation in the case report form is 
collected by state and local health 
officials and is not systematically veri-
fied against the medical record or au-
topsy report, which may lead to 
  misclassification or underreporting of 
  high-risk medical conditions, compli-
cations, vaccination status, and antiviral 
treatment. Finally, data on the timing 
and duration of influenza antiviral 
treatment were not collected, thus 
limiting the interpretation of antiviral 
treatment impact. 

CONCLUSIONS 

Although influenza usually causes a self-
limited illness, influenza can also be 
associated with severe outcomes in 
children, including death. Deaths can 
occur within a few days after illness 
onset. The potential for severe outcomes 
from influenza should be recognized in all 
children, both those with conditions that 
place them at higher risk of influenza-
associated complications as well as 
healthy children. The findings of this 
national surveillance system report 
highlight the importance of influenza 
vaccination for all children ≥6 months of 
age and early empirical antiviral treat-
ment of all children with suspected or 
confirmed influenza virus infection who 
are hospitalized; who have severe, com-
plicated, or progressive illness; or who 
are at higher risk of influenza-associated 
complications due to younger age (<2 

years) or medical conditions. 

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A SCENT FOR THE GODS: I had just finished making a cappuccino for my wife. The foam was heaped high and just the right consistency, and for a special touch I sprinkled a bit of cinnamon over the top. The scent was subtle and lovely, and my wife was pleasantly surprised and pleased with the effects.

Cinnamon is a spice that has long inspired consumers – Egyptians embalmed their dead in cinnamon, and King Solomon allegedly sent explorers to India in search of it. The spice was valued for its aroma, taste, and health attributes, and in ancient times was incredibly expensive and considered a gift for the gods or royals. Nero purportedly burned a year’s supply of cinnamon at his wife’s funeral pyre to demonstrate how much he loved her.

Nowadays, the spice is ubiquitous and can be found in supermarkets for pennies an ounce. However, not all cinnamon is the same. Most of the inexpensive cinnamon found in stores in the United States is not true cinnamon, but a closely related cousin known as cassia. Both come from the inner bark of trees from the genus Cinnamomum, but true cinnamon is derived from C. verum while common supermarket varieties of cinnamon are often from C. burmannii. True cinnamon has a more refined flavor than cassia – less sweet, more complex, and with hints of citrus – and is more expensive. Most true cinnamon is produced in Sri Lanka, usually on small plantations, while most cassia is grown in China, Indonesia, and Vietnam.

Distinguishing between the two can be challenging. Sticks of true cinnamon look as though they have several layers, while those from its cousin seem to have a single layer. If buying the spice already ground, look for a product that lists the species or the country of origin, or buy from a shop specializing in spices. The flavor is worth it.

Noted by WWR, MD