Additional Visit Burden for Universal Influenza Vaccination of US School-Aged Children and Adolescents

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Objective: To estimate the additional primary care visits needed for universal influenza vaccination of all US children and adolescents if all vaccinations occurred in primary care settings.

Design: Cross-sectional design.

Setting: Well-child care and other visits to primary care practices from the 2003-2004 Medical Expenditure Panel Survey.

Participants: Children aged 5 to 18 years (n=3047) with a usual source of care.

Main Outcome Measure: Percentage of children needing 0, 1, or 2 additional visits to be immunized against influenza in a 3-, 4-, or 5-month vaccination window.

Results: In a 3-month window, if only well-child care visits were used for first immunization, 97% of 5- and 6-year-olds and 98% of 7- and 8-year-olds would need 1 or 2 additional visits for complete vaccination; 95% of 9- to 18-year-olds would need 1 visit. If instead all visits were used for immunization, 90% of 5- and 6-year-olds and 91% of 7- and 8-year-olds would need 1 or 2 visits; 78% of 9- to 18-year-olds would need 1 visit. Expanding the window to 4 or 5 months slightly reduces the need for additional visits. Nationally, using all opportunities for vaccination, 42 million additional visits would be needed in a generous 5-month window.

Conclusions: Most children and adolescents would need additional visits for universal influenza vaccination, even if all existing visits were used as vaccination opportunities. Efficient methods for vaccinating large numbers of children and adolescents are needed if primary care practices are to provide influenza vaccine for all children.


Influenza viruses cause an average of roughly 200,000 hospitalizations and 36,000 deaths in the United States annually, and children younger than 2 years have a risk of influenza hospitalization similar to that of older adults. Influenza infections also result in frequent outpatient and emergency department visits (most not clinically recognized as influenza), school absenteeism, and loss of parental work productivity. Further, school-aged children spread influenza disease to other members of their household and throughout the community.

Both live attenuated and inactivated influenza vaccine have been shown to be effective in reducing influenza illness and associated outpatient health care visits and use of both prescription and over-the-counter drugs. Vaccinating children 6 months to 18 years of age against influenza might also reduce the burden of disease among the entire population.

In 2006, the Advisory Committee on Immunization Practices (ACIP) recommended that all children 6 to 59 months of age and their household contacts be vaccinated against influenza, with a goal of reducing influenza-related physician visits and decreasing hospitalization and death among those at high risk. In early 2008, ACIP expanded this recommendation to include all children younger than 19 years. Most experts anticipate that primary care practices would be the first-line sites for universal influenza vaccination of this large population.

It is currently unknown how many children and adolescents have sufficient visits within the influenza vaccination season to receive their age-specific recommended 1...
or 2 influenza vaccinations. Having a better understanding of how many additional visits would be needed to vaccinate the entire pediatric population will enable primary care practices to prepare for an expansion of the vaccine recommendation and can help national organizations, including the Centers for Disease Control and Prevention, the American Academy of Pediatrics, and the American Association of Family Physicians, to develop strategies for influenza vaccination of all children and adolescents. The objectives of this study were to estimate, for the potentially targeted population of 5- to 18-year-olds, the number of children and adolescents who would need additional primary care visits to receive influenza vaccine, above and beyond their current primary care visits and assuming that all vaccinations were provided in primary care. A second objective was to determine factors associated with needing additional primary care visits for universal influenza vaccination.

### METHODS

We analyzed the Medical Expenditure Panel Survey (MEPS) Household Component (HC). The MEPS is cosponsored by the Agency for Healthcare Research and Quality and the National Center for Health Statistics. The MEPS-HC is a nationally representative survey of the U.S. civilian noninstitutionalized population that collects medical expenditure data at both the person and household levels. The focus of MEPS-HC is to collect detailed data on demographic characteristics, health conditions, use of medical care services, charges and payments, access to care, and health insurance coverage. We analyzed the 2003-2004 panel of the MEPS-HC to measure well-child care (WCC) and other visits to primary care offices (pediatric, family medicine, and internal medicine) during the influenza vaccination season. These years were the most recently available data from the MEPS. The data were collected in 5 rounds of interviews that took place over 2 and a half years. Each round of MEPS-HC interviews collects information pertaining to a specific period, ranging from 3 to 6 months.

Respondents are given calendars during the MEPS precontact interview for use in recording visits to medical providers. The response rate was 65.9% for the panel followed up in 2003-2004. To improve the precision of survey estimates for subgroups, Hispanic, black, and Asian households and families with income less than 200% of the poverty level were oversampled. Altogether, 3047 children and adolescents (from 1755 families) 5 to 18 years of age (as of October 1, 2003) were included in our analyses, which represents 49.3 million children in the United States when weighted. Ten percent of 5- to 8-year-olds and 16% of 9- to 18-year-olds who did not have a usual source of care were excluded since they would be unlikely to be reached with influenza vaccination in a primary care practice. The period for potential receipt of influenza vaccine was varied from 3 months (October-December) to 4 months (October-January) and to 5 months (October-February) because the ACIP and American Academy of Pediatrics recommend vaccinating throughout the influenza season.

<table>
<thead>
<tr>
<th>Child Characteristic</th>
<th>Age 5-6 y</th>
<th>Age 7-8 y</th>
<th>Age 9-18 y</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overall</strong></td>
<td>454 (100.0)</td>
<td>473 (100.0)</td>
<td>2120 (100.0)</td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>248 (51.0)</td>
<td>244 (52.1)</td>
<td>1072 (50.7)</td>
</tr>
<tr>
<td>F</td>
<td>206 (49.0)</td>
<td>229 (47.9)</td>
<td>1048 (49.3)</td>
</tr>
<tr>
<td><strong>Race/ethnicity</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White non-Hispanic</td>
<td>193 (63.0)</td>
<td>206 (62.9)</td>
<td>945 (64.8)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>152 (18.2)</td>
<td>136 (15.1)</td>
<td>607 (15.1)</td>
</tr>
<tr>
<td>Black non-Hispanic</td>
<td>72 (11.8)</td>
<td>100 (16.8)</td>
<td>408 (13.8)</td>
</tr>
<tr>
<td>Asian non-Hispanic</td>
<td>18 (2.6)</td>
<td>20 (3.1)</td>
<td>91 (3.0)</td>
</tr>
<tr>
<td>Other non-Hispanic</td>
<td>19 (4.2)</td>
<td>11 (2.1)</td>
<td>69 (3.3)</td>
</tr>
<tr>
<td><strong>Insurance status during 2003</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any private</td>
<td>216 (64.5)</td>
<td>233 (65.9)</td>
<td>1142 (69.1)</td>
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<tr>
<td>Public only</td>
<td>217 (31.9)</td>
<td>218 (28.5)</td>
<td>824 (25.0)</td>
</tr>
<tr>
<td>Uninsured</td>
<td>21 (3.6)</td>
<td>22 (4.6)</td>
<td>154 (5.9)</td>
</tr>
<tr>
<td><strong>Federal poverty level during 2003, %</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;100</td>
<td>125 (16.8)</td>
<td>129 (14.5)</td>
<td>518 (15.3)</td>
</tr>
<tr>
<td>100 to &lt;200</td>
<td>143 (26.5)</td>
<td>129 (21.5)</td>
<td>581 (19.8)</td>
</tr>
<tr>
<td>200 to &lt;400</td>
<td>109 (29.8)</td>
<td>126 (32.4)</td>
<td>598 (35.1)</td>
</tr>
<tr>
<td>≥400</td>
<td>77 (26.9)</td>
<td>89 (31.6)</td>
<td>423 (29.8)</td>
</tr>
</tbody>
</table>

*Among children with a usual source of care.*
we estimated a low of 20% and high of 30% would have re-
ceived influenza vaccination (randomly assigned) in a prior sea-
son and determined the number who would need 0, 1, or 2 more
visits in a 3-, 4-, and 5-month vaccination window.

Children 7 to 8 years of age: This age group did not have a
prior recommendation for vaccination, unless they were con-
sidered high risk. We similarly estimated a low of 10% and a
high of 20% would have received influenza vaccination and de-
termined the number needing 0, 1, or 2 additional visits in 3-
4-, and 5-month vaccination windows. To predict visit needs
for future years, we also estimated additional visits needed if
50% of children 5 to 8 years of age had received prior influ-
enza vaccination.

Children and adolescents 9 years to 18 years of age: This age
group would require only 1 vaccination (regardless of prior vac-
cinations); therefore, we determined the number who would
need 0 or 1 additional visits to primary care offices in a 3-, 4-, and 5-month vaccination window.

We performed bivariate analyses using simple logistic regres-
sion with 1 variable at a time entered into the model to deter-
mine characteristics of children and adolescents associated with
needing 0, 1, or 2 primary care visits in a 3-, 4-, and 5-month time
frames. We then performed multivariate logistic regressions, with
all demographic factors entered a priori, to determine factors asso-
ciated with the need for 0 vs 1 to 2 additional visits in a 4-month
time frame, the most likely scenario. Age was examined based on
recommendations for influenza vaccination (5-6, 7-8, and 9-18
years of age). Race/ethnicity was classified into 5 groups (His-
panic, white non-Hispanic, black non-Hispanic, Asian non-
Hispanic, and other non-Hispanic), insurance was delineated as
"any private, public only, or uninsured," and federal poverty level
(FPL) during 2003 was defined as less than 100%, 100% to less
than 200%, 200% to less than 400%, and 400% or more. SUDAAN
version 9.0.24 was used to account for the complex sampling de-
sign and to provide national estimates.

RESULTS

The MEPS cohort included 454 children 5 and 6 years
of age, 473 children 7 and 8 years of age, and 2120 ado-
lescents 9 to 18 years of age. Characteristics of this popu-
lation are shown in Table 1, with percentages reflect-
ing weighted data. The majority of children in the sample
were white, non-Hispanic, and privately insured.

CHILDREN 5 AND 6 YEARS OF AGE:
FIRST VACCINATION AT WCC VISIT

As a first scenario, we assumed that the initial influ-
enza vaccination would occur at a WCC visit. If we assume
that 20% of 5- and 6-year-old children had received in-
fluenza vaccination in a prior season, almost one-
quarter would need 1 additional visit and three-
quarters would need 2 additional visits in a 3-month
vaccination window (Figure 1). Expanding the time win-

dow for vaccination from 3 to 5 months reduced the num-
ber needing 2 visits by only 2.5%. Overall, there would
need to be an additional 11.6 million (3-month vaccina-
tion window), 11.5 million (4-month vaccination win-
dow), or 11.3 million (5-month vaccination window) vis-

Figure 1. Proportion of children 5 to 8 years of age needing 0, 1, or 2 additional visits for influenza vaccination in both scenarios, first vaccination at well-child
care (WCC) visits and vaccination at all visits.

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dow), 13.2 million (4-month vaccination window), or 13.1 million (5-month vaccination window) visits nationally among this age group. Assuming 20% with prior vaccination reduces additional visits needed by 600,000 visits.

All Visits Used for Vaccination

If we instead assume that all visits are used for vaccination (ie, no missed opportunities), then one-third of 5- and 6-year-old children would need 1 visit, regardless of the time window for vaccination, and 57%, 53%, and 48% would need 2 additional visits within 3-, 4-, and 5-month windows, respectively (Figure 1) (assuming 20% with prior vaccination). For 7- and 8-year-olds, 23%, 28%, and 29% would need 1 additional visit within 3-, 4-, and 5-month vaccination windows, and 69%, 63%, and 59% would need 2 visits, respectively (assuming 10% vaccinated prior). In this scenario, an additional 21.8 million visits would be needed to reach all 5- to 8-year-old children with influenza vaccination in a 3-month window and 20.7 million visits (4-month window) or 19.6 million visits (5-month window) if longer periods were used for vaccination. If instead 30% of 5- and 6-year-olds and 20% of 7- and 8-year-olds had been vaccinated in a prior season and all opportunities are used, 20.6 million (3-month window), 19.6 million (4-month window), and 18.5 million (5-month window) visits would be needed.

Bivariate and Multivariate Analyses

In bivariate analyses, in a typical 4-month window, the poorest group of 7- and 8-year-olds was the least likely to need zero additional visits (Table 2). No other demographic factors were significant for 5- and 6-year-olds or 7- and 8-year-olds. In multivariate analyses, also examining a 4-month time frame and assuming 20% prior vaccination, 5- and 6-year-olds at 100% to less than 200% of the FPL were more likely to need additional visits (odds ratio, 2.6) than those at more than 400% of the FPL. No multivariate results were significant for 7- and 8-year-old children.

Estimation of Future Visit Needs

Since, over time, more school-aged children will have been vaccinated and need only 1 vaccination each season, we estimated the additional visits needed if 50% of children 5 to 8 years of age had been vaccinated in the past. If the first vaccine is given at a WCC visit, an additional 19.7 million (3-month window), 19.5 million (4-month window), and 19.3 million (5-month window) visits would be needed. But if instead all visits are used for vaccination, 16.9 million (3-month window), 15.9 million (4-month window), and 15 million (5-month window) visits would be needed.

CHILDREN AND ADOLESCENTS 9 TO 18 YEARS OF AGE

Vaccination at WCC Visit

For this age group, 95%, 94%, and 92% would need an additional visit in 3-, 4-, and 5-month windows, respectively, if influenza vaccinations are given at WCC visits (Figure 2). This would account for an additional 33.5

Table 2. Percentage of Children 5 to 18 Years of Age Who Would Need Additional Visits During a 4-Month Influenza Season Interval\(^a\)

<table>
<thead>
<tr>
<th>Demographic</th>
<th>Age 5-6 y (n = 454)</th>
<th>Age 7-8 y (n = 473)</th>
<th>Age 9-18 y (n = 2120)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 Visits</td>
<td>1 Visit</td>
<td>2 Visits</td>
</tr>
<tr>
<td>Overall</td>
<td>14.3</td>
<td>32.3</td>
<td>53.4</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>15.3</td>
<td>30.7</td>
<td>54.0</td>
</tr>
<tr>
<td>F (reference)</td>
<td>13.3</td>
<td>33.9</td>
<td>52.8</td>
</tr>
<tr>
<td>Race/ethnicity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White non-Hispanic (reference)</td>
<td>15.7</td>
<td>31.3</td>
<td>53.0</td>
</tr>
<tr>
<td>Hispanic</td>
<td>13.1</td>
<td>32.1</td>
<td>54.8</td>
</tr>
<tr>
<td>Black non-Hispanic</td>
<td>10.3</td>
<td>36.2</td>
<td>53.5</td>
</tr>
<tr>
<td>Asian non-Hispanic</td>
<td>15.4</td>
<td>22.2</td>
<td>62.4</td>
</tr>
<tr>
<td>Other non-Hispanic</td>
<td>10.4</td>
<td>43.8</td>
<td>45.8</td>
</tr>
<tr>
<td>Insurance status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any private (reference)</td>
<td>13.2</td>
<td>31.2</td>
<td>55.7</td>
</tr>
<tr>
<td>Public only</td>
<td>17.4</td>
<td>35.5</td>
<td>47.1</td>
</tr>
<tr>
<td>Uninsured</td>
<td>7.8</td>
<td>23.9</td>
<td>68.3</td>
</tr>
<tr>
<td>Federal poverty level, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;100</td>
<td>21.0</td>
<td>26.0</td>
<td>52.9</td>
</tr>
<tr>
<td>100 to &lt;200</td>
<td>8.4</td>
<td>36.3</td>
<td>55.3</td>
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<tr>
<td>200 to &lt;400</td>
<td>15.7</td>
<td>31.2</td>
<td>53.1</td>
</tr>
<tr>
<td>≥400 (reference)</td>
<td>14.5</td>
<td>33.5</td>
<td>52.1</td>
</tr>
</tbody>
</table>

\(a\) Bivariate analyses.
\(b\) \(P < .05\).
\(c\) \(P < .005\), Bonferroni significant.
Not surprisingly, we found that the majority of children and adolescents would need additional visits for universal influenza vaccination. On multivariate analyses, subgroups of children were not more likely to need additional visits, suggesting that practice-based strategies should focus on the entire population rather than on subgroups. Conservatively, we estimate that approximately 42 million (18.3 million for 5- to 8-year-olds, 23.5 million for 9- to 18-year-olds) additional visits would be needed for universal influenza vaccination of children and adolescents, if all opportunities and a generous 5-month time frame for vaccination are used, assuming that 30% of 5- and 6-year-olds and 20% of 7- and 8-year-olds were vaccinated in a prior season. Approximately 49 million would be needed if influenza vaccination was provided during a 3-month period or if a lower coverage rate existed during a prior season.

Given an estimated 117 million visits in 12 months for children aged 0 to 18 years overall in this sample, vaccinating the population of 5- to 18-year-olds would increase the total number of annual primary care visits across the United States by 36%. These results show that the types of visits used for vaccination, the length of the vaccination period, and prior rates of vaccination can all affect the burden of additional visits to primary care practices.

**TYPE OF VISITS USED FOR VACCINATION**

Vaccinating at all types of visits, rather than strictly at WCC visits, had the greatest impact in reducing the additional burden of visits needed. Depending on the time frame and prior rates of immunization, an additional 7% to 15% of 5- to 8-year-olds would not need any extra visits if every visit was used for vaccination, and an additional 2% to 10% would need only 1 extra visit instead of 2 extra visits. For 9- to 18-year-olds, influenza vaccination rates could improve by 17 to 25 percentage points if all primary care visits were used for vaccination, depending on the time window. To reach all school-aged children and adolescents with influenza vaccination, it will be particularly important to avoid missed opportunities, given the relative scarcity of WCC visits for these age groups during the influenza vaccination season. By using all primary care visits as vaccination opportunities, up to 13.6 million additional visits nationally by 5- to 18-year-olds could be saved during a 5-month vaccination window compared with using only WCC visits. Thus, just as for routine childhood vaccinations or children with asthma, reducing missed opportunities would play a major role in influenza vaccination of all children and adolescents.

**LENGTH OF THE VACCINATION WINDOW**

Lengthening the influenza vaccination window had a surprisingly small but measurable effect on visit burden. For each 1-month forward extension of the vaccination time frame, approximately 1% to 4% of 5- to 8-year-olds would
need no additional visits to be fully vaccinated, and 5% of 9- to 18-year-olds could be vaccinated. Of course, lengthening the vaccination window is important to provide primary care practices with time to notify families and vaccinate the large number of eligible children and adolescents. However, vaccination before the onset of influenza activity in the community is ideal.

POTENTIAL STRATEGIES

Annual vaccination of the entire pediatric population within medical homes will be challenging, but additional methods that have proven effective for other childhood vaccinations are likely to be helpful for influenza vaccination of all school-aged children and adolescents. These include establishing influenza immunization clinics or special hours within primary care offices, informing parents and patients about the need for vaccination, implementing reminder/recall systems for those who are not vaccinated or need a second dose, and implementing audit and reviewing processes with feedback cycles to inform health care providers about their rates of immunization. Finally, given the large number of additional visits needed, we recommend that each practice form an ‘influenza vaccination team’ to develop, implement, and monitor the practice-based strategies for influenza vaccination of children and adolescents. Ongoing studies are evaluating the practice costs for primary care practices to provide influenza vaccination for all children and adolescents.

OTHER SITES FOR INFLUENZA VACCINATION

Given the large additional burden of visits needed to vaccinate the entire US population of school-aged children and adolescents, additional sites for vaccination outside of medical homes are being considered.

Schools: One potential, additional vaccination site might be schools, which have been successful for hepatitis B vaccine delivery in studies when free vaccine is provided. However, school-based vaccination programs present major logistic challenges.

Pharmacies: While state laws vary regarding influenza vaccination within pharmacies, such sites could be explored as another potential source for childhood influenza vaccination.

Alternative settings: Immunization information systems that communicate with medical homes might enhance the attractiveness of vaccinating in alternative settings, including public health clinics, since medical homes could be notified about vaccinations that were administered.

Use of other settings is being debated, and there is concern that current resources and delivery systems are not sufficient in these other settings to administer large-scale influenza vaccination programs. Thus, it is likely that medical homes will, in the foreseeable future, be the mainstay for influenza vaccination of children and adolescents in the United States.

CHILDREN WITH NO USUAL SOURCE OF CARE

We excluded children without a usual source of health care from analyses presented earlier; these children/adolescents may need alternative settings and extensive outreach to be reached for influenza vaccination. In a sub-analysis, including these children would account for an estimated additional 3.1 million visits for 5- to 8-year-olds (assuming 2 visits needed) and 6.7 million visits for 9- to 18-year-olds, a total of 9.8 million additional visits needed for those with no usual source of health care.

REDUCTION IN OUTPATIENT VISITS BY INFLUENZA VACCINATION

The increased number of outpatient visits measured earlier would be tempered somewhat by a decrease in the number of outpatient visits among 5- to 18-year-olds due to illness from influenza. Based on the literature, outpatient visits could be reduced by approximately 5 visits per 100 children if the influenza vaccine were 70% effective. Assuming 49.3 million children with a usual source of care, outpatient visits would be reduced by 2.5 million by influenza vaccination.

STRENGTHS AND LIMITATIONS

First, visits reported for children in the MEPS are by parent report and are affected by recall bias. Frequent interviews ameliorate that effect. Second, we were unable to measure prior receipt of influenza vaccine (primarily for high-risk children) using the MEPS and relied instead on estimates based on previously reported data. In the national cohort examined, 8.0% of school-aged children and 7.5% of adolescents had a diagnosis of asthma, and less than 1% had other high-risk diagnoses. We included these children in the overall estimates since only a slightly higher percentage (29%-35%) would have been likely to have had a prior vaccination, based on published reports. Third, visit patterns of children in 2003-2004 (the most recently available data from MEPS) may differ from those in subsequent influenza seasons, particularly as other vaccinations have been introduced for adolescents (eg, meningococcal, human papillomavirus), and the number of children older than 60 months needing only 1 vaccination should increase with time as prior recommendations are implemented. However, it is unlikely that these new recommendations would dramatically affect the rate of WCC visits offered during an influenza season.

In our multivariate analysis results, only Asian/other race groups were significantly associated with needing additional visits, findings that are not consistent with prior studies that suggest that black or Hispanic adolescents have fewer visits to primary care. The lack of significant factors associated with needing additional visits may be due to our excluding those with no usual source of health care. This suggests that the impact of a usual source of health care on needing additional visits might be greater than the effect of the other demographic, insurance, and income factors.
CONCLUSIONS

In conclusion, the vast majority of 5- to 18-year-olds would need 1 or 2 additional visits to primary care practices for universal influenza vaccination, even if all existing office visits and a generous vaccination window were used. The widest interval for vaccination predicts that an additional 42 million visits to primary care medical homes will be needed for children 5 to 18 years of age to receive influenza vaccine in a 5-month window, not including an additional 9.8 million visits needed among those children/adolescents with no usual source of care. To best cope with this additional burden of visits, primary care providers should offer the vaccine over the widest possible interval, vaccinate at every possible opportunity, implement intensive reminder/recall systems to notify eligible patients, perform audits to measure vaccination rates, and mobilize offices to implement effective strategies to efficiently handle the increased visit volume.

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Author Contributions: Study concept and design: Rand and Szilagyi. Acquisition of data: Auinger. Analysis and interpretation of data: Rand, Yoo, Auinger, Albertin, and Coleman. Drafting of the manuscript: Rand and Szilagyi. Critical revision of the manuscript for important intellectual content: Rand, Szilagyi, Yoo, Auinger, Albertin, and Coleman. Statistical analysis: Rand, Yoo, and Auinger. Obtained funding: Szilagyi. Administrative, technical, and material support: Rand, Albertin, and Coleman. Study supervision: Szilagyi.

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REFERENCES


Announcement

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