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Sofas and Infant Mortality

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KEY WORDS
SIDS, suffocation, injury, sofa

ABBREVIATIONS
aOR—adjusted odds ratio
ASSB—accidental suffocation and strangulation in bed
CDR-CRS—Child Death Review and Case Reporting System
CI—confidence interval
SIDS—sudden infant death syndrome

Dr Rechtman carried out the initial analyses and drafted the initial manuscript; Dr Colvin conducted data analysis and reviewed and revised the manuscript; Drs Blair and Moon contributed to the conception and design, contributed to the interpretation of data, and reviewed and revised the manuscript; and all authors approved the final manuscript as submitted.

doi:10.1542/peds.2014-1543

Accepted for publication Aug 20, 2014

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PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275). Copyright © 2014 by the American Academy of Pediatrics

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

FUNDING: Authors received support from the National Institutes of Health (grant P20MD000198) and the Maternal and Child Health Branch, Health Resources and Services Administration (grant R40MC21511). The funding was used for design and conduct of the study, collection, management, analysis, and interpretation of the data and manuscript preparation. The study sponsor had no role in study design, collection, analysis, and interpretation of data, writing of the manuscript, or the decision to submit the manuscript for publication. Dr Rechtman wrote the first draft of the manuscript; no honorarium, grant, or other form of payment was given to anyone to produce the manuscript. Funded by the National Institutes of Health (NIH).

POTENTIAL CONFLICT OF INTEREST: The authors have indicated they have no potential conflicts of interest to disclose.

WHAT’S KNOWN ON THIS SUBJECT: Sleeping on a sofa increases the risk of sudden and unexpected infant death.

WHAT THIS STUDY ADDS: Infant deaths on sofas are associated with nonsupine placement, being found in side position, surface sharing, changing sleep location, and experiencing prenatal tobacco exposure. These results may help explain why sofa sleeping is hazardous for infants.

abstract

OBJECTIVE: Sleeping on sofas increases the risk of sudden infant death syndrome and other sleep-related deaths. We sought to describe factors associated with infant deaths on sofas.

METHODS: We analyzed data for infant deaths on sofas from 24 states in 2004 to 2012 in the National Center for the Review and Prevention of Child Deaths Case Reporting System database. Demographic and environmental data for deaths on sofas were compared with data for sleep-related infant deaths in other locations, using bivariate and multivariable, multinomial logistic regression analyses.

RESULTS: A total of 1024 deaths on sofas made up 12.9% of sleep-related infant deaths. They were more likely than deaths in other locations to be classified as accidental suffocation or strangulation (adjusted odds ratio [aOR] 1.9; 95% confidence interval [CI], 1.6–2.3) or ill-defined cause of death (aOR 1.2; 95% CI, 1.0–1.5). Infants who died on sofas were less likely to be Hispanic (aOR 0.7; 95% CI, 0.6–0.9) compared with non-Hispanic white infants or to have objects in the environment (aOR 0.6; 95% CI, 0.5–0.7) and more likely to be sharing the surface with another person (aOR 2.4; 95% CI, 1.9–3.0), to be found on the side (aOR 1.9; 95% CI, 1.4–2.4), to be found in a new sleep location (aOR 6.5; 95% CI, 5.2–8.2), and to have had prenatal smoke exposure (aOR 1.4; 95% CI, 1.2–1.6). Data on recent parental alcohol and drug consumption were not available.

CONCLUSIONS: The sofa is an extremely hazardous sleep surface for infants. Deaths on sofas are associated with surface sharing, being found on the side, changing sleep location, and experiencing prenatal tobacco exposure, which are all risk factors for sudden infant death syndrome and sleep-related deaths. Pediatrics 2014;134:e1293–e1300
Sudden infant death syndrome (SIDS) is the leading cause of infant mortality after the first 30 days of life in the United States, with a rate of 53.9 deaths per 100,000 live births. The incidence of SIDS has declined >50% since 1992, when the national “Back to Sleep” campaign was launched after research demonstrated the association between SIDS and prone sleep position. However, during this time the rates of other sleep-related infant deaths (eg, accidental suffocation, strangulation, ill-defined causes) have increased.

The risk of SIDS and other sleep-related infant deaths can be affected by an infant’s sleep environment. Soft bedding, sleeping somewhere other than in a crib (eg, on a sofa), surface sharing (when an infant is sleeping on the same surface as another person), and bumper pads contribute to an unsafe sleep environment. In 2011, the American Academy of Pediatrics released expanded recommendations for a safe sleep environment to reduce the risk of all sleep-related infant deaths. However, many infants continue to be placed in unsafe sleep environments.

Sleeping on sofas is extremely hazardous. Compared with sleeping on other surfaces (eg, beds, cribs), it increases the risk 49- to 67-fold. Sleeping somewhere other than in a crib (eg, on a sofa), surface sharing (when an infant is sleeping on the same surface as another person), and bumper pads contribute to an unsafe sleep environment. In 2011, the American Academy of Pediatrics released expanded recommendations for a safe sleep environment to reduce the risk of all sleep-related infant deaths. However, less is known about the specific factors associated with infant deaths on sofas. One study has described the dangers associated with sofa sleeping but included only 10 sofa deaths. The purpose of this study is to describe the environmental and situational factors associated with infant deaths on sofas, as compared with other sleep-related infant deaths.

**METHODS**

**Data Source**

Data were obtained from the National Center for the Review and Prevention of Child Deaths Child Death Review and Case Reporting System (CDR-CRS) database. The CDR-CRS, funded by the Maternal and Child Health Bureau, is a web-based system used for the collection, reporting, and analysis of individual child deaths by state child death review teams. The database includes >84,000 child deaths, including >45,300 infant deaths. As of June 2014, 35 states were contributing to the database, which contains >1,700 data elements, with each element linked to definitions and a code book to ensure standardization and consistency in reporting. (At the time these data were collected, 24 states were participating.) Data were analyzed from all states that made their data available for the relevant years. Data sources include death scene investigations, autopsies, law enforcement reports, medical records, and death certificates. The reporting system includes information on the child, family, and supervisor at the time of death, as well as data about incident characteristics, investigation actions, risk and protective factors, and services needed or provided.

**Subjects**

The study population included all infants (~365 days of age) whose death was recorded in the CDR-CRS as a sleep-related death (ie, occurring during sleep or in a sleep environment, such as a crib, bassinet, or bed) in 2004 to 2012 for 24 states (see Acknowledgments for list of states). Deaths occurring during sleep but from an explained non–sleep-related medical cause (eg, infection) or weapon-related homicide were excluded. Depending on when they began participating in the CDR-CRS, some states did not have data for all study years; however, even if a state did not provide data for all years, data from that state were still included. To ascertain factors significantly associated with deaths on sofas, we extracted and compared deidentified data from these deaths with data from other sleep-related infant deaths occurring in other locations. The institutional review board at Children’s National Medical Center approved this study.

**Statistical Analysis**

The following variables were analyzed: infant characteristics (age, gender, race or ethnicity, complex chronic condition, or technology dependence, eg, ventilator dependence, gastrostomy tube feeds), place of incident, whether an autopsy was performed, cause of death, sleep environment factors (surface sharing, object found in sleep environment, sleep position, and sleep position change), and pregnancy characteristics (maternal medical problems, intimate partner violence, and substance use or abuse). Data elements regarding the manner and cause of death from the death certificate were used to assign cases to 1 of 3 causes of death: SIDS, accidental suffocation and strangulation in bed (ASSB, which included asphyxia), and ill-defined (which included undetermined causes). ASSB encompassed any incidents of accidental suffocation by soft bedding (including pillow or mattress), overlay, or wedging and entrapment, or strangulation in a sleep environment.

We performed all statistical analyses by using SPSS Statistics Data Editor version 21 (IBM Corporation, Armonk, NY), and P values <.05 were considered statistically significant. We performed multiple imputation by using the Markov Monte Carlo method to impute missing data for variables used in the analyses. (Information on the proportions of missing data is included in Tables 1 and 2.) Multiple imputation has been previously used for analyses of the CDR-CRS database. Multiple imputation predicts values for
incomplete variables by using regression equations from complete variables. This minimizes assumptions that the subset of cases with complete data are representative of the entire sample population. Multiple imputation is used so that biases resulting from missing data are reduced; it provides better, nearly unbiased estimates than other methods of handling missing data.21,22 All subsequent analyses were conducted with pooled imputed data. The $\chi^2$ test was performed for bivariate analyses to compare deaths on sofas with other sleep-related infant deaths. Multi-variable, multinomial logistic regressions were performed to create adjusted odds ratios (aORs) of deaths on sofas compared with other sleep-related infant deaths. Table 3 shows the aORs using imputation; Supplemental Table 4 shows the aORs for both imputed and original (unimputed) data.

### RESULTS

**Study Population Characteristics (Table 1)**

Of the 9073 sleep-related infant deaths in the database, 7934 (87.4%) met inclusion criteria. Of these, 1024 occurred on sofas, and 6910 occurred elsewhere. Most of the deaths on other surfaces occurred on adult beds (50.5%), cribs (20.1%), and bassinets (8.1%). The majority of deaths on sofas occurred in infants age 0 to 3 months (72.1%) and boys (59.5%). A higher proportion of infants who died on sofas were 0 to 2 months of age (36.9% vs 30.8% of other sleep-related deaths, $P < .05$). Non-Hispanic white was the largest represented ethnicity (44.8%) and made up a statistically significant larger proportion of the deaths on sofas than the other sleep-related deaths (49.0% vs 44.2%, $P < .001$). Most of the study population was cared for primarily by a parent (95.2%) and did not have any complex chronic conditions (98.8%). Most deaths (94.5%) occurred in the infant’s home, with deaths on sofas more likely than other deaths to occur in the infant’s home (96.3% vs 94.2%, $P < .05$). Additionally, an autopsy was performed in most cases (97.9%). The most common cause of death overall was ill-defined cause (38.6%), followed by SIDS (34.5%). However, the cause of death was classified as ASSB significantly more often for infants who died on sofas compared with other sleep-related deaths (40.0% vs 25.0%, $P < .001$). Overall, deaths on sofas made up 12.1% of all sleep-related deaths, 9.0% of SIDS deaths, 12.1% of ill-defined deaths, and 19.2% of ASSB deaths.

**Sleep Environment Factors (Table 2)**

Compared with other sleep-related infant deaths, surface sharing occurred in a significantly higher percentage (86.8% vs 66.2%, $P < .001$), and an object was found in the sleep
environment significantly less frequently (23.6% vs 38.0%, \( P < .001 \)) in the deaths on sofas. Overall, infants were most commonly placed in the supine position to sleep (40.7%), and 13% of infants in both groups were placed on the side. However, infants on sofas were more likely to be placed prone for sleep than infants in other sleep locations (29.9% vs 21.4%, \( P < .001 \)). Infants on sofas were also significantly more likely to be found on their back (17.0% vs 11.6%, \( P < .001 \)), whereas infants in other sleep locations were significantly more likely to be found in the supine (28.6% vs 20.1%, \( P < .001 \)) or prone (39.3% vs 37.9%, \( P < .001 \)) positions. Infants on sofas were less likely than infants in other sleep locations to change from the back or side to prone (10.4% vs 16.5%, \( P < .001 \)) but more likely to move from prone to the back or side (4.0% vs 1.7%, \( P < .001 \)). The sofa was also more likely to be a new or different sleep location for the infant (29.7% vs 13.7%, \( P < .0001 \)).

### Pregnancy History

Maternal medical problems during pregnancy and intimate partner violence during pregnancy occurred in 15.8% and 1.0% of the entire study population, respectively, with no significant difference between groups. Maternal tobacco use during pregnancy was present in 25.1% of the study population, with infants on sofas significantly more likely to have prenatal tobacco exposure than infants in other sleep locations (29.9% vs 24.4%, \( P < .001 \)). Illicit drug use and heavy alcohol use during pregnancy occurred in 7.8% and 1.6% of the study population, respectively; although this proportion was slightly higher among mothers of infants who died on sofas, there were no statistically significant differences between groups. No data were available about environmental tobacco exposure or parental consumption of alcohol or illicit drugs before the last sleep.

### Multivariable Analysis (Table 3 and Supplemental Table 4)

After we adjusted for all variables included in the model, deaths on sofas were less likely in Hispanic infants (aOR 0.7, 95% CI, 0.6–0.9) than in non-Hispanic white infants. They were also more likely to be associated with surface sharing (aOR 2.4; 95% CI, 1.9–3.0) but less likely to be associated with objects found in the sleep environment (aOR 0.6; 95% CI, 0.5–0.7), compared with other sleep-related infant deaths. Infants on sofas were more likely to be placed for sleep in the prone (aOR 2.2; 95% CI, 1.3–3.7) or side (aOR 1.4; 95% CI, 1.0–1.8) positions and to be found on the side (aOR 1.9; 95% CI, 1.4–2.4). A new or different sleep location was \( \geq 6 \) times more likely if the death occurred on a sofa (aOR 6.5; 95% CI, 5.2–8.2). Infants who died on sofas were more likely to have been exposed to tobacco in utero (aOR 1.4; 95% CI, 1.2–1.6). The cause of death for infants who died on sofas was more likely to be classified as ASSB (OR 1.9; 95% CI, 1.6–2.3) or ill-defined cause of death (aOR 1.2; 95% CI, 1.0–1.5; \( P = .05 \)).

### DISCUSSION

It has been well documented that sleeping on a sofa is extremely hazardous for an infant and increases the risk of sudden and unexplained infant death up to 67-fold.8,9,15–17 However, this is the first large analysis comparing
factors associated with infant deaths
on sofas with factors associated with other sleep-related infant deaths. This
analysis demonstrates that deaths on
sofas make up a large proportion of
sleep-related infant deaths. Furthermore, these deaths are significantly
more likely, compared with other sleep-related infant deaths, to be
associated with surface sharing, nonsupine placement, being found in
the side position, a change in usual sleep location, and in utero tobacco
exposure.

The finding of a greater association
between sleeping on a sofa and surface
sharing may be due in part to the in-
herent use of this type of furniture.
Sofas and similar objects are often
shared with others and are meant to be
used during waking hours. Sharing
a sofa with an infant is becoming in-
creasingly common in some countries and may be done to calm or feed the
infant, and the parent may inadvertently
or intentionally fall asleep with the in-
fant. It has been assumed that much of the
risk associated with sleeping on a sofa
results from the soft cushioning and
sloping surface of sofas. The American
Academy of Pediatrics specifically rec-
ommends that infants sleep on a
firm, flat surface and that soft cushions and
pillows be avoided. The soft surface of
most sofas may create rebreathing and
a potentially asphyxiating environment
for infants, especially if they are placed
in a nonsupine position. Some sofa
surfaces also slope down toward the
back cushions, which makes it easier
for infants to roll and wedge between
the seat and back-supporting surface.
In this sample, infants who died on
sofas were more likely than those who
died on other surfaces to be found in
the side position. Sleeping on the side
with one’s face against the back cush-
ions of the sofa or against another
person can result in suffocation. Past
analyses have found that infant deaths
on sofas are usually asphyxias deaths
from entrapment between a person and the sofa cushions, overlay by an-
other person, or wedging against the
sofa cushions. Indeed, the cause of
death for infants on sofas in this
sample was most frequently classified
as ASSB rather than SIDS.

### Table 3

<table>
<thead>
<tr>
<th>Variable</th>
<th>aORs</th>
<th>(95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mo)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–3 mo</td>
<td>0.93</td>
<td>0.80</td>
<td>1.1</td>
</tr>
<tr>
<td>4–11 mo</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>0.9</td>
<td>0.8</td>
<td>1.1</td>
</tr>
<tr>
<td>Unknown</td>
<td>1.2</td>
<td>0.2</td>
<td>6.1</td>
</tr>
<tr>
<td>Male</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Race or ethnicity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Hispanic black</td>
<td>1.0</td>
<td>0.9</td>
<td>1.2</td>
</tr>
<tr>
<td>Hispanic</td>
<td>0.7</td>
<td>0.6</td>
<td>0.9</td>
</tr>
<tr>
<td>Other</td>
<td>0.8</td>
<td>0.6</td>
<td>1.1</td>
</tr>
<tr>
<td>Non-Hispanic white</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
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<td>0.2</td>
<td>1.1</td>
</tr>
<tr>
<td>Unknown</td>
<td>0.6</td>
<td>0.1</td>
<td>4.2</td>
</tr>
<tr>
<td>Child’s home</td>
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<td></td>
</tr>
<tr>
<td>Surface sharing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>2.4</td>
<td>1.9</td>
<td>3.0</td>
</tr>
<tr>
<td>Unknown</td>
<td>2.2</td>
<td>0.9</td>
<td>5.2</td>
</tr>
</tbody>
</table>
| Any object present in the sleep environ-
ment                                    |      |          |           |
| Yes                                   | 0.6  | 0.5      | 0.7       | <.001    |
| No                                    |      |          |           |
| Position placed for sleep             |      |          |           |
| Prone                                 | 2.2  | 1.3      | 3.7       | <.01     |
| Side                                  | 1.4  | 1.0      | 1.8       | <.05     |
| Unknown                               | 1.0  | 0.7      | 1.4       | .9 (NS)  |
| Supine                                |      |          |           |
| Position change                       |      |          |           |
| Supine/side to prone                  | 0.9  | 0.5      | 1.5       | .6 (NS)  |
| Prone to prone                        | 0.8  | 0.4      | 1.7       | .6 (NS)  |
| Prone to supine or side               | 0.9  | 0.4      | 1.8       | .8 (NS)  |
| Unknown                               | 1.0  | 0.6      | 1.6       | .8 (NS)  |
| Supine or side to supine or side      |      |          |           |
| Position found                        |      |          |           |
| Prone                                 | 1.4  | 0.8      | 2.4       | <.01     |
| Side                                  | 1.9  | 1.4      | 2.4       | .3 (NS)  |
| Unknown                               | 1.3  | 0.8      | 1.9       | <.001    |
| Supine                                |      |          |           |
| Change in sleep location              |      |          |           |
| Different location                    | 6.5  | 5.2      | 8.1       | <.001    |
| Unknown                               | 5.1  | 4.1      | 6.2       | <.001    |
| Same location                         |      |          |           |
| Maternal smoking during pregnancy    |      |          |           |
| Yes                                   | 1.4  | 1.2      | 1.6       | <.001    |
| No                                    |      |          |           |
| Diagnosis of cause of death           |      |          |           |
| Ill-defined                           | 1.2  | 1.0      | 1.5       | <.05     |
| ASSB                                  | 1.9  | 1.6      | 2.3       | <.001    |
| SIDS                                  |      |          |           |

NS, not significant.

* Adjusted for all variables in the model.
Infants in the sofa group were more likely to be placed in a nonsupine position. The prone and side sleeping positions increase the risk of sudden and unexplained infant death during any sleep, including napping. However, caregivers may be less aware or less concerned about the infant’s sleeping position if they believe that they will be awake and observing the infant. Anecdotal data suggest that parents often place their infants on sofas when they will be in the same room and want the infant within sight (R.Y.M., unpublished data). Indeed, a high priority for many parents is to ensure that they can closely monitor their infant, whether the parent is awake or asleep, and this is thought to be best done when the infant is within sight and hearing distance. This may also explain why, when infant deaths occurred on sofas, the sofa was likely to be a new or different sleep location, that is, not the usual location for the infant to sleep. Surveys of sleep location have not found sofas to be a commonly used sleep location for infants. Although we do not have data about time of death, it is possible that many of these infants were placed on a sofa, when this was not a usual sleep location, for naps while the parent was in the same room, or on the parent’s chest while the parent was lying down on the sofa. However, it should be noted that a change in sleep environment may be associated with an increased risk of death.

Maternal tobacco use during pregnancy has been demonstrated to be a major risk factor for SIDS, increasing the risk of SIDS twofold. It is unclear why infants who die on sofas are more likely to have mothers who smoke. However, this is consistent with Ball and colleagues’ findings that sleeping with an infant on a sofa was 79% more likely if the mother was a smoker. It may be that those who place infants in an unsafe sleep environment are also less informed about other SIDS risk factors, such as prenatal maternal tobacco use. Smoking is also more common among low-income women, and lower-income families are, in general, at higher risk of sleep-related infant deaths.

This study has several limitations. Despite being a large database, the CDR-CRS does not include child deaths from all states or all child deaths within a state, because participation in the case reporting system is voluntary and not all child deaths are reviewed. Thus, the CDR-CRS is not a comprehensive population-based database, nor does it contain comparison data for nonaffected infants. As a result, it is impossible to determine an appropriate denominator for the deaths included in the study. Second, despite its definitions of variables and a standardized reporting system, the quality of the data varies between states because of differences in reporters and failure to routinely access the data dictionary. In addition, some variables have large proportions of missing data, which was found to be more likely with novice reporters and decreased with time. Consequently, data were imputed to account for missing values. It should also be noted that these deaths included all sleep-related infant deaths, including those for which the sleep surface was unknown. Other studies that have examined deaths on sofas have been epidemiologic analyses of SIDS deaths. Because there has recently been a shift in how the cause of death is coded for sudden and unexpected infant deaths in the United States, we chose to examine all deaths occurring suddenly and unexpectedly. Nonetheless, we acknowledge that this encompasses deaths from causes that are both explained (eg, accidental suffocation) and unexplained (ill-defined and SIDS). This implies that there may be >1 mechanism of death on sofas. Finally, the information available about the final sleep of these infants is limited compared with observational case-control studies and does not include socioeconomic status or specific circumstances, such as who was on the sofa with the infant, whether they were sleeping, whether they intended to sleep with the infant, and whether any alcohol or sleep-inducing drugs were consumed before the death.

Despite its limitations, the CDR-CRS has numerous strengths. The database captures a wealth of critical information on child deaths and houses it in 1 location. Additionally, the CDR-CRS is continually growing as new states begin to participate in the review process, thereby expanding the data available for analysis. The expanding database and improvement in data quality will enable the CDR-CRS to broaden its ability to identify risk factors and elucidate the circumstances surrounding all types of child deaths.

CONCLUSIONS

Infant deaths occurring on sofas make up a large proportion of sleep-related infant deaths. They are more likely to be associated with nonsupine placement for sleep, being found in the side position, surface sharing, changes in sleep environment, and in utero tobacco exposure, compared with other sleep-related infant deaths in the CDR-CRS database. These results may help explain why sofa sleeping is hazardous for infants. Although it is unclear why deaths on sofas are associated with these factors, these data indicate that many parents and caregivers may consider the sofa to be a safe environment in which the infant can sleep while remaining within sight and hearing range. Given that the risk of death for infants sleeping on sofas is so
high, it is important that parents and caregivers be educated about safe sleep guidelines in general and, more specifically, the dangers of placing infants on sofas and similar surfaces and sharing these surfaces with an infant.

ACKNOWLEDGMENTS
This data set was provided by the National Center for the Review and Prevention of Child Deaths, which is funded in part by grant U49MC000225 from the US Department of Health and Human Services, Health Resources and Services Administration, and in part by the US Centers for Disease Control and Prevention Division of Reproductive Health. The contents are solely the responsibility of the authors and do not necessarily represent the official views of the National Center for the Review and Prevention of Child Deaths, the US Department of Health and Human Services, or the participating states. Twenty-four states contributed data, including Alabama, Arizona, California, Colorado, Connecticut, Delaware, Georgia, Hawaii, Iowa, Michigan, Minnesota, Nebraska, Nevada, New Jersey, Ohio, Oklahoma, Rhode Island, Tennessee, Texas, West Virginia, and Wisconsin.

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Pediatrics 2014;134;e1293
DOI: 10.1542/peds.2014-1543 originally published online October 13, 2014;

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