Cytomegalovirus Transmission in Child Care Homes

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Background: Children attending child care centers have high rates of cytomegalovirus (CMV) excretion. Women exposed to such children have an increased risk of acquiring CMV infection, and primary infection places the offspring of such women at risk of congenital CMV infection. We studied family child care homes to determine if this child care alternative might represent a safe haven from CMV.

Methods: One hundred thirty-two women providing care in their homes were studied using a latex agglutination method to determine the rate of CMV seropositivity at baseline. Women who were seronegative for CMV were then sampled prospectively at 6-month intervals between March 1991 and August 1994 to determine the annual rate of CMV acquisition. A point prevalence of CMV excretion in family homes was determined by sampling 106 children from 25 randomly selected homes. Cytomegalovirus isolates were compared by molecular analysis using polymerase chain reaction–based methods to identify transmission.

Results: At baseline, 57.6% of the 132 providers were seropositive for CMV. Seropositive providers were more likely to be caring for toddlers (aged 1-2 years) (67% vs 46%; \( \text{OR}=2.37; \, P=0.02 \)) and had worked in child care somewhat longer (median of 28.5 vs 21.5 months; \( \text{P}=0.08 \)). Using stepwise logistic regression, the strongest predictors of seropositivity at baseline were caring for children aged 1 to 2 years (odds ratio [OR]=2.37; \( \text{P}=0.02 \)) and number of months as a child care provider (OR=1.17 for an increase of 24 months as provider; \( \text{P}=0.08 \)). Six or more years as a provider was highly associated with seropositivity (OR=3.27; \( \text{P}=0.02 \)). During follow-up, 5 of 51 seronegative providers seroconverted, yielding an annual infection rate of 6.8%. The point prevalence survey of children from the 25 homes (14 had seropositive providers) identified 8 CMV-excreting children. Three children in 1 home had indistinguishable isolates by polymerase chain reaction mapping. The provider seroconverted and excreted an isolate with a molecular profile indistinguishable from that of the children.

Conclusions: The prevalence of CMV excretion is low among children attending child care homes (8% vs 15% in prior studies of child care centers; \( \text{P}=0.07 \)), and only 1 (20%) in 5 of the homes had CMV-excreting children. However, the overall CMV seroconversion rate of home child care providers was comparable to the rate observed among providers in child care centers. Families who use family home child care as an alternative to large child care centers are exposed to a low and unpredictable risk of CMV infection.


Editor’s Note: In this case, home is not a safe haven.

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SUBJECTS AND METHODS

RECRUITMENT OF FAMILY CHILD CARE HOMES

Family child care homes in the area of Iowa City–Cedar Rapids, Iowa, a metropolitan region with approximately 200,000 inhabitants, were identified from lists compiled by local social service agencies. In Iowa, a *family child care home* is defined as 6 or fewer children cared for by 1 provider in his or her own home. Homes can care for more than 6 children if the additional children are present for only part of the day; eg, before and after school. The state of Iowa does not require licensing or regulation of family child care homes.

Providers were contacted by study personnel and invited to participate in this study. In addition, providers were recruited via advertisements placed in the local newspaper. At enrollment, each provider completed a detailed questionnaire that assessed factors related to his or her employment in child care. The research proposal was approved by the University of Iowa Human Subjects Review Committee, and informed consent was obtained prior to enrollment.

SEROLOGIC STUDIES FOR CMV

Serologic studies for CMV were performed using a latex agglutination method as described previously. A positive response was defined as an agglutination titer of 1:8 or higher. Providers who were seronegative at baseline underwent sampling serially at 6-month intervals. Seroconversions were confirmed by assaying paired specimens simultaneously. Serologic studies were conducted between March 1991 and August 1994.

VIROLOGIC STUDIES FOR CMV

To determine the background rate of CMV excretion among children, a point prevalence survey was conducted approximately 14 months after starting the study. Children from 25 child care homes, selected by use of a random number table, were invited to participate, and informed consent was obtained from a parent or guardian prior to enrollment.

Urine samples were obtained from the disposable diapers of children who were not toilet trained or from sterile urine collections of children who were no longer diapered. Urine samples were cultured for CMV in duplicate on confluent monolayers of human foreskin fibroblast cells using methods described previously.

MOLECULAR ANALYSIS OF CMV ISOLATES

Cytomegalovirus strains were studied using polymerase chain reaction (PCR)–based methods, as described previously. Strains were compared according to the size or restriction fragment length polymorphisms of the PCR products obtained by amplification with primers for the a-sequence, glycoprotein B, or major immediate early gene regions of human CMV. Isolates were considered indistinguishable if they exhibited identical a-sequence product size and identical restriction fragment length polymorphisms for a-sequence, glycoprotein B, and major immediate early gene products.

STATISTICAL ANALYSIS

Age of provider, number of months as a provider, and number of diapered children cared for were compared between CMV-seropositive and -seronegative providers by using the Wilcoxon rank sum test. The association of categorical variables, such as race, education level, marital status, presence of children in the home, and employment in large child care centers with baseline seropositivity was tested by using the Fisher exact test. From these univariate analyses, the variables that suggested a possible association with provider seropositivity (P < .15) were included in a stepwise logistic regression analysis. A significance level of P < .10 was used for entry into the logistic regression model and a level of P > .10 for removal from the model.

The annual rate of seroconversion was computed by dividing the number of providers who seroconverted with the sum of the number of years of follow-up for all the providers who were seronegative at baseline. The Fisher exact test was used to compare CMV excretion between children in family home care and those in large child care centers.

RESULTS

SEROEPIDEMIOLOGY OF PROVIDERS

At baseline, 57.6% of 132 providers enrolled in the study were seropositive for CMV. Seropositive providers were more likely to care for children aged 1 to 2 years (67.1% in seropositive providers vs 46.4% in seronegative providers; P = .02) and had worked somewhat longer in child care (median of 28.5 months and interquartile range of 10-96.5 months vs a median of 21.5 months and interquartile range of 7.5-52 months in seronegative providers; P = .11). Seropositive providers were slightly, but not significantly older (median of 31.4 years and interquartile range of 28-36 years vs a
Urinary samples were obtained from 106 children in 25 different child care homes approximately 14 months after initiating the seroepidemiologic studies of providers working in child care centers in the same geographic area.8 Cytomegalovirus was isolated from the urine of 1 woman who seroconverted to CMV, yielding an annual seroconversion rate of 7.9% among providers working in child care centers, and no differences were observed in the number of diapered children for seropositive and seronegative providers.

Using logistic regression, the strongest predictors of seropositivity at baseline were caring for children aged 1 to 2 years (odds ratio [OR]=2.37; 95% confidence interval [CI], 1.15-4.86; P=.02) and the length of time in months as a child care provider (OR=1.17 for an increase of 24 months as provider; 95% CI, 0.98-1.39; P=.08). Six or more years as a child care provider was strongly associated with CMV seropositivity (OR=3.27; 95% CI, 1.26-8.50; P=.02).

During follow-up, 5 of the seronegative providers seroconverted to CMV, yielding an annual seroconversion rate of 6.8%. This compares with an annual seroconversion rate of 7.9% among providers working in child care centers in the same geographic area.8 Cytomegalovirus was isolated from the urine of 1 woman who seroconverted during the current study.

Table

Summary of Cytomegalovirus (CMV) Results for Providers and Children in the 25 Sampled Homes

<table>
<thead>
<tr>
<th>Home No.</th>
<th>Provider Serology</th>
<th>Age Range of Children, y (Median)</th>
<th>No. of CMV Excretors/No. of Children Sampled (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>+</td>
<td>2.3-8.4 (3.2)</td>
<td>1/6 (17)</td>
</tr>
<tr>
<td>4</td>
<td>-</td>
<td>1.9-9.4 (3.8)</td>
<td>0/6 (0)</td>
</tr>
<tr>
<td>7</td>
<td>+</td>
<td>4.1 (4.1)</td>
<td>0/2 (0)</td>
</tr>
<tr>
<td>10</td>
<td>-</td>
<td>1.2-8.4 (4.2)</td>
<td>0/8 (0)</td>
</tr>
<tr>
<td>13</td>
<td>+</td>
<td>0.9 (0.9)</td>
<td>0/1 (0)</td>
</tr>
<tr>
<td>17</td>
<td>-</td>
<td>0.9-6.8 (3.7)</td>
<td>1/6 (17)</td>
</tr>
<tr>
<td>19</td>
<td>Seroconverter</td>
<td>0.8-6.9 (1.5)</td>
<td>3/6 (50)</td>
</tr>
<tr>
<td>24</td>
<td>-</td>
<td>0.3-6.2 (3.6)</td>
<td>0/8 (0)</td>
</tr>
<tr>
<td>27</td>
<td>+</td>
<td>0.4-10.9 (2.8)</td>
<td>0/3 (0)</td>
</tr>
<tr>
<td>37</td>
<td>-</td>
<td>0.9-1.7 (1.3)</td>
<td>0/2 (0)</td>
</tr>
<tr>
<td>42</td>
<td>-</td>
<td>3.5-10.8 (6.5)</td>
<td>0/4 (0)</td>
</tr>
<tr>
<td>45</td>
<td>+</td>
<td>0.3-6.0 (2.1)</td>
<td>0/5 (0)</td>
</tr>
<tr>
<td>46</td>
<td>-</td>
<td>1.1-5.0 (1.3)</td>
<td>1/3 (33)</td>
</tr>
<tr>
<td>50</td>
<td>Seroconverter*</td>
<td>1.2-9.5 (7.5)</td>
<td>0/4 (0)</td>
</tr>
<tr>
<td>51</td>
<td>+</td>
<td>1.2-3.3 (1.5)</td>
<td>0/3 (0)</td>
</tr>
<tr>
<td>59</td>
<td>+</td>
<td>1.6 (1.6)</td>
<td>0/1 (0)</td>
</tr>
<tr>
<td>64</td>
<td>+</td>
<td>4.6-6.2 (5.4)</td>
<td>0/2 (0)</td>
</tr>
<tr>
<td>67</td>
<td>+</td>
<td>0.5-10.6 (2.4)</td>
<td>0/3 (0)</td>
</tr>
<tr>
<td>79</td>
<td>+</td>
<td>Newborn</td>
<td>0/1 (0)</td>
</tr>
<tr>
<td>82</td>
<td>+</td>
<td>0.3-6.1 (1.7)</td>
<td>2/6 (33)</td>
</tr>
<tr>
<td>83</td>
<td>-</td>
<td>0.1-8.9 (4.7)</td>
<td>0/6 (0)</td>
</tr>
<tr>
<td>87</td>
<td>+</td>
<td>1.0-1.5 (1.3)</td>
<td>0/2 (0)</td>
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<tr>
<td>89</td>
<td>-</td>
<td>3.3-12.3 (5.1)</td>
<td>0/5 (0)</td>
</tr>
<tr>
<td>90</td>
<td>+</td>
<td>0.8-3.1 (2.2)</td>
<td>0/6 (0)</td>
</tr>
<tr>
<td>94</td>
<td>+</td>
<td>0.4-6.6 (3.5)</td>
<td>0/5 (0)</td>
</tr>
</tbody>
</table>

*This provider seroconverted approximately 1 year after the point prevalence sample.

Family home care, a commonly used form of child care, has been viewed by some as a potentially favorable alternative to large child care centers because the former setting, usually consisting of 6 or fewer children, reduces a child's exposure to large numbers of children who may be harboring infectious agents. Consequently, the epidemiology of CMV transmission in child care homes has important public health implications for the women who care for young children in their homes, as well as for the parents who may elect to use this as a potential strategy to reduce the risk of exposure to infectious agents. Data from the CMV registry suggest that exposure to CMV is a legitimate concern for parents with young children.11

The results of this study indicated that the prevalence of CMV excretion among the sampled children was relatively low. The frequency of CMV excretion was 7.6% among the 106 children from 25 different homes. This rate was less than the overall excretion rate of 15% among 219 children in 3 child care centers (P<.07) sampled during a prior study8 and comparable to the low rate of CMV excretion observed among young children cared for in their own homes.12

Of 23 sampled child care homes, CMV was detected in only 5 (20%). This supports the conclusion that the aggregate probability of exposure to CMV is lower in child care homes than in child care centers, because most sampled centers in the Iowa City—Cedar Rapids area have had 1 or more CMV-excreting children.8,9 Using child care homes may thus reduce the overall probability of exposure to CMV, although there is no way for parents to ascertain which homes lack CMV-excreting children at any given time.
Molecular analysis of the CMV isolates from 1 child care home confirmed horizontal spread of CMV, indicating that when CMV is introduced into the home child care environment, the virus can be transmitted, analogous to the horizontal transmission observed in large centers at several US locations. The data do not allow us to determine the precise pattern of transmission. However, because the provider seroconverted during the study, the most likely event was CMV transmission among the children and from a single child or children to the provider.

Of major relevance is the potential risk of CMV transmission to the adults who have close contact with the young children in family homes. The seroepidemiology of CMV infection among child care providers is a useful measure of the risk of CMV transmission from child to adult. Five home child care providers seroconverted during follow-up in the present study, yielding an annual seroconversion rate of 6.8%. This was comparable to the rate of 7.9% observed in a prior study of providers who worked in large child care centers in the same communities.

These results indicate that there may be little or no difference in the risk of CMV transmission among adult providers whether they care for small numbers of children in their own homes or have contact with large numbers of children in center-based programs. However, the rates of provider seroconversions in home or center-based child care observed in this and a prior Iowa study are lower than the 12% to 20% rates of seroconversion observed among day care center providers in other geographic locations in the United States and Canada. This suggests that there may be important regional variations regarding the risks of CMV acquisition, probably related to baseline rates of CMV excretion among young infants entering child care.

What are the implications of this study for the parents of young children and for women who care for young children in their homes? First, the results indicate that parents who might choose family home child care as a strategy to diminish their exposure to CMV assume a low but unpredictable risk of CMV acquisition. Although most child care homes lack CMV-excreting children, CMV will be present in a certain proportion of homes; 1 in 5 (20%) in the current study. When CMV is present, the results of this study indicate that the virus can be transmitted widely to children and adults, implying that the same variables (hygienic behaviors, child care practices, and so on) affecting CMV transmission in child care centers also influence transmission in child care homes. We suspect that the risk of CMV acquisition by the parents of young children parallels that of providers.

Importantly, these results indicate that the overall risk of CMV infection among adult providers exposed to children in child care homes may be comparable to that of workers in large child care centers. The precise risk of CMV infection in a given home is difficult to predict, however, because it is impractical and costly to screen children routinely for CMV excretion. Consequently, providers, as well as parents, should assume that CMV may be present in any home with young children. Given that the outcome of congenital CMV infection correlates strongly with the mother's antibody status prior to pregnancy, we recommend that CMV serologic status be known by women of reproductive age who care for young children and intend to become pregnant. Women who care for children in their homes should be counseled regarding the mechanisms of CMV transmission and their risks of acquiring CMV from the children in their care.

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REFERENCES