INJURIES IN CHILD-CARE CENTERS

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Permalink
https://escholarship.org/uc/item/1fz2k0xr

Journal
AMERICAN JOURNAL OF DISEASES OF CHILDREN, 143(4)

ISSN
0002-922X

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Publication Date
1989-04-01

Peer reviewed
The Epidemiology of Injuries in 4 Child Care Centers

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Objectives: (1) To describe the pattern of injury in preschool-aged children in 4 child care centers as compared with the results of other studies; (2) to compare injury rates by sex, age, and child care center; and (3) to examine environmental and child factors contributing to injury severity.

Design: A 2-year cohort study of 362 preschool-aged children attending 4 urban child care centers. Teachers completed standardized injury forms on the type of injury, body location, site of injury, and contributing factors.

Results: During the 2 years of the study, 1886 injuries were reported. The mean and median child injury rate was 6 and 4 injuries per 2000 exposure hours (equivalent to 1 full-time child care year), respectively. The majority of injuries (87%) were minor, occurred during free play (81%) and on the playground (74%), and were precipitated by child-related factors (59%), such as being pushed. Boys had significantly higher median injury rates than girls. Age-adjusted injury rates for each child care center were significantly different by center ($F_3 = 61, P < .001$). While moderate to severe injuries were more often precipitated by combinations of child and environmental factors ($\chi^2 = 20, P < .001$), minor injuries were usually precipitated by child-related factors.

Conclusions: Injury data from child care centers are important for identifying common risk factors for frequent or severe injury events and for designing injury prevention programs. More research is needed to identify factors contributing to injuries, such as children’s behavior and the child care centers’ physical and socioemotional environments.


Injuries are the leading cause of mortality and morbidity for children older than 1 year. Each year an estimated 600,000 US children are hospitalized because of injuries and more than 15 million are seen in emergency departments. Understanding how to prevent these severe injuries should be the ultimate goal of injury research. Epidemiologic data describing and analyzing common injuries are necessary for designing effective interventions to lower children’s injury rates.

Studies of preschool-aged children in child care centers provide an opportunity to investigate injuries with large numbers of children in a normative, natural setting. In 1990, 43% of US preschool-aged children with employed mothers and 30% of preschool-aged children with unemployed mothers were enrolled in child care centers.

Injury studies in child care centers show that minor injuries are the most common injuries and severe injuries, those requiring medical attention, comprise just 1% to 7% of the overall injury incidence. However, recent evidence suggests that children who sustain frequent minor injuries are more likely to sustain severe injuries. Studies of minor injuries may, therefore, be useful to identify risk factors for severe injuries.

Although prevention of severe childhood injuries is the ultimate goal of injury research in child care centers, methodological differences across studies make it difficult to identify commonalities across studies. Various studies use different definitions of injury events, calculations of injury rates, informants of injury events, and study designs. Injury definitions range from injury events that required medical attention to events defined by teachers completing a report form or defined...
SUBJECTS, MATERIALS, AND METHODS

The injury surveillance data presented in this article were collected as part of a larger research project that studied the relationship between stress and health among preschool-aged children in 4 urban child care centers. The cohort study was conducted between January 1990 and January 1992, and its procedures were approved by the Human Subjects Committees of the University of California, San Francisco, and the University of California, Berkeley. Informed consent was obtained from parents prior to their child's involvement in the study.

SUBJECTS

Demographic information was collected on 362 children from the child care centers' records. Dates of birth were available for 360 children.

CHILD CARE CENTERS

Two child care centers were university-affiliated and 2 were private, nonprofit centers. The centers included 35, 60, 113, and 154 children, respectively. The age distribution differed across centers; the smallest center had the highest percentage of 4-year-olds and the lowest percentage of 2-year-olds, while the largest center had the highest percentage of 5-year-olds.

All centers were open 50 weeks per year. Although the centers had different curricula and daily schedules, each allotted 50% to 60% of the day to free play outdoors. During the winter season, outdoor time was curtailed only when it rained.

Injury data were collected for 2 years on all study children in 3 of the 4 centers. In 1 center, only first-year data were analyzed, because data collection in the second year was inconsistent due to staff changes.

INJURY DEFINITION AND DATA COLLECTION

Teachers completed standardized forms when an injury met the study definition of "an event that resulted in bodily harm, as reflected by a physical mark or a sustained complaint more than 5 minutes in duration." The definition included objective indicators (eg, physical mark) to reduce subjective reporting by teachers. The injury form was based on forms used in previous injury research in child care centers and elementary schools. It included injury information about the date, time, type of injury, body part injured, location in center, activity when injury occurred, and factors that contributed to the injury, such as faulty equipment or a child being pushed by another child.

Teachers at each child care center attended semianual meetings with research staff to review injury reporting procedures. In addition, feedback about incomplete or ambiguous reports was regularly given to teachers.

INJURY RATES

Injury rates were calculated as: (total number of injuries/total exposure time in hours) × 2000 exposure hours. Each child's total exposure time was the number of hours he or she was enrolled in the center during the study period, calculated as: [(days per week) × (mean hours per day)] × (number of weeks enrolled). Two thousand exposure hours is equivalent to a full-time child being present in a center for 50 weeks, 8 hours per day. For example, if a child sustained 6 injuries and was enrolled 30 weeks, 5 days per week, 8 hours per day, his or her injury rate would be 6 injuries per 2000 exposure hours.

Age-adjusted center rates were calculated using direct age adjustment, to compare rates free of the influence of age. A direct age adjustment was calculated as \( \frac{\sum p_r n_r}{\sum n_r} \), where \( r \) represents the age-specific rates in each center and \( p_r \) is the proportion in each age group in a standardized population, or \( p_e = n_e/\sum n_e \). A standard population was created by adding the number of children in each age category (2.0-2.9 years, 3.0-3.9 years, 4.0-4.9 years, 5.0-5.9 years) across centers.

SEVERITY

Injuries were rated as minor, moderate, or severe. Minor injuries were defined as superficial cuts, bumps, bruises, and bites. Moderate injuries included deep cuts, crush injuries, multiple cuts, burns, chipped teeth, or minor injuries requiring medical attention or telephone contact with parents. Severe injuries were moderate injuries requiring medical attention and/or telephone contact with parents.

CONTRIBUTING FACTORS

Teachers identified 1 or more contributing factor(s) that preceded each injury as environmental, child-related, or both environmental and child-related. Environmental factors were defined as characteristics of the physical environment that contributed to the injury occurrence, such as a wet or slippery floor, faulty equipment or furniture, a sharp object, or a window or door. Child-related factors were defined as individual behaviors, such as falls and collisions with objects, or the behavior of another child, such as pushing or hitting that contributed to the occurrence of an injury. Combinations of child-related and environmental factors could also be reported (eg, a child pushed by another child into a sharp object).

ANALYSES

Mean and median child injury rates per 2000 exposure hours were calculated by sex, age, and child care center. Moderate to severe injury rates per 2000 exposure hours were also calculated. Age categories were created for ages 2.0 to 3.5 and 3.6 to 6.0 years to create fairly even distributions in each category.

Injury rates were compared across sex and age using \( t \) tests for mean rates and rank sums for median rates. Poisson confidence intervals (CIs) were calculated for mean injury rates. Age-adjusted injury rates were calculated for each child care center. Analyses of variance were used to analyze differences across centers for age-adjusted rates and moderate to severe injury rates.

Frequency distributions for the time, month, type of injury, body part injured, location, activity, contributing factors, and severity of the injuries were calculated, and the relations between contributing factors and injury severity were analyzed by the \( \chi^2 \) test.

Statistical significance was set at \( P<.05 \). Data were analyzed using Stata Statistical Software (Stata Corp, College Station, Tex).
by the research team. Furthermore, injury rates are calculated with different denominators: 1000 student-years, number of subjects, 100,000 exposure hours, 1 year, and 1 day. Rate calculations sometimes adjust for length of time exposed to potential injuries, although such adjustments differ across studies.

Informants include parents, teachers, or health professionals, each of whom can bias the number and type of injuries reported. In some studies of preschool injuries, for example, parents have been asked to recall injury events that occurred during the past year, while teachers are often asked to report injury events in the child care center as they occur.

Various studies have compared injury rates across sex, age, and child care centers. Most studies show sex differences, with boys having 1.5 to 3 times the number of injuries as girls. However, 2 studies of largely minor injuries reported no significant sex differences.

Children younger than 5 years are at higher risk of severe injuries compared with children aged 6 to 13 years. In child care centers, toddlers have higher injury rates compared with 3- to 4-year-olds. Rate calculations sometimes adjust for length of time exposed to potential injuries, although such adjustments differ across studies.

The purpose of this article is to describe the pattern of injury in preschool-aged children in 4 child care centers during 2 study years and to identify factors contributing to injuries. The study investigated minor and moderate to severe injuries sustained in the centers and addressed the following research questions: What are the child injury rates among preschool-aged children attending urban child care centers? Do child injury rates differ by sex or age? Do age-adjusted injury rates differ by child care center? What are the characteristics of injuries that occur in child care centers (i.e., severity, type of injury, body part involved, time of day, month, location, activity, severity, environmental and child contributing factors)? Is injury severity different for injuries precipitated by environmental, child, or both environmental and child contributing factors?

### RESULTS

#### CHILD DEMOGRAPHICS

Children’s ages at study enrollment ranged from 2.0 to 5.9 years, with a mean age of 3.7 years. One hundred ninety-nine children (55%) were male. Most children (n = 319 [88%]) attended the centers full-time.

#### DISTRIBUTION AND INJURY RATES

A total of 1886 injuries were reported during the 2 study years for the 362 children. The range of injuries was from 0 to 47 with a skewed distribution: 19% (n = 70) of the children had no injuries and 15% (n = 55) sustained more than 50% of all the injuries. The overall mean injury rate was 5.7 injuries per 2000 exposure hours (median = 3.8). The mean moderate to severe injury rate was 0.8 per 2000 exposure hours.

#### SEX

Boys had a mean injury rate of 6.4 (CI, 6.0-6.7) injuries per 2000 exposure hours, slightly higher than the girls’ rate of 5.0 (95% CI, 4.6-5.3) injuries per 2000 exposure hours (P = .07) (Table 1). Boys also had a higher mean injury rate than girls (P = .02). Moderate to severe injury rates were significantly different (P = .01) for boys and girls. Boys had a rate of 1.0 moderate to severe injury per 2000 exposure hours (95% CI, 0.8-1.3), compared with 0.6 injury per 2000 exposure hours (95% CI, 0.4-0.7) for girls.

#### AGE

Younger preschool children, aged 2.0 to 3.5 years, had significantly higher mean and median injury rates per 2000 exposure hours than older children, aged 3.6 to 6.0 years (P = .01). Younger children had a mean (median) injury rate of 6.8 (5.1) injuries per 2000 exposure hours.

### Table 1. Injury Rates per 2000 Exposure Hours by Sex

<table>
<thead>
<tr>
<th>Sex, No. of Children</th>
<th>Overall Mean Injury Rate (CI)</th>
<th>Overall Median Injury Rate</th>
<th>Moderate to Severe Injury Rate (CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys (n = 199)</td>
<td>6.4 (6.0-6.7)</td>
<td>4.5</td>
<td>1.0 (0.8-1.3)</td>
</tr>
<tr>
<td>Girls (n = 163)</td>
<td>5.0 (4.6-5.3)</td>
<td>3.0</td>
<td>0.8 (0.4-0.7)</td>
</tr>
<tr>
<td>Total (N = 362)</td>
<td>5.7 (5.4-6.9)</td>
<td>3.8</td>
<td>0.8 (0.7-1.0)</td>
</tr>
</tbody>
</table>

*P = .07. CI indicates 95% confidence interval.
†z = −2.39, P = .02.
‡t360 = 2.55, P = .01.
and older children had a mean (median) injury rate of 4.5 (2.9) injuries per 2000 exposure hours.

CHILD CARE CENTER

Differences were identified among child care centers in injury rates (Table 2). Age-adjusted injury rates by center ranged from 3.1 to 15.3 injuries per 2000 exposure hours (P < .001), and moderate to severe injury rates ranged from 0.5 to 1.5 injuries per 2000 exposure hours (P < .01). The 2 smaller centers (centers 1 and 3) had the highest age-adjusted injury rates.

CHARACTERISTICS OF INJURIES

Severity

Eighty-seven percent (n = 1629) of the injuries reported were minor, 12% (n = 234) were moderate, and 1% (n = 23) were severe.

Type of Injury

The most frequent types of minor injuries were scrapes or superficial cuts (36.5%) and bumps or bruises (34.5%) (Table 3). Moderate to severe injuries included deep cuts (5.8%), crush injuries (2.8%), multiple cuts (0.3%), burns (0.4%), and chipped teeth (0.4%). The most common body parts injured were the face, eyes, nose, or mouth (31%) and head or neck (17%). Arms, hand, or shoulder were involved in 27% of the injuries.

Location

The playground was the most common location of injuries (74%). Other locations of injuries were the classroom (17%), field trips (4%), entry hall (3%), and bathroom (1%).

Activity

The activity at the time of the injury was usually free play (81%). However, 11% of the injuries occurred during transition times, ie, brief periods between one activity and another. The remaining 8% of the injuries occurred during other activities (eg, circle time, meals).

Hourly, Daily, and Seasonal Peaks

Injuries most frequently occurred between 11 AM and noon (24%). Specifically, this peak was before lunch in each center. There was no peak by month or day of the week.

Contributing Factors

Table 4 shows that child factors alone contributed to 58.9% (n = 1103) of the total injuries and environmental factors alone to only 1.8% (n = 34). Environmental and child factors combined were involved in 39.3% (n = 736) of the injuries. Thirteen of the injury forms (1%) had no etiologic or contributing factor noted.

Falls accounted for 40% (n = 744) of the injuries, and another child was involved in 37% (n = 693) of all injuries.

Table 2. Comparison of Child Care Centers by Injury Rates per 2000 Exposure Hours and Mean Exposure Hours

<table>
<thead>
<tr>
<th>Center</th>
<th>Age-Adjusted Injury Rates*</th>
<th>Median Injury Rate</th>
<th>Moderate to Severe Mean Injury Rate†</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7.7</td>
<td>5.7</td>
<td>0.6</td>
</tr>
<tr>
<td>2</td>
<td>3.1</td>
<td>2.2</td>
<td>0.5</td>
</tr>
<tr>
<td>3</td>
<td>15.3</td>
<td>12.4</td>
<td>1.5</td>
</tr>
<tr>
<td>4</td>
<td>5.2</td>
<td>4.5</td>
<td>0.9</td>
</tr>
<tr>
<td>All centers</td>
<td>5.7</td>
<td>3.8</td>
<td>0.8</td>
</tr>
</tbody>
</table>

*Center by age-adjusted injury rate (F₃ = 60.6, P < .001).
†Center by moderate to severe injury rate (F₃ = 6.4, P < .01).

Table 3. Frequency by Type of Injury

<table>
<thead>
<tr>
<th>Type of Injury</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scrape/superficial cut</td>
<td>686</td>
<td>36.4</td>
</tr>
<tr>
<td>Bump/bruise</td>
<td>650</td>
<td>34.4</td>
</tr>
<tr>
<td>Human bite</td>
<td>163</td>
<td>8.6</td>
</tr>
<tr>
<td>Deep cut</td>
<td>109</td>
<td>5.8</td>
</tr>
<tr>
<td>Complaint of pain</td>
<td>76</td>
<td>4.0</td>
</tr>
<tr>
<td>Bloody nose</td>
<td>59</td>
<td>3.1</td>
</tr>
<tr>
<td>Crush injury</td>
<td>53</td>
<td>2.8</td>
</tr>
<tr>
<td>Injury by foreign object</td>
<td>30</td>
<td>1.6</td>
</tr>
<tr>
<td>Insect bite or sting</td>
<td>22</td>
<td>1.2</td>
</tr>
<tr>
<td>Chipped teeth</td>
<td>7</td>
<td>0.4</td>
</tr>
<tr>
<td>Burn</td>
<td>7</td>
<td>0.4</td>
</tr>
<tr>
<td>Sprain</td>
<td>5</td>
<td>0.3</td>
</tr>
<tr>
<td>Multiple cuts</td>
<td>5</td>
<td>0.3</td>
</tr>
<tr>
<td>Other or missing</td>
<td>14</td>
<td>0.7</td>
</tr>
<tr>
<td>Total</td>
<td>1886</td>
<td>100</td>
</tr>
</tbody>
</table>

*Types of injuries are mutually exclusive.

Table 4. Contributing Factors by Injury Severity

<table>
<thead>
<tr>
<th>Contributing Factors</th>
<th>Minor</th>
<th>Moderate</th>
<th>Severe</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child only†</td>
<td>962</td>
<td>109</td>
<td>12</td>
<td>1103</td>
</tr>
<tr>
<td>Environmental only‡</td>
<td>25</td>
<td>9</td>
<td>0</td>
<td>34</td>
</tr>
<tr>
<td>Environmental and child factors</td>
<td>611</td>
<td>114</td>
<td>11</td>
<td>736</td>
</tr>
<tr>
<td>Total</td>
<td>1618</td>
<td>232</td>
<td>23</td>
<td>1873</td>
</tr>
</tbody>
</table>

*Pearson χ² = 20.3, P < .001.
†Child contributing factors included falls, other person involved, and being hit or pushed.
‡Environmental contributing factors included slippery floor, broken equipment, and intact equipment.
This cohort study describes injuries in 4 child care centers and compares injury rates by sex, age, and center using statistical methods not commonly used in child care injury research. Injury rates per 2000 exposure hours (equivalent to 1 year in full-time child care) were calculated to compare rates by sex and age, while age-adjusted rates were calculated to compare center rates. Child and environmental contributing factors were related to the severity of injuries, with minor injuries precipitated mostly by child factors, such as injuries involving another child.

INJURY METHODOLOGY

Child Injury Rates

The mean child injury rate for preschool-aged children in this study was 5.7 injuries per 2000 exposure hours, a rate substantially higher than most other preschool injury studies.5,7,11,14 Because some studies calculate injury rates without adjustment for individual children's exposure hours,7,14,29 such studies may underestimate the true rate. To adjust for exposure hours, detailed data must be collected on enrollment dates (ie, start and leave dates), days absent, hours enrolled per day, and hours spent using playground equipment.15

Mean injury rates are often higher and less precise than median injury rates, because mean injury rates are sensitive to outliers. In this study, for example, the mean child injury rate of 5.7 injuries per 2000 exposure hours is higher than the median injury rate of 3.8 injuries per 2000 exposure hours. Most childhood injury studies show this skewed distribution of injuries, with only a relatively small number of children experiencing the majority of the injuries.5,13,20,31

Injury rates should be easy to interpret and useful for teachers, parents, and health care providers of preschool-aged children. Therefore, this study uses the time frame of 1 year when calculating injury rates per 2000 exposure hours, because it is practical and easy to understand and interpret. Leland et al15 reported injury rates per 8-hour days and also estimated expected yearly injury rates for children in full-time child care; the expected injury rates ranged from 1.5 to 12.5 injuries per year, depending on which child care center the child attended. These rates are similar to the pattern in this study; that is, rates differ by center and span a wide range.

Injury Rates and Sex

Consistent with prior research, this study shows that boys have higher injury rates than girls, especially when comparing the moderate to severe injury rates. Boys’ higher injury rates may be the result, in part, of behavioral characteristics such as aggressive behaviors, high activity levels, and behavior problems.13,16,17 Because sex is associated with injury rates and child behavior,13,17 it may confound the relationship between behavior and injuries. In more complex models, where sex and behavior are both included as predictors of injury rates, children’s behavioral characteristics may be a stronger predictor of injury rates than sex.

Injury Rates by Center

Consistent with the study by Leland et al,15 these data indicate that child care centers’ injury rates differed dramatically. Such unevenness in injury rates may reflect different levels of staff education, child care center environments, socioemotional and physical safety, and/or individual children’s behavioral characteristics.10

In this study, the lowest injury rate was in the largest center, contrary to Sacks et al,11 who reported higher severe injury rates in larger centers. Injury rates are probably affected not solely by the number of children in the center but other factors as well, such as turnover rate of children and/or staff and staff-child ratio. With lower turnover rates, there is more stability in peer and staff-child relationships. Howes and Stewart32 found that stressed families choose lower-quality centers. Therefore, family factors and child care quality may also affect injury rates.

Description of Injuries

Consistent with previous studies of injuries in child care centers, these data indicate that the most common body parts injured are the face and upper extremities, ie, hand, elbow, and arm,5,10,15 and the most common injuries are scratches, bumps, and bruises.5,10,14 Our study was also consistent with past research indicating that the most common injuries are minor injuries, which occur most frequently on the playground and during free play.5,7,10,14,15,33 Minor injuries may serve as markers of potentially hazardous situations and may have a positive educational effect.10 Teachers may be encouraged to intervene with children who experience many minor injuries as a means of preventing more severe injuries.34

In this study, most injuries occurred before lunch. Similarly, Chang et al14 and Elardo et al7 reported peaks between 10 AM and noon. In contrast, Lee and Bass5 reported a peak in the late afternoon and Sacks et al11 reported peaks at 11 AM and 4 PM. Higher injury rates before lunch or evening meals have been attributed to hunger35; however, they may also reflect transient changes in routine and decreased child-staff ratios as some staff prepare for mealtime.11

Injury Severity and Contributing Factors

Our study provides new knowledge about the child and environmental characteristics that precede or co-occur with injuries in child care centers. Falls are the most common child factor contributing to minor and severe injury rates.5,11,14 Our study found that 37% of injuries involved another child, a proportion higher than the 16%
to 25% found in other reports. In the preschool-aged group, peer relationships are being established and group play may involve aggression and conflicts that contribute to injuries.

LIMITATIONS

The limitations of this study include the small number of centers, imprecise exposure time calculations, potentially inconsistent reporting of injuries, and limited generalization of the results. Exposure time or length of time in the center was based on days enrolled in the center, without accounting for days absent, because this information was not always accurate or available. Therefore, children's exposure time was probably overestimated in this study and the injury rates reported may actually be an underestimate of the true rates.

The accuracy and consistency of injury reports was not validated by an objective observer. Some teachers may complete injury forms more regularly and accurately than other teachers, or reporting may have been inconsistent during the 2 years. This may have contributed to some variation in injury rates across centers, although the cohort design provided ongoing regular monitoring of completed injury forms and review of the injury definition at staff meetings.

Generalization of these results is limited by our convenience sample of 4 urban child care centers.

IMPLICATIONS FOR PREVENTION

Because most injuries occur during free play, on the playground, and before meals, improved adult supervision may help prevent injuries in preschool-aged children. Other potentially useful interventions to reduce child factors that contribute to injuries may be limiting the number of children on the playground at one time and providing more structured small-group activities. In-service workshops for teachers would heighten their awareness of the consequences of injuries, emphasize the importance of identifying children who sustain frequent minor injuries, and inform teachers of what they can do to decrease injuries at their center.

FURTHER RESEARCH

Future injury research among preschool-aged children should include more child care centers, wider ranges of center environments, and more diverse groups of children. The methodologies discussed in this article, including age-adjusted rates, comparison of median injury rates, prospective injury reporting, and standard injury definitions, could improve the accuracy of information and introduce new standardized approaches to summarize and compare injury data across contexts and studies. Subsequent studies should also expand our knowledge of risk factors for injuries by identifying specific behavioral and contextual characteristics (family, child care center) that may help distinguish high-injury from low-injury children, and identify sex differences, and clarify the effect of children's environments on their risk of injuries.

Most preschool-aged children are now spending large amounts of time in child care settings and they need safe and stimulating physical and socioemotional environments. Research on injuries can help parents and teachers find the balance between adequately protecting children from severe injuries and encouraging them to engage in activities that provide peer socialization, creative play, and exploration of their environment.

Accepted for publication May 26, 1999.

This study was supported by grant RO1 HD24718 from the National Institute of Child Health and Development, and training grant T32-HLOT365 from the National Institutes of Health, Bethesda, Md.

Presented at the annual meeting of the American Public Health Association, Washington DC, November 1, 1994.

We thank the families, staff, and directors in the centers that supported our work. Dr Alkon thanks S. Leonard Syme, PhD, and Steve Selvin, PhD, for their support of this work during graduate school.

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