

Dog bites: still a problem?

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ABSTRACT

Objective: To estimate the incidence of dog bites in the USA and compare it with similar estimates from 1994.

Design: Nationally representative cross-sectional, list-assisted, random-digit-dialed telephone survey conducted during 2001–2003.

Methods: Weighted estimates were generated from data collected by surveying 9684 households during 2001–2003 and compared with results from a similar survey conducted in 1994. Estimates for persons aged 15–17 years were extrapolated on the basis of rates for 10–14-year-olds.

Results: Whereas the incidence of dog bites among adults remained relatively unchanged, there was a significant (47%) decline in the incidence of dog bites among children compared with that observed in the 1994 survey, particularly among boys and among those aged 0–4 years. Between 2001 and 2003, an estimated 4 521 300 persons were bitten each year. Of these, 885 000 required medical attention (19%). Children were more likely than adults to receive medical attention for a dog bite. Among adults, bite rates decreased with increasing age. Among children and adults, having a dog in the household was associated with a significantly increased incidence of dog bites, with increasing incidence also related to increasing numbers of dogs.

Conclusions: Dog bites continue to be a public health problem affecting 1.5% of the US population annually. Although comparison with similar data from 1994 suggests that bite rates for children are decreasing, there still appears to be a need for effective prevention programs.

Dog bites have been recognized around the world as a substantial public health problem disproportionately affecting children.¹ Bites can lead to infections, psychological trauma, disfiguring injuries requiring reconstructive surgery, hospitalizations, and rarely death.^{2–9} It is estimated that 3–18% of dog bite wounds become infected, with occasional complications including meningitis, endocarditis, septic arthritis, and septic shock.⁶ In one Belgian study, symptoms of post-traumatic stress disorder were identified in more than half of children suffering dog bites.⁴ In the USA, more than 31 000 patients underwent reconstructive surgical procedures in 2007 as the result of dog bites, which equates to approximately 10.3 persons per 100 000 population.⁷ An international comparison of data from surveillance systems in industrialized countries suggests that the death rate from dog bites in these countries is 0.004–0.07 per 100 000 population, with hospital admissions of 4.8–11.3 per 100 000 population.^{1 8} Developing countries may experience higher death rates from dog bites, in part because of the risk of rabies infection. Although much less common in

industrialized countries, dog bites still account for 99.9% of human rabies deaths worldwide.⁹

In the USA, although dog bites are usually reported locally, there is no national reporting system to track the extent of this public health problem. A study using National Hospital Ambulatory Medical Care Survey data from 1992–1994 estimated that each year about 333 000 people sought care in an emergency department for a dog bite and 13 000 were hospitalized.¹⁰ Another study estimated almost 6000 hospitalizations for dog bites in 1994 at a cost of over \$40.5 million.¹¹ In 1994, the Centers for Disease Control and Prevention (CDC) sponsored the Injury Control and Risk Survey (ICARIS), a national, cross-sectional, list-assisted, random-digit-dial telephone survey of English-speaking or Spanish-speaking adults conducted in all 50 states and the District of Columbia. The study, conducted from April through September 2004, resulted in 5238 completed adult interviews providing information for a total of 3541 children aged 0–14 years. It was estimated from data from this study that 4.7 million Americans were bitten by dogs in 1994, and almost 800 000 of them sought medical care for their bites.¹²

Since then, few national surveillance data on dog bites have been published. An examination of 20 years of fatality data from 1979–1998 revealed an average of 16 fatalities per year over that time.¹³ In addition, the first report from a new emergency department data system suggested that almost 370 000 people sought treatment for dog bites in emergency departments in 2001.¹⁴

During 2001–2003, a second nationally representative telephone survey about injuries (ICARIS-2) was conducted using methodology similar to that used in the first such study. Many of the questions from the 1994 survey were repeated, including those on dog bites. This report updates national estimates on the incidence of dog bites in the USA, compares these estimates with those from ICARIS-1994, re-examines individual and household characteristics of victims of dog bites, and shows that dog bites continue to be of public health concern.

METHODS

Like the 1994 ICARIS, the Second Injury Control and Risk Survey (ICARIS-2) was a cross-sectional, list-assisted random-digit-dial telephone survey of English-speaking or Spanish-speaking adults in all 50 states and the District of Columbia. Data collection took place from 23 July 2001 through 7 February 2003. The survey, designed to obtain national estimates on the occurrence of, and risk factors for, injury, was sponsored by the CDC's National Center for Injury Prevention and Control and conducted using a computer-assisted

Table 1 Estimated annual number of persons with dog bites and incidence, by selected person and household characteristics, ICARIS-2, USA

| Characteristic | Sample size | Reported dog bites | | | p Value* |
|------------------------------|-------------|--------------------|-------------------|-----------------------------------|----------|
| | | Count | National estimate | Rate per 1000 population (95% CI) | |
| Adults | 9672† | 157 | 3 582 600 | 16.6 (13.4 to 19.9) | – |
| Sex | | | | | |
| Male | 4801 | 84 | 1 980 100 | 19.0 (14.0 to 24.0) | 0.1736 |
| Female | 4871 | 73 | 1 602 400 | 14.4 (10.1 to 18.7) | |
| Age group (years) | | | | | |
| 18–24 | 829 | 25 | 777 400 | 30.2 (15.8 to 44.5) | 0.0210¶ |
| 25–34 | 1603 | 30 | 727 400 | 18.3 (10.3 to 26.3) | |
| 35–44 | 2105 | 28 | 612 700 | 13.4 (7.5 to 19.4) | |
| ≥45 | 4974 | 71 | 1 388 100 | 13.8 (9.6 to 17.9) | |
| Household income | | | | | |
| <\$34 999 | 3006 | 46 | 1 094 300 | 17.1 (11.0 to 23.2) | 0.8736 |
| \$35 000–\$49 999 | 1450 | 21 | 689 500 | 20.1 (9.9 to 30.4)§ | |
| ≥\$50 000 | 3825 | 73 | 1 506 100 | 17.7 (12.6 to 22.9) | |
| Household education | | | | | |
| ≤ High school | 2606 | 34 | 697 400 | 12.1 (7.2 to 17.1) | 0.1213 |
| Some post-high school | 1900 | 35 | 957 300 | 22.0 (13.2 to 30.9) | |
| College graduate | 5064 | 88 | 1 927 900 | 17.2 (12.6 to 21.9) | |
| Census region | | | | | |
| Northeast | 2161 | 35 | 797 700 | 19.3 (11.7 to 26.9) | 0.4509 |
| Midwest | 1649 | 25 | 622 600 | 12.8 (6.9 to 18.7)§ | |
| South | 4028 | 65 | 1 205 500 | 15.6 (10.4 to 20.9) | |
| West | 1834 | 32 | 956 700 | 19.9 (11.8 to 28.0) | |
| No of dogs in household | | | | | |
| None | 6189 | 44 | 941 800 | 7.2 (4.6 to 9.8) | 0.0001¶ |
| One | 2252 | 70 | 1 569 800 | 29.7 (20.9 to 38.5) | |
| Two or more | 1225 | 43 | 1 071 000 | 34.3 (21.3 to 47.3) | |
| Medically attended | 9672 | 31 | 644 900 | 3.0 (1.6 to 4.5) | – |
| Children (0–14 years) | 5638‡ | 79 | 789 300 | 13.1 (9.8 to 16.3) | – |
| Sex | | | | | |
| Boys | 2859 | 43 | 391 300 | 12.7 (8.5 to 16.9) | 0.8101 |
| Girls | 2736 | 36 | 397 900 | 13.5 (8.6 to 18.5) | |
| Age group (years) | | | | | |
| 0–4 | 1709 | 17 | 169 100 | 8.7 (3.9 to 13.5) | 0.0607 |
| 5–9 | 1825 | 37 | 366 000 | 18.7 (11.9 to 25.5) | |
| 10–14 | 2029 | 25 | 254 100 | 12.2 (7.0 to 17.4) | |
| No of dogs in household | | | | | |
| None | 3318 | 29 | 293 100 | 8.3 (4.8 to 11.8) | 0.0064¶ |
| One | 1552 | 31 | 275 000 | 16.1 (9.7 to 22.6) | |
| Two or more | 766 | 19 | 221 200 | 26.6 (13.9 to 39.2)§ | |
| Medically attended | 5638 | 20 | 191 100 | 3.2 (2.0 to 5.2) | – |

*Log likelihood χ^2 test.

†Excludes data from 12 adult respondents (six men, six women) for whom dog bite status was not known. Numbers may not add up to the total because of missing values.

‡Excludes data from five children (two boys, three girls) for whom dog bite status was not known. Numbers may not add up to the total because of missing values.

¶Test for linear trend.

§Potentially unstable (23% < RSE ≤ 30%).

telephone interviewing system. Details of this survey have been described elsewhere.^{12–15} Briefly, telephone exchanges were stratified into high-minority (those with ≥10% black or Hispanic households) and low-minority groups. Seventy percent of the ICARIS-2 sample was drawn from the high-minority stratum in an attempt to approximate their representation in the population. One adult was selected for interview from each eligible household. Once a household was reached, the number and gender of adults in the household were determined, and one gender was randomly selected with a pre-specified probability. If more than one eligible adult was of the chosen gender, the one with the nearest birthday was chosen. Data were collected on a wide range of injury topics including smoke alarm use, helmet

use, water safety, automobile-related safety practices, pedestrian injuries, injuries related to physical activity, falls, alcohol use, firearm ownership and use, interpersonal violence, and suicide.

Respondents were asked demographic questions about themselves and children aged 0–14 years living in their household (eg, age and sex), as well as household characteristics (eg, educational attainment, household income). The survey questions on dog bites were identical in the two surveys; the topic was introduced with the statement, “One injury problem that we know little about is dog bites.” Respondents were then asked, “In the past 12 months, has anyone in your household been bitten by a dog?” A positive response generated additional

questions to determine who was bitten and if they sought medical care for the bite from the emergency department, hospital, doctor's office, or other place. Dog bites in persons for which age and gender were captured (ie, the adult respondent and children aged 0–14 years in the household) were used to estimate annual sex-specific and age-specific incidence of dog bites in the USA. In ICARIS-2, information was also collected on the number of dogs in the household.

Survey data were weighted to adjust for unequal selection probabilities, non-coverage, and non-response. They were then post-stratified to conform to the distribution of household composition for the 2000 census by census region and metropolitan status, after incorporation of information using the March 2002 Current Population Survey, to produce nationally representative estimates.¹⁶ Each adult respondent and all children in the household under 15 years of age were further ratio-adjusted to their age/sex/race distribution in the population, using data from the July 2002 Bridged Population data file prepared by the US Census Bureau in collaboration with the National Center for Health Statistics.¹⁶ Because data were collected on only one randomly selected adult in the household, adult respondent data were used to estimate the total number of bites and medically attended bites for all adults. To adjust for lack of coverage of 15–17-year-olds, we extrapolated the total number of bites and medically attended bites for the approximately 12.2 million people in this age group¹⁶ by applying the rates for 10–14-year-olds.

All analyses were conducted using SUDAAN software to account for the complexity of the survey design.¹⁷ Data for adults and children were analyzed separately. Because the adult respondent provided proxy dog bite data on all children in the household under 15 years of age, we restructured the data to reflect one record per child per household and included a

variable in the design statement to identify children from the same household, thereby allowing the correlation among children in the same household to be taken into account when computing confidence intervals and conducting statistical testing. Log likelihood χ^2 tests were performed on weighted percentages to formally test for the association between variables related to dog bites and demographic characteristics. Comparisons of the prevalence of dog bites and medically attended dog bites reported in ICARIS-2 with those reported in the 1994 ICARIS were carried out using a standard t test. For testing purposes, we considered $p < 0.05$ to be significant. Rates are presented per 1000 population. Estimated totals were rounded to the nearest hundred.

RESULTS

Of the 113 476 telephone numbers sampled, 66 949 (59%) were ineligible, 31 803 (28%) were of unknown eligibility, and 14 724 (13%) were eligible. Respondents completed 9684 interviews representing a total of 5643 children aged 0–14 years. Using the standard definitions published by the American Association for Public Opinion Research, we obtained a response rate of 48% (AAPOR formula RR3).¹⁸

Information on dog bites was missing for 12 adult respondents and proxy data for five children, and these were excluded from the analysis. Of the 9672 adult respondents remaining, 157 reported incurring a dog bite in the past 12 months resulting in a weighted estimate of 3 582 600 adults bitten (rate 16.6 per 1000; 95% CI 13.4 to 19.9) (table 1).

These adult respondents also reported 79 dog bites among the 5638 children aged 0–14 years in their household with information on dog bites, resulting in a weighted estimate of 789 300 children aged 0–14 years bitten (rate 13.1; 95% CI 9.8 to 16.3). Medical attention was reportedly sought by 31 adults and

Table 2 Estimated annual incidence rate of reported and medically treated dog bites among adults and children: comparison of ICARIS (1994) and ICARIS-2, USA

| Characteristic | Incidence rate per 1000 population (95% CI) | | p Value† |
|--------------------------|---|---------------------|----------|
| | 1994 ICARIS* | ICARIS-2 | |
| Adults | | | |
| Dog bites | | | |
| Overall | 16.1 (12.1 to 20.0) | 16.6 (13.4 to 19.9) | 0.8262 |
| Sex | | | |
| Male | 21.3 (14.9 to 27.7) | 19.0 (14.0 to 24.0) | 0.5765 |
| Female | 11.2 (6.6 to 15.9) | 14.4 (10.1 to 18.7) | 0.3210 |
| Age group (years) | | | |
| 18–24 | 29.3 (13.3 to 45.3) | 30.2 (15.8 to 44.5) | 0.9374 |
| 25–34 | 19.7 (11.6 to 27.9) | 18.3 (10.3 to 26.3) | 0.7984 |
| 35–44 | 21.2 (10.8 to 31.6) | 13.4 (7.5 to 19.4) | 0.2035 |
| ≥45 | 7.9 (4.0 to 11.8) | 13.8 (9.6 to 17.9) | 0.0453 |
| Medically attended bites | 2.0 (0.7 to 3.3) | 3.0 (1.6 to 4.5) | 0.3037 |
| Children | | | |
| Dog bites | | | |
| Overall | 24.5 (18.2 to 30.8) | 13.1 (9.8 to 16.3) | 0.0018 |
| Sex | | | |
| Boys | 29.2 (20.4 to 38.0) | 12.7 (8.5 to 16.9) | 0.0010 |
| Girls | 20.0 (11.0 to 28.9) | 13.5 (8.6 to 18.5) | 0.2231 |
| Age group (years) | | | |
| 0–4 | 24.9 (14.2 to 35.5) | 8.7 (3.9 to 13.5) | 0.0066 |
| 5–9 | 28.4 (17.0 to 39.7) | 18.7 (11.9 to 25.5) | 0.1516 |
| 10–14 | 21.0 (12.3 to 29.6) | 12.2 (7.0 to 17.4) | 0.0882 |
| Medically attended bites | 6.4 (3.6 to 9.2) | 3.2 (2.0 to 5.2) | 0.0470 |

*ICARIS, 1994 data previously published by Sacks *et al.*¹²

†The p value is based on a standard t test for the comparison of differences between two proportions within a single category of a characteristic (eg, males), across studies.

20 children, yielding weighted estimates of 644 900 (rate 3.1; 95% CI 1.9 to 4.9) and 191 100 (rate 3.2; 95% CI 2.0 to 5.2), respectively. On the basis of the rate for 10–14-year-olds (12.2 per 1000), we extrapolated that there were an additional 149 400 bites (including 49 000 medically attended bites) in those aged 15–17 years, yielding an estimated total of 4 521 300 bites (15.8 per 1000) for the entire population each year, of which an estimated 885 000 were medically attended (3.1 per 1000).

There were no significant differences in bite rates by sex for either children or adults. Those 5–9 years of age had the highest rate among children (incidence rate of 18.7 per 1000); 18–24-year-olds had the highest rate among adults (30.2 per 1000) (table 1). Bite rates among adults decreased significantly with increasing age ($p < 0.0210$, test for linear trend). Although children and adults had roughly similar overall bite rates, 24% of children bitten received medical attention for the bite, compared with 18% of adults.

For both children and adults, having a dog in the household was associated with a significantly increased incidence of dog bites, with increasing incidence also related to increasing numbers of dogs in the household ($p = 0.0064$ and 0.0001 , respectively, test for linear trend). Adults with two or more dogs in the household were almost five times more likely to report being bitten than adults not living with a dog in their household. Bite rates were 7.2 per 1000 (95% CI 4.6 to 9.8) in adults with no dogs in the household, 29.7 (95% CI 20.9 to 38.5) in adults with one dog, and 34.3 (95% CI 21.3 to 47.3) in adults with two or more dogs in the household. Similarly, children living with two or more dogs were more than three times more likely to have been bitten. Bite rates among children with no dogs in the household were 8.3 per 1000 (95% CI 4.8 to 11.8), with one dog 16.1 (95% CI 9.7 to 22.6), and two or more 26.6 (95% CI 13.9 to 39.2). Other variables examined (census region, household income, educational attainment) were not associated with increased bite rates in adults. We were unable to assess these characteristics in children because small numbers led to unstable estimates.

In comparison with previous estimates,¹² overall the rate of dog bites has decreased by 13% from 18.2 per 1000 population in 1994 to 15.8 per 1000 in the present study. The 3% increase in rates among adults from 16.1 per 1000 (95% CI 12.1 to 20.0) in 1994 to 16.6 (95% CI 13.4 to 19.9) in the present study was not significant ($p = 0.8262$) (table 2). However, among children aged 14 years and younger, the rate has decreased an estimated 47% from 24.5 (95% CI 18.2 to 30.8) to 13.1 (95% CI 9.8 to 16.3), with significant declines seen primarily in boys (57%) and among those aged 0–4 years (65%).

Overall, the incidence of medical care for dog bites did not significantly change (3.1 per 1000 in both surveys). However, there was a significant decline in the rate of medically attended bites among children (6.4 per 1000 to 3.2 per 1000; $p = 0.0470$) and a non-significant increase among adults (2.0 per 1000 to 3.0 per 1000, $p = 0.3037$) (table 2).

DISCUSSION

Excluding the extrapolation for persons aged 15–17 years, the survey data suggest that an estimated 4.37 million people were bitten annually in 2001–2003, and, of these, 836 000 (19%) required medical attention. These estimates equate to about 1.5% of the population bitten annually and 0.3% requiring medical attention. In 1994, estimates from the original ICARIS, also excluding persons aged 15–17 years, were 4.49 million bites, of which 756 700 (17%) required medical care. Although the

overall numbers appear similar, they mask an important shift. In 1994, bites to adults were estimated at 3.05 million (medically attended 379 300); in 2001–2003, they are estimated at 3.58 million (medically attended 644 900). For children aged 0–14 years in 1994, bites were estimated at 1.44 million (medically attended 377 400); in 2001–2003, they are estimated at 789 300 (medically attended 191 100). These numbers reflect a significant change in the rate of occurrence. Whereas the 16.6 per 1000 incidence rate estimate for adults is 3% higher than the estimated 16.1 per 1000 for 1994, the rate for children decreased by 47%, from 24.5 per 1000 in 1994 to 13.1 per 1000. This decrease was seen primarily in boys and children <5 years of age. In addition, whereas the rate of medical care received for dog bites did not change significantly from 1994 to 2001–2003 for adults (2.0 vs 3.0, $p = 0.3037$), the rate of medical care received for dog bites decreased significantly among children, mirroring the decreases in all bites (6.4 vs 3.2, $p = 0.0470$). This occurred while overall injury visits to healthcare providers among children were not decreasing. The National Ambulatory Medical Care Surveys reported 12.1 million injury visits in 1994 (20.5 per 100 children under 15 years) and 13.1 million in 2003 (21.6 per 100 children under 15 years).^{19 20} Although the reasons for this decrease in bite rates and rates of medical care among children are not known, we speculate that the longstanding emphasis on pediatric dog bite prevention may have begun to bear fruit.^{12 14 21}

Another interesting finding was that members of households with dogs were more likely to be bitten than those from households without dogs. As this question was not on the original survey, we are unable to compare it with the 1994 survey. We do not know if the bite was from a dog residing in the household, although some studies suggest that this may be the case.²² It is also possible that the association may reflect that those who are around dogs in the household are more comfortable with dogs and thus more likely to interact with and be bitten by dogs from other households or in the local environs.

This study has strengths. Firstly, it used similar ascertainment methods to those used in the 1994 study and thus allows comparisons over time. Secondly, the sample size of 9684 adults is larger than the original survey of 5238 adults, leading to smaller error boundaries (the number of proxy reports collected on children also increased from 3541 in 1994 to 5643 in this study).

There are also a number of limitations, in addition to the fact that the data are self-reported and unvalidated. The response rate was 48% compared with 56% in 1994. Research has established that random-digit-dialed surveys with low response rates do not necessarily produce high non-response bias and that such surveys may still be generalizable.^{23 24} We compared ICARIS-2 sample demographics with the 2000 US census, the July 2002 US Census Bureau/National Center for Health Statistics Bridged Population data file, and the March 2002 Current Population Survey and found that our sample was representative with respect to age, gender, race/ethnicity, household income, and employment status. Our respondents were slightly more likely to be married, to be more highly educated, and to own their own homes than the general US population; however, such differences were less than 10%.¹⁵ To the extent that these characteristics are associated with a lower or higher risk of dog bite, the true incidence would be underestimated or overestimated in this report. We assessed the association between household educational attainment, marital status, home ownership, and dog bites in our analysis

and found none. Whether bites were more or less likely among non-respondents to ICARIS-2 is unknown. The recall period of 1 year may be relatively long and may tend to lead to underestimation. In addition, as data for children are proxy-reported, they too may be subject to underestimation. Parents may also only recall the more severe; alternatively, adults may seek care more often for injured children than for themselves. The estimates are based on 157 reported bites among adults and 79 among children 0–14 years. The relatively small number may have limited our ability to detect differences in characteristics between groups. In addition, we asked whether respondents had been bitten by a dog, not specifically whether they had been injured as a result of a dog bite. Some bites resulting in no injury or only minor injuries (eg, scratches, abrasions, minor contusions) may have been reported, which would lead to overestimation of actual dog bite injuries. Finally, like the original ICARIS, the survey design did not allow delineation of demographics of household members other than the respondent and children aged 0–14 years. As in the case of the first ICARIS survey, children aged 15–17 years were not covered, and their bites were again extrapolated. However, whether this age group is included or not, it appears that dog bites remain a public health problem in the USA.

There are many comprehensive recommendations for lowering this burden further.^{14 15} In general, the suggested strategies involve: (1) promoting responsible dog ownership (including training, socializing, and neutering of dogs); (2) increasing knowledge about how to behave around a dog (eg, do not run from a dog, be still like a tree when approached by an unfamiliar dog); (3) supporting animal control efforts (eg, stray management, low-cost neutering, licensing, dealing with irresponsible owners); (4) regulatory/legislative measures (eg, targeting dogs of any breed that have exhibited harmful behavior such as unprovoked attacks on persons or animals, requiring insurance, placing primary responsibility for a dog's behavior on the owner). Most existing programs focus on dog bite prevention in children in both the USA and other countries. Although children's behavior around unknown dogs may be changed in the short term,²¹ whether this translates into an actual reduction in bites has not been examined. Many of the strategies require further evaluation to ensure that the burden of dog bites is effectively reduced.

Tracking the number of dog bites and their consequences remains troublesome in the USA and around the world. The experience of a dog bite can result in lasting physical and psychological scars. It is important to improve research and surveillance to identify the true mental and physical burden of these injuries, as well as improving prevention methods.

IMPLICATIONS FOR PREVENTION

Results suggest that dog bites remain a public health problem affecting ~1.5% of the US population each year, with increased risk among those with dogs in their households. Although rates among children appear to be decreasing, they are not among adults. Decreases in the incidence of dog bites in children between the two surveys may provide some ecological evidence of the effect of programs focusing on children. These efforts should be evaluated as they are continued. Additional efforts to target adults and dog owners may also be beneficial.

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What is already known on this topic

- ▶ Dog bites are a substantial public health problem worldwide, disproportionately affecting children.
- ▶ In 1994, an estimated 4.7 million Americans were bitten by dogs, and almost 800 000 of them sought medical care for their bites.

What this study adds

- ▶ Between 2001 and 2003, an estimated 4.5 million Americans, or 1.5% of the US population, were bitten by dogs each year, and 885 000 sought medical care for their dog bite.
- ▶ The bite rates for children aged 0–14 years have decreased by 47% since 1994; the rates for adults have not decreased.
- ▶ Among both children and adults, having one or more dogs in the household was associated with a significantly increased incidence of dog bites, with the incidence also related to the number of dogs in the household.

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