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The incidence of infant physical abuse in Alaska

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Abstract

Objectives: To determine the incidence of and risk factors associated with infant (<1 year of age) physical abuse in Alaska.

Methods: A population-based retrospective cohort study for the 1994–2000 resident birth cohort was conducted by linking data from birth certificates, Child Protective Services, a statewide hospital-based trauma registry, hospital discharge data, and the Alaska Infant Mortality Review (including death certificates). The main outcome measures were the incidences of overall physical abuse and abuse resulting in hospitalization or death. A case of child abuse was defined as an instance of substantiated physical abuse to an infant identified in the Child Protective Services database or an infant death with homicide identified on the death certificate as the manner of death.

Results: During the 7-year study period, there were 70,842 births and 325 cases of physical abuse including 72 that led to hospitalization ($n = 58$), death ($n = 4$), or both ($n = 10$); respective incidences for all abuse and abuse leading to hospitalization or death were 4.6 and 1.0 per 1000 live births. Following multivariate analyses, the risk factors with the highest population attributable risks were maternal or paternal education ≤12 years, unmarried mother, and maternal prenatal substance use. To determine if the study methodology was likely to have missed cases of severe abuse, we examined information for all 216 infants hospitalized for trauma during the study period who did not have identification of abuse in one of the study databases; of these, at least 39 had injuries inconsistent with the reported mechanism (a long bone or skull fracture that reportedly resulted from a fall of less than 3 feet or from a caretaker's arms or for which the caretaker denied a history of trauma).

Conclusions: Alaska has one of the highest documented infant physical abuse incidences reported in the literature and abuse is associated with potentially modifiable—primarily social—risk factors. Despite this high incidence, substantial under-reporting of hospitalized cases likely occurs.

Keywords: Abuse; Alaska; Epidemiology; Incidence; Physical abuse

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Introduction

Although some studies have evaluated the incidence of infant (less than 1 year of age) physical abuse resulting in death (Siegel et al., 1996) or hospitalization (Barlow & Minns, 2000; Forjuoh, 2000; Jayawant et al., 1998), their number is small. Moreover, none has conducted a comprehensive evaluation of the incidence of all physical abuse resulting in hospitalization, death, or substantiation by Child Protective Services. Similarly, few population-based studies have evaluated the incidence of infant physical abuse among high-risk groups (Overpeck, Brenner, Trumble, Trifiletti, & Berendes, 1998). The former information is necessary for helping to prioritize resources while the latter is necessary for designing intervention programs. The current study reports the incidence of infant physical abuse in Alaska during the 7-year period 1994–2000 by linking birth certificate data with data from Child Protective Services, an Infant Mortality database (including death certificates), a statewide hospital-based trauma registry, and a hospital discharge database for the state's only pediatric tertiary care center.

Methods

Data sources

Child Protective Services. The Alaska Division of Family and Youth Services, the state's Child Protective Services agency, provided a database of all cases of infant physical abuse perpetrated by a primary caretaker. Child Protective Services does not have jurisdiction over abuse committed by other persons, such as babysitters; consequently, these cases may have been missed. Alaska Statutes define child physical abuse as the physical injury of a child under the age of 18 years by a person under circumstances that indicate that the child's health or welfare is harmed or threatened thereby (Alaska Statute 47.17.290). Unlike all other analyzed data sources (which included children from birth to <1 year of age), cases from the Child Protective Services database were limited to those reported at 1 week to <1 year of age to eliminate instances where an infant was born to a mother who used illicit substances during pregnancy.

The Child Protective Services database did not include a description of the abuse and most of the individual case records could not be retrieved; consequently, it was not possible to evaluate the severity of most cases of abuse not resulting in hospitalization or death. Since understanding the severity of non-hospitalized, non-fatal substantiated abuse is an important public health issue, a convenience sample of case records for 31 infants with abuse occurring primarily during 1999–2000 was reviewed. This review indicated that abuse not resulting in hospitalization or death consisted primarily of bruising or bleeding resulting from slapping on the face, spanking, or beating with objects such as electrical cords or belts. Other cases not involving hospitalization or death included shaking, attempted smothering, striking a caretaker holding an infant with subsequent injury to the infant, and hot water immersion.

Alaska Maternal and Infant Mortality Review (AMIMR). Records gathered for the AMIMR process included birth and death certificates, autopsies, maternal and infant medical records, police and other first responder reports, and occasionally home interviews for all Alaska resident infant deaths. Each month, a panel of experts—primarily physicians but also nurses, social workers, law enforcement officials, and

staff of various state agencies—reviewed all available records to identify preventable causes of death, including physical abuse.

The Alaska Trauma Registry. The Alaska Trauma Registry relied on voluntary reporting from the state's hospitals; during the study period, all 24 in-state hospitals participated. At each hospital, Trauma Registry personnel reviewed medical charts to enhance the likelihood of complete case ascertainment. The Trauma Registry database consisted of reports of children admitted for trauma and included International Classification of Diseases, 9th Revision (ICD-9) codes and a descriptive narrative of the diagnosis.

Hospital discharge database. Alaska has a single pediatric tertiary care referral center. As a check on the Alaska Trauma Registry, the discharge database for this hospital for the years 1996–2000 was reviewed (data for 1994–1995 were not available).

Vital statistics. The Alaska Bureau of Vital Statistics provided a birth certificate data file with linked death certificates for the study period. Information on the birth certificate included demographic information, previous pregnancy history, infant birth weight and gestation, and maternal substance use history.

Data linkage

During the 7-year study period, Alaska had 70,842 births (approximately 10,000 births per year) of which 38% occurred to residents of Anchorage, the most populous city in the state. Because of the relatively low number of births, few data elements were needed to identify individuals. The Child Protective Services, Alaska Maternal-Infant Mortality Review, and tertiary care hospital databases were matched using date of birth and name. The Alaska Trauma Registry did not collect names. Consequently, this database was linked to the other three by an exact match of the date of birth, village of residence, and gender and an approximate match of the Child Protective Services date of investigation with the date of death or hospital admission. For all databases, a hand linkage was also performed to identify instances where obvious transcription errors prevented an exact computer generated match.

The complete outcome database was then linked to birth certificate data. First, a computer-generated match was performed by linking on the child's last name and date of birth. For the remaining unmatched infants, a hand linkage was performed. Using this method, 90% of the abuse episodes were linked to birth certificates. The remaining 10% had insufficient data for matching or could not be matched, possibly because of name changes; because of this, not all cases had birth certificate risk factor information available for analysis. Cases with a birth certificate match did not differ from cases without a match by race, gender, age, or hospitalization or death status.

Case definitions

A case of child abuse was defined as an instance of substantiated physical abuse to an infant identified in the Child Protective Services database or an infant death with homicide identified on the

death certificate as the manner of death. In Alaska, assignment of child physical abuse also can occur if the criminal justice system makes a legal determination of purposely-inflicted death or injury; however, criminal justice system records were not available. Non-accidental head injury was defined as a skull fracture or intracranial bleed in conjunction with Child Protective Services substantiation of abuse.

Two exceptions to the above case definitions were made. Two out-of-hospital deaths identified by the Infant Mortality Review Committee—but not by the death certificate—as due to homicide were included. Also included were 12 hospitalizations and two emergency room visits where a physician assigned a diagnosis of intentional injury (ICD-9 codes E960–969 [homicide and injury purposely inflicted by other persons] or 995.5 [child maltreatment syndrome] in the context of a substantial physical injury) but no corresponding Child Protective Services investigation was identified in the database. This usually occurred because the perpetrator was a non-primary caretaker and thus Child Protective Services did not have jurisdiction over the case or because the infant died. It is likely that these 14 cases represented child abuse since all but one other instance of physician-assigned abuse for which a corresponding Child Protective Services investigation was identified were substantiated.

Occasionally, multiple records existed for a single individual in the Child Protective Services database. As a conservative assumption to control for multiple entries of a single event, reports of harm that occurred greater than 1 month apart to the same infant were considered independent episodes while those that occurred at a lesser interval were considered the same episode.

Analysis

The linked database was used to conduct a retrospective descriptive analysis of total and hospitalized or fatal physical abuse episodes involving infants less than 1 year of age. Consistent with standard reporting for infants, outcomes are reported per 1000 live births; because of the low infant mortality rate (7.2 per 1000 live births for 1994–1998) and relatively constant number of births each year during the study period in Alaska, outcomes per 1000 live births approximated outcomes per 1000 infants per year.

Risk factors that were significant at the 95% confidence level during univariate analysis were entered into a backwards stepwise multiple logistic regression model with variables removed based on $p < .05$. Parental education and age were converted to the binary variables education less than or equal to 12 years and age less than 20 years. To preserve the assumption of independence between observations, for the small number of children with more than one reported episode of abuse, only the first episode was included during multivariate analyses. All analyses were conducted with SPSS version 10.0 statistical software (SPSS, 1999).

Because the current study was population-based, univariate analysis yielded incidence rates for various subgroups. Logistic regression analysis, however, yields results in terms of odds ratios (the ratio of the odds of disease among persons with the risk factor over the odds of disease among persons without the risk factor). For relatively rare outcomes, such as those presented in the current analysis, the odds ratio approximates the rate ratio (i.e., the ratio of incidence rates). The percent population attributable risk for various risk factors was calculated from the odds ratios obtained from the final logistic regression models as follows: percent population attributable risk $= [f \times (\text{odds ratio} - 1)]/[1 + f \times (\text{odds ratio} - 1)]$ where f is the percent of the population with the risk factor. The percent population attributable risk incorporates both the strength of the association between a risk factor and an outcome (in this case, the odds ratio)

and the frequency of the risk factor in the population; thus, it provides a measure of the excess fraction of cases of disease that would not have occurred in the absence of the risk factor in question.

Institutional Review Board approval

This study involved linkage of existing legally authorized administrative databases housed at the Alaska Department of Health and Social Services and all investigators were employees of this organization. The tertiary care hospital provided a discharge database as part of accepted administrative practice to evaluate the accuracy of the Alaska Trauma Registry, a registry in which the hospital plays an active role. No novel data were obtained. Under these circumstances of routine public health evaluation, Institutional Review Board approval was neither sought nor obtained.

Results

Overall incidence and age distribution

During 1994–2000, there were 325 instances of documented physical abuse that occurred to 314 infants (4.6 per 1000 live births). Of the 325 instances of abuse, Child Protective Services substantiated 301. Fifty-eight episodes involved hospitalization and survival, 10 episodes led to hospitalization followed by death, and 4 episodes involved death without hospitalization. In summary, there were 72 episodes (each involving a unique infant) of hospitalization or death (1.0 per 1000 live births), 68 hospitalizations with or without death (0.96 per 1000 live births), and 14 deaths with or without hospitalization (0.20 per 1000 live births). The incidence of hospitalization or death for non-accidental head injury (0.66 per 1000 live births) was also determined.

Among all instances of abuse, infants younger than 4 months of age accounted for 41% of episodes compared to 34% and 25% for infants 4 to <8 and 8 to <12 months of age, respectively. For hospitalization or death, infants <4 months of age accounted for 49% of episodes compared to 30% for infants 4 to <8 months and 21% for infants 8 to <12 months.

Subgroup incidences and risk factor Analyses

Some subgroups had particularly high incidences of overall infant physical abuse, including infants born as the product of a multiple gestation birth, at low birth weight, to young or less educated mothers or fathers, or to African American, unmarried, or substance using mothers (Table 1). Most of these subgroups also had high incidences of abuse leading to hospitalization or death.

Characteristics presented in Table 1 were analyzed for their association with infant physical abuse and those factors associated with abuse then were entered into a multivariate logistic regression model. Final models included similar risk groups for all cases and those involving hospitalization or death (Table 2). Birth to a parent with ≤12 years of education, an unmarried mother, or to a mother with a history of prenatal alcohol or substance use were risk factors that were highly prevalent in the population, and thus were associated with a high population attributable risk. Because paternal education or age was missing from approximately one-third of analyzed birth certificates, a separate analysis was conducted with these variables excluded. No change in risk factors identified occurred.

Table 1
The incidence per 1000 live births of infant physical abuse resulting in hospitalization, death, or a substantiated report of physical abuse to Child Protective Services; Alaska, 1994–2000

Subgroup	All cases ($N = 325$) (per 1000 live births)	Cases involving hospitalization or death ($N = 72$) (per 1000 live births)
Total population	4.6	1.0
Parental characteristics at infant birth		
Maternal education		
<12 years ($N = 9638$)	8.8	2.1
12 years ($N = 29,320$)	4.9	1.1
>12 years ($N = 30,260$)	1.6	0.23
Paternal education		
<12 years ($N = 4862$)	8.6	1.9
12 years ($N = 27,751$)	4.1	1.0
>12 years ($N = 27,793$)	1.4	0.25
Maternal race		
African American ($N = 3125$)	8.3	3.2
Alaska Native ($N = 16,841$)	7.8	1.3
Asian/Pacific Islander ($N = 3518$)	1.4	0.57
Caucasian ($N = 46,489$)	2.9	0.62
Unmarried mother		
Yes ($N = 22,019$)	7.8	1.5
No ($N = 48,63$ 1)	2.3	0.53
Maternal age		
<20 years ($N = 8040$)	7.5	2.0
20–29 years ($N = 38,363$)	4.0	0.86
30+ years ($N = 24,345$)	2.6	0.33
Paternal age		
<20 years ($N = 2440$)	7.0	2.5
20–29 years ($N = 29,655$)	3.9	0.91
30+ years ($N = 31,789$)	2.8	0.35
Mother a resident of a US military base		
Yes (9597)	3.2	1.3
No (61,245)	4.8	0.98
Pregnancy history		
Multiple gestation birth		
Yes ($N = 1792$)	13	2.8
No ($N = 68,938$)	3.8	0.78
Prenatal tobacco or alcohol use		
Yes ($N = 17,207$)	8.0	1.6
No ($N = 52,655$)	2.7	0.59
Previous child death		
Yes ($N = 2473$)	7.3	1.2
No ($N = 68,260$)	3.9	0.82

Table 1 (*Continued*)

Subgroup	All cases ($N = 325$) (per 1000 live births)	Cases involving hospitalization or death ($N = 72$) (per 1000 live births)
Previous pregnancy termination		
Yes ($N = 22,389$)	4.9	1.0
No ($N = 48,339$)	3.6	0.74
No other living children		
Yes ($N = 26,793$)	3.4	0.82
No ($N = 43,771$)	4.4	0.85
Infant characteristics		
Birth weight <2500 g		
Yes ($N = 3980$)	9.8	3.0
No ($N = 66,780$)	3.7	0.70
Anchorage residence		
Yes ($N = 26,918$)	3.9	1.0
No ($N = 43,922$)	4.9	0.98
Male		
Yes ($N = 36,281$)	4.5	1.3
No ($N = 34,561$)	4.7	0.72

Clinical features

The most common clinical finding among the 72 hospitalized or fatal cases was fracture of one or more bones (38%) including fracture of the skull ($n = 15$), femur ($n = 12$), ribs ($n = 11$), humerus ($n = 3$), and radius and vertebrate (1 each). Twenty-seven infants (38%) had an intracranial hemorrhage. Other diagnoses included the battered child syndrome (ICD-9 code 995.5) (46%), bruising or other superficial injury (33%), burn (3%), and intentional drowning and suffocation (1% each). Of the 14 deaths, 12 involved blunt trauma to the head or massive cranial injuries and 1 each involved intentional drowning and suffocation.

Perpetrators

For total and hospitalized or fatal cases, the Child Protective Services database provided most of the information on perpetrators; consequently, results were skewed toward perpetrators who were primary caretakers. Thus, abuse perpetrated by persons such as babysitters, non-primary caretaker relatives, and strangers was likely underestimated. Among 244 of 325 total cases for which this information was known, the confirmed or suspected perpetrator was most commonly a father figure or mother alone for both all cases and those involving hospitalization or death (Table 3).

Previous interaction with Child Protective Services

For each index case, a complete Child Protective Services database for 1993–2000 was evaluated to identify interactions that occurred before the index case. As with the cases of substantiated abuse, interactions that occurred within a month of each other were considered the same event. Eighteen percent of

Table 2
Final logistic regression model of risk factors for infant physical abuse; Alaska, 1994–2000

Risk factor	All cases			Hospitalization or death	
	% of population with risk factor (*f*)	Odds ratio (OR) (95% CI)	% population, attributable risk[a]	Odds ratio (OR) (95% CI)	% population, attributable risk[a]
Maternal education ≤12 years	56	1.8 (1.2, 2.7)	31	2.8 (0.99, 8.0)	50
Paternal education ≤12 years	44	1.6 (1.1, 2.5)	24	2.7 (0.96, 7.5)	48
Unmarried mother	31	2.3 (1.7, 3.2)	29	Not in final model[b]	–
Maternal prenatal alcohol or tobacco use	25	1.7 (1.2, 2.3)	15	1.8 (0.92, 3.7)	16
Infant birth weight <2500 g	5.6	2.0(1.2, 3.3)	5.3	3.8 (1.7, 8.4)	14
Multiple gestation birth	2.5	2.7 (1.4, 4.9)	4.1	Not in final model[b]	–
Maternal age <20 years	11	Not in final model[b]	–	2.6 (1.3, 5.3)	15
Maternal race				Not in final model[b]	–
African American	4.7	2.7 (1.5,4.7)	7.4	3.6 (1.3, 9.8)	11
Alaska Native	24	1.3 (0.91, 1.8)	–	0.91 (0.42, 2.0)	–
Asian/Pacific Island.	5.0	0.80 (0.32, 2.0)	–	1.3 (0.30, 7.4)	–
Caucasian	66	Ref.	–	Ref.	Ref.

[a] Population attributable risk = $(f \times (OR - 1))/(1 + f \times (OR - 1))$.

[b] Variables were not included in the final model because of lack of significance at the 95% confidence level.

Table 3
Perpetrators of infant physical abuse; Alaska, 1994–2000

Perpetrator	All cases ($N = 325$)	Cases involving hospitalization or death ($N = 72$)
Biological father	89 (27%)	20 (28%)
Mother's boyfriend	18 (6%)	6 (8%)
Step-father	7 (2%)	1 (1%)
Mother alone	102 (31%)	18 (25%)
Both parents	4 (1%)	4 (6%)
Another relative	11 (3%)	2 (3%)
Babysitter	5 (2%)	5 (7%)
Temporary primary caretaker	2 (1%)	2 (3%)
Other	6 (2%)	1 (1%)
Unknown	81 (25%)	13 (18%)

all cases and 17% of hospitalized or fatal cases involved infants that had interacted with Child Protective Services before the episode of substantiated abuse occurred, usually for neglect or unsubstantiated physical abuse.

Hospitalization for abuse and referral to Child Protective Services

Of the 68 instances of physical abuse leading to hospitalization, 14 (21%) were not identified as abuse in any of the hospital data sources but had a subsequent Child Protective Services investigation that substantiated abuse. By contrast, one episode of abuse identified in the hospital data sources was unconfirmed during a subsequent Child Protective Services investigation (and thus was not counted as a case).

The proportion of trauma-related admissions attributable to abuse

A sub-analysis of all infants included in the trauma registry—regardless of whether their injury resulted from suspected abuse—was conducted to determine the proportion of trauma-related admissions attributable to abuse. Cases that met the definition of abuse for the current study constituted 23% ($n = 64$) of all 280 infant trauma hospitalizations identified in the trauma registry. Additionally, cases that met the definition of abuse constituted 25% ($n = 26$) of 104 hospitalizations for bone fracture, 21% ($n = 14$) of 66 hospitalizations for skull fracture, and 72% ($n = 23$) of 32 hospitalizations for intracranial hemorrhage.

Hospitalization for unintentional trauma and referral to Child Protective Services

To ascertain if the study methodology was likely to have missed many hospitalized or fatal cases of abuse, a further analysis of the complete trauma registry was conducted. First, cases that met the study definition for abuse were excluded. Thus, the remaining cases did not have an ICD-9 code indicating intentional trauma or a substantiation of abuse when linked to the Child Protective Services database. Among these cases, a Child Protective Services investigation (without substantiation of abuse) was documented

for 6.5% of all episodes including 11% of 79 episodes of bone fracture, 7.5% of 53 episodes of skull fracture, and 10% of 10 episodes of intracranial hemorrhage. This indicated that a substantial proportion of infants experiencing major trauma were never referred for a Child Protective Services evaluation. Some of these children had no clear mechanism for their injury. For example, 39 episodes of long bone or skull fracture were identified that reportedly resulted from a fall of less than 3 feet or from a caretaker's arms or for which the caretaker denied a history of trauma. Of these, 12 were reported to have involved no history of trauma or a fall of no more than 1 foot; 3 of these 12 were identified in the Child Protective Services database.

Discussion

Incidence

Among the few population-based incidence studies in the literature, different outcomes have been measured, and none has included Child Protective Services findings, making comparisons with the current study difficult. Although no studies using identical methodology to the current study were identified, some reported identical outcomes, allowing for a rough point of comparison. For example, Alaska had an incidence 50% higher for infant abuse resulting in hospitalization (.96 per 1000 live births) than that found in Pennsylvania (.68 per 1000 live births) (Forjuoh, 2000). Additionally, Alaska had an almost threefold higher incidence for hospitalization or death due to intentional head injury (.66 per 1000 live births) than that found in Scotland (.25 per 1000 live births) (Barlow & Minns, 2000) and a twofold higher incidence of intentional injury death (.20 per 1000 live births) than that found in Colorado (.11 per 1000 live births) (Siegel et al., 1996).

The inclusion of Child Protective Services data allowed us to go beyond previous incidence studies in several ways. For approximately one-fifth of the hospitalized cases in the current study, abuse was not identified in the hospital databases but only during a Child Protective Services investigation; this suggests that previous studies relying on hospital data may have underestimated incidence. The study methodology allowed estimation of the incidence of abuse substantiated by Child Protective Services rather than simply suspected abuse. Finally, a more comprehensive view of the burden of abuse was obtained, specifically that for every child hospitalized or killed due to an abuse-related injury, another three to four children experienced substantiated abuse.

Nevertheless, similar to at least one other study (Ewigman, Kivlahan, & Land, 1993), the current study found evidence that both clinicians and Child Protective Services did not identify some infant physical abuse cases involving hospitalization. Among infants who had injuries commonly seen with abuse (e.g., skull or long bone fractures), the great majority of those who did not have abuse suspected or diagnosed by a physician also could not be found in the Child Protective Services database at all, suggesting a report was never filed. Some, or possibly most, of these cases may have been correctly diagnosed as non-intentional. Others, however, may have been abuse cases that were missed. This hypothesis is supported by the identification of 39 episodes of long bone or skull fracture that were not diagnosed as intentional despite the severity of the injury being inconsistent with the reported mechanism; depending on how many of these represented actual abuse, their inclusion would have increased the incidence of hospitalization or death by up to 54%. Consequently, the incidences reported here should be regarded as lower bounds on the true incidences.

Risk groups

The incidence of infant physical abuse varied dramatically between subgroups. Similar to a study of infant homicides (Overpeck et al., 1998), the incidence of abuse was high among infants born to less educated parents, and parental education level was the most important risk factor in terms of population attributable risk for all cases and cases involving hospitalization or death. This effect occurred independent of parental age. Previous studies have also supported the finding of an association between infant physical abuse and low birth weight birth (Overpeck et al., 1998; Winpisinger, Hopkins, Indian, & Hostetler, 1991) as well as young maternal age (Overpeck et al., 1998; Siegel et al., 1996; Winpisinger et al., 1991). The current study further documented an association between infant physical abuse and maternal substance use (including tobacco smoking), multiple gestation birth, and unmarried parents. The picture that emerges is that of an infant—often fragile or requiring additional care—born to parents without the skills and support systems necessary to protect their child from harm.

Most commonly, and as others have found (Herman-Giddens et al., 1999; Jayawant et al., 1998; Sinal et al., 2000; Starling & Holden, 2000; Starling, Holden, & Jenny, 1995), the biologic parent perpetrated the abuse, suggesting that the above factors were directly associated with a parent's decision to act out violently. The proportion of abuse perpetrated by the biologic father was particularly high in the current study, although the reasons for this are unknown. Occasionally, non-parental caretakers perpetrated the abuse, suggesting that the identified risk factors also contributed indirectly, possibly by affecting the parents' ability to protect their child from the violent actions of others.

Limitations

Although a variety of high-risk groups were identified, the current study was limited by an inability to evaluate other potentially pertinent risk factors, particularly those related to domestic issues. Although Child Protective Services charts usually document a wide range of domestic issues that are identified during the course of an investigation, for most children in the current study these charts were no longer available thus preventing systematic evaluation. As noted in the Methods section, a convenience sample of Child Protective Services charts (primarily from 1999 to 2000) was available for review. Review of these charts documented what others have found, namely that infant abuse commonly occurred in the context of domestic violence against the mother (Eckenrode et al., 2000; McGuigan & Pratt, 2001), physical and sexual abuse perpetrated against other children in the household, caretaker drug abuse (including alcohol and illicit substances) (Kelleher, Chaffin, Hollenberg, & Fischer, 1994), and previous experience of abuse (Ertem, Leventhal, & Dobbs, 2000) or history of criminal activity by the perpetrator.

Three additional limitations may have affected the results. It is probable that the true incidences of various outcomes were underestimated since not all cases of physical abuse would have been recognized as such by physicians (a limitation that others have raised, e.g., Ewigman et al., 1993; Hampton & Newberger, 1985; Sedlak, Diane, & Broadhurst, 1996) or reported to Child Protective Services. Additionally, we may have missed cases of early neonatal abuse since we did not include infants identified by Child Protective Services at less than 7 days of age (although early neonatal deaths and hospitalizations might have been identified through the other analyzed databases). Also, episodes perpetrated by persons such as babysitters or other non-primary caretakers may have been missed because Child Protective Services has jurisdiction only over episodes committed by a primary caretaker. Secondly, some of the identified risk factors may reflect diagnostic bias if Child Protective Services investigators or physicians were less

willing to assign a diagnosis of abuse to infants with particular characteristics, such as those having a married or well-educated parent or belonging to a racial majority; for example, others have found that abusive head trauma was more likely to go unrecognized among young, white children (Jenny, Hymel, Ritzen, Reinert, & Hay, 1999). Lastly, the current analysis was facilitated by the relatively small number of cases and agencies involved; thus, the methodology used may not be generalizable to other states within the US or other countries.

Implications for interventions

The high incidence of infant physical abuse in Alaska, combined with previous studies documenting an association between experience of child abuse and multiple severe future adverse outcomes (Anda et al., 2001; Bayatpour, Wells, & Holford, 1992; Dietz et al., 1999; Herman, Susser, Struening, & Link, 1997; Hillis, Anda, Felitti, Nordenberg, & Marchbanks, 2000; Olds et al., 1997), indicate that prevention of child abuse should assume a high priority for public health in Alaska. Consistently effective interventions for child abuse prevention, however, do not yet exist.

Based on previous studies (Olds et al., 1997; Olds, Henderson Jr., Chamberlin, & Tatelbaum, 1986), Alaska has implemented a child abuse prevention program based on intensive home visitation to high-risk families. The current study suggests that these programs should use screening tools that target families that have one or more of the identified risk factors and that interventions should target both the mother and her male partner. Furthermore, interventions must occur either prenatally or during the early postpartum period since approximately half of all episodes of serious abuse occurred during the first 4 months of life, a finding supported by multiple previous investigations (DiScala, Sege, Li, & Reece, 2000; Forjuoh, 2000; Haviland & Russell, 1997; Irazuzta, McJunkin, Danadian, Arnold, & Zhang, 1997; Reece & Sege, 2000; Sinal et al., 2000; Starling & Holden, 2000; Starling et al., 1995). Theoretically, risk factor screening and intervention by Child Protective Services early in an infant's life might protect the infant from more serious harm later. This strategy, though, could have prevented only a small portion of the cases in the current study since over 80% of physical abuse episodes occurred in the absence of a previous interaction with Child Protective Services.

Ongoing public health surveillance programs are important for monitoring the need for and effectiveness of various interventions. However, routine and systematic child abuse surveillance using multiple data sources does not exist in any state. The methodology used for the current study provides one potential paradigm for conducting surveillance in a way that provides a relatively comprehensive assessment of infant abuse, requires no new collection of data, and uses ongoing databases. As with infectious disease surveillance, routine surveillance of abuse could potentially improve the effectiveness of interventions and lead to more successful advocacy for funding.

Summary

Alaska has a high incidence of substantiated infant physical abuse and identifiable risk groups exist. In particular, the infants of less educated and unmarried parents are at high risk of experiencing abuse, especially during the first few months of life and from one or both biologic parents. The next step will involve using these data to improve the reach and specificity of intervention projects. Ongoing surveillance efforts involving multiple data sources—such as the process presented here—will allow for the timely evaluation of these interventions.

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