A Prospective Study of Sudden Unexpected Infant Death after Reported Maltreatment

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Objective To examine whether infants reported for maltreatment face a heightened risk of sudden infant death syndrome (SIDS) and other leading causes of sudden unexpected infant death (SUID).

Study design Linked birth and infant death records for all children born in California between 1999 and 2006 were matched to administrative child protection data. Infants were prospectively followed from birth through death or 1 year of age. A report of maltreatment was modeled as a time-varying covariate; risk factors at birth were included as baseline covariates. Multivariable competing risk survival models were used to estimate the adjusted relative hazard of postneonatal SIDS and other SUID.

Results A previous maltreatment report emerged as a significant predictor of SIDS and other SUID. After adjusting for baseline risk factors, the rate of SIDS was more than 3 times as great among infants reported for possible maltreatment (hazard ratio: 3.22; 95% CI: 2.66, 3.89).

Conclusion Infants reported to child protective services have a heightened risk of SIDS and other SUID. Targeted services and improved communication between child protective services and the pediatric health care community may enhance infant well-being and reduce risk of death. *(J Pediatr 2014;164:142-8)*.

Each year in the US, approximately 4500 children die during the first 12 months of life with no immediately identifiable cause or explanation, occurrences broadly defined as sudden unexpected infant death (SUID).[1-3] More than one-half of SUIDs are ultimately classified as caused by sudden infant death syndrome (SIDS),[4] the designation for infant deaths that remain unexplained following a thorough autopsy, death scene investigation, and review of the child's medical history.[5] Another 14% of these initially unexplained deaths are coded as accidental suffocation and strangulation in bed (ASSB), and approximately 30% are certified as deaths of unspecified cause.[6] The current distribution of SUID classifications reflects a diagnostic shift largely attributed to increasing medical examiner and coroner adherence to criteria for certifying a death as SIDS.[5] Deaths that would have once been coded as SIDS may now be certified as ASSB or unspecified in cause.[4,6,7]

Of concern is that regardless of how deaths are coded, postneonatal mortality rates have remained static since 2001.[8,9] The American Academy of Pediatrics expanded its policy on safe-sleeping practices in 2005 with specific recommendations for sleep surfaces, bedding, separate but proximate sleeping environments, and use of pacifiers.[8] Yet in 2009, the US mortality rate for SIDS was 53.9 per 100 000 live births—nearly unchanged from prior years and consistent with a similarly flat rate of postneonatal deaths.[10] The absence of continued declines in the rate of SIDS led to a further expansion of sleep-related recommendations in 2011, the impact of which is yet unknown.[9] A child's previous involvement with child protective services (CPS) has been documented as a risk factor for preventable death.[11,12] A similar relationship between CPS contact and SIDS, however, has not emerged. An early study found that the prevalence of CPS investigations was not higher among 157 cases of SIDS compared with a similar group of living infants.[13] A study by Krous et al[14] examined 384 cases of SIDS over a 10-year period and found that an earlier substantiated report of maltreatment was not associated with an increased likelihood of SIDS. Krous et al[14] noted the limitations of a retrospective study and suggested future research that would allow for comparisons to living infants.

This study builds upon prior research by using linked birth, CPS, and death records to prospectively model the relative likelihood of a SUID following a report of maltreatment. We conceptualized a report to CPS, regardless of substantiation, as a signal of a high-risk infant likely to experience poorer

ASSB	Accidental suffocation and strangulation in bed
CPS	Child protective services
HR	Hazard ratio
SIDS	Sudden infant death syndrome
SUID	Sudden unexpected infant death

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Supported by the Maternal and Child Health Research Program, Maternal and Child Health Bureau (Title V, Social Security Act), Health Resources and Services Administration, Department of Health and Human Services (R40MC25689 to E.H.), and *Eunice Kennedy Shriver* National Institute of Child Health and Human Development (K01-HD05798 to J.S.). Data linkages were funded by the Harry Frank Guggenheim Foundation. Ongoing financial support for the management of child protection data is provided to the Child Welfare Indicators Project by the California Department of Social Services and the Stuart Foundation. The authors declare no conflicts of interest.

 http://dx.doi.org/10.1016/j.jpeds.2013.08.073

outcomes and greater adversities. We hypothesized that after adjusting for other risk factors, infants reported for possible maltreatment would face a heightened risk of SIDS and other forms of SUID.

Methods

To create the analysis dataset, linked birth and infant death records were matched to CPS data. Confidential birth and infant death records were obtained from the California Department of Public Health. Files captured all children born in California between 1999 and 2006 and included death record information for infants who died before 1 year of age. Infant CPS records were available from the California Department of Social Services through a longstanding interagency agreement with the University of California, Berkeley. This project received approval from both state and university committees for the protection of human subjects.

To link vital records to CPS data, a probabilistic matching methodology was employed in which a record pair was deemed a match/nonmatch based on a formal statistical model.[15] Match-status cut-points were established following an extensive examination of record pairs, with a clerical review of uncertain matches falling between established lower- and upper-bound match thresholds.[16] Across birth cohorts, 90% of CPS records were matched to a birth record. Unmatched records reflected infants born in other states and subsequently reported for maltreatment in California, as well as records in which missing data elements prevented a successful match. Further details regarding the linkages underlying this dataset have been previously published.[11]

Our final analytic dataset consisted of the full population of children born in California between 1999 and 2006 (N = 4 317 736), with corresponding CPS and death records through each child's first birthday. From this population of live births, we excluded 15 402 children who did not survive the neonatal period (ie, died before 28 days of life). We also excluded 599 children with dates of birth/death that were either missing or did not logically align.

Variables

Dependent Variable

Postneonatal deaths were classified using the *International Classification of Diseases, 10th Revision*.[17] SUID were defined as deaths coded as SIDS (code R95), unspecified cause (code R99), or ASSB (code W75).[7] For each model, all other causes of postneonatal deaths were coded as competing, censored events.

Independent Variable

We examined an earlier, nonfatal report of maltreatment as an independent predictor of SUID. We included all reports, including those screened out over the phone prior to an investigation, as well as those that were investigated and determined to be unfounded. This decision is consistent with a growing body of research suggesting that a report to CPS is a meaningful marker of risk, regardless of whether or not the report is substantiated.[18,19] A nonfatal report was entered into our models as a time-varying covariate based on the report date. As such, infants remained in the general population of infants born and at risk of death until the date they were first reported, at which point they were prospectively followed as an infant with an earlier report to CPS.

Other Covariates

Risk factors for SIDS/SUID have been identified in prior research. Higher rates of SIDS have been observed among infants who are male, African American, or Native American.[20-23] Developmental risk factors include premature birth, low birth weight, and 2-4 months of age.[1,21,23,24] Family/maternal risk factors for SIDS include young maternal age, short intergestational interval, single motherhood, late or absent prenatal care, and low socioeconomic status.[1,21,22] Additional risks for SIDS include an unsafe sleep environment,[25] as well as gestational cigarette and/or alcohol exposure.[22,26,27]

In the present study, adjustments were made for 7 covariates available in the birth records: (1) child's sex (male vs female); (2) maternal race/ethnicity (Black, Latino, Asian/Pacific Islander, or Native American vs White); (3) birth weight (<2500 g vs ≥2500 g); (4) prenatal care (first trimester care vs late or absent care); (5) birth payment method (public insurance vs private insurance); (6) maternal age (≤19 years vs >19 years); and (7) paternity (missing vs established). In addition, our modeling approach captured exposure time from birth to death, and therefore incorporated infant age.

Statistical Analyses

All infants were prospectively followed from birth through death or 1 year of age. The distribution of sociodemographic, health, and developmental characteristics were assessed using χ^2 tests. Comparisons were made between (1) SUID (deaths coded as R95, R99, or W75) and infants surviving to 1 year of age; and (2) SUID classified as SIDS (R95) vs those that were unspecified (R99) or coded as ASSB (W75). Multivariable competing risk survival models were used to estimate the hazard of a sudden unexpected death following an infant's report to CPS as a possible victim of maltreatment.[28,29] This modeling technique accounted for the fact that each infant was at risk of not only SIDS, ASSB, and death coded as unspecified, but also other postneonatal causes of death. Observations were censored upon death or 1 year of age. Model estimates are reported as hazard ratios (HR) and 95% CI. Statistical analyses were conducted using StataSE (Stata Corp, College Station, Texas).[30]

Results

Table I compares the sociodemographic and health characteristics of infants surviving to 1 year of age (n = 4 299 642) to the population of postneonatal SUID (n = 2093). Among infants in the SUID group, 16.6% had been reported to CPS, compared with only 4.9% of