

Original Communication

Pulmonary intra-alveolar hemorrhage in SIDS and suffocation

Henry F. Krous MD^{a,b,*}, Amy E. Chadwick BA^a, Elisabeth A. Haas MPH^a,
Christina Stanley MD^c

^a Department of Pathology, Rady Children's Hospital, San Diego, CA, USA

^b Departments of Pathology and Pediatrics, University of California, San Diego School of Medicine, La Jolla, CA, USA

^c Office of the Medical Examiner, County of San Diego, CA, USA

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Abstract

The differentiation of SIDS from accidental or inflicted suffocation may be impossible in some cases. Severe pulmonary intra-alveolar hemorrhage has been suggested as a potential marker for such differentiation. Our aims are to: (1) Compare pulmonary hemorrhage in SIDS and a control group comprised of infants whose deaths were attributed to accidental or inflicted suffocation. (2) Review individual cases with the most severe pulmonary hemorrhage regardless of the cause of death, and (3) Assess the effect of age, bedsharing, cardio-pulmonary resuscitation, and postmortem interval, with regard to the severity of pulmonary hemorrhage in SIDS cases. We conducted a retrospective study of all postneonatal cases accessioned by the Office of the Medical Examiner in San Diego County, California who died of SIDS or suffocation between 1999 and 2004. A total of 444 cases of sudden infant death caused by SIDS (405), accidental suffocation (36), and inflicted suffocation (3) from the San Diego SIDS/SUDC Research Project database were compared using a semiquantitative measure of pulmonary intra-alveolar hemorrhage [absent (0) to severe (4)]. Grades 3 or 4 pulmonary hemorrhage occurred in 33% of deaths attributed to suffocation, but in only 11% of the SIDS cases, however, all grades of pulmonary hemorrhage occurred in both groups. Therefore, our results indicate that the severity of pulmonary hemorrhage cannot be used in isolation to determine the cause or manner of sudden infant death. Among SIDS cases, those with a higher pulmonary hemorrhage grade (3 or 4) were more likely to bedshare, and with more than one co-sleeper, than those with a lower pulmonary hemorrhage grade (0 or 1). We conclude that each case must be evaluated on its own merits after thorough review of the medical history, circumstances of death, and postmortem findings.

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1. Introduction

Sudden infant death syndrome (SIDS) is generally defined as the sudden unexpected death of an infant less than one year of age, with onset of the fatal episode apparently occurring during sleep, that remains unexplained after a thorough case investigation, including performance of a complete autopsy and review of the circumstances of death and the clinical history.¹ As such, SIDS remains a

diagnosis of exclusion. Nevertheless, there are cases in which SIDS cannot be differentiated from accidental or inflicted suffocation by postmortem examination alone when postmortem findings are minimal, and none are considered pathognomonic of a cause of death. This is particularly true in cases of “soft” suffocation where anatomic findings diagnostic of oronasal occlusion or chest compression are not identified during the postmortem examination. This difficulty has led to subsequent reclassification of some SIDS cases to either accidental or inflicted suffocation after re-evaluation of the circumstances of death.^{2–7} Ultimately, differentiating SIDS from accidental or inflicted suffocation may be impossible in the absence of a convincing demonstration of an unsafe sleep site in the case of the

* Corresponding author. Address: Department of Pathology, Rady Children's Hospital, San Diego, CA, USA. Tel.: +858 966 5944; fax: +858 966 8087.

E-mail address: hkrous@chsd.org (H.F. Krous).

former or a reliable confession in the case of the latter. Therefore, investigators have continued to search for post-mortem markers, such as pulmonary hemorrhage, that might reliably distinguish these cases, especially given the substantial legal consequences and ramifications for survivors.

Severe pulmonary hemorrhage and/or pulmonary intra-alveolar siderophages have been proposed previously as morphologic markers to aid in distinguishing SIDS from “soft” suffocation.^{1,8–13} Our previous analysis of infants dying of SIDS or accidental or inflicted suffocation who were accessioned into the San Diego SIDS/SUDC Research Project database has shown that pulmonary siderophages (PS) cannot be used as an independent marker to distinguish SIDS from suffocation.¹⁴ The aims of this study are to: (1) Compare pulmonary hemorrhage in SIDS and a control group comprised of infants whose deaths were attributed to accidental or inflicted suffocation. (2) Review the individual cases with the most severe pulmonary hemorrhage regardless of the cause of death, and (3) Assess the effect of age, bedsharing, cardiopulmonary resuscitation, and postmortem interval on the severity of pulmonary hemorrhage in SIDS cases.

2. Materials and methods

This study was approved by the Rady Children’s Hospital and Health Center Institutional Review Board. Postneonatal infants (29–365 days of age) accessioned by the San Diego County, California, Medical Examiner’s Office between 1991 and 2004 whose deaths were attributed to SIDS or accidental or inflicted suffocation were selected from the San Diego SIDS and Sudden Unexplained Death in Childhood Research Project database located in the Pathology Department of Rady Children’s Hospital and Health Center in San Diego, California. Infants with only one lung section for microscopic review, or whose causes of death were other natural diseases or undetermined were excluded, as were cases whose deaths were delayed and cases who underwent more than three hours of continuous cardiopulmonary resuscitation.

Case data were selected from the medical history, death scene, and postmortem information in the investigative and autopsy reports and from two standardized data protocols for the death scene investigation and postmortem examination. In 1989, a California statute mandated use of standardized scene investigation and postmortem examination protocols (developed by a multidisciplinary expert committee) for cases of sudden, unexpected infant death without external evidence of inflicted injuries. Trained, experienced investigators from the Medical Examiner are charged with collecting this information within 30 h of an infant’s death. The data are not complete for every case.

A diagnosis of SIDS was made only when criteria for the general definition proposed in 2004 in San Diego were ful-

filled.¹ Cases of accidental or inflicted suffocation were diagnosed upon analysis of information obtained from the medical histories, circumstances of death, and postmortem findings.

For purposes of this study a total of 444 cases were included: SIDS, 405 cases; accidental suffocation, 36 cases; and inflicted suffocation, 3 cases. Since the mechanism of death was similar, the 39 cases of accidental and inflicted suffocation were combined into a single control group for comparison with the SIDS cases. These 39 control cases represent all of the accidental or inflicted suffocation deaths accessioned by the San Diego County Office of the Medical Examiner during the period of 1991–2004 for which at least two lung sections were available for microscopic review. At least two microscopic sections of the lung(s) were available for evaluation on 39/40 (98%) of control cases and 96% (405/423) of SIDS cases within this time frame.

As part of a separate report,¹⁵ we have data on Child Protective Services referrals and their adjudication for cases from 1991 through 2000 only. Child Protective Services data for cases beyond the year 2000 are not available because our study had Institutional Review Board approval to review cases only through the year 2000.

Presence or absence of oronasal blood exuding from the nose and/or mouth, as described by the first person to discover the infant before the onset of cardiopulmonary resuscitation,¹⁶ was compared between the SIDS and suffocation control groups. We reviewed frank oronasal blood, as opposed to the description of any other secretions (for example: purge, pink froth, bloody froth, vomitus, formula). The presence and distribution of intrathoracic petechiae were recorded from the postmortem records.

The postmortem interval was defined as the interval from the date and time the infant was pronounced dead until the date and time the postmortem examination was begun; as such, it is an underestimate, given that most of these infants were dead for some time before being discovered.

Pulmonary intra-alveolar hemorrhage was semiquantitatively assessed in hematoxylin and eosin (H&E) stained sections of formalin-fixed lung using the following grading system: grade 0 = none; 1 = mild; 2 = moderate, focal; 3 = moderate, multifocal; and 4 = diffuse, severe.

3. Data analysis

SIDS and suffocation control cases were compared to one another with respect to medical history, circumstances of death, and postmortem findings. Categorical variables were analyzed using the χ^2 test or Fisher’s exact test, along with odds ratios. Continuous data were analyzed with two-sample *t*-tests and are summarized using means \pm standard deviations. Calculations were performed with SPSS Version 12.0. A *P* value less than .05 was considered significant.

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