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# Infant Death in San Francisco 1989–1990

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**ABSTRACT:** This paper examines all of the unexplained and violent deaths of children less than one year of age in the City and County of San Francisco during the years 1989–1990. A total of 62 cases were collected and analyzed retrospectively. Among the cases we examined, 34 deaths were determined as SIDS, while seven were moded as accidents and two as homicides. The deaths were examined with respect to the following parameters: sex, race, age, height and weight, cause and manner of death, significant autopsy and microscopic findings; circumstances of death including place, the person discovering or reporting the death, the presence of siblings or previous child death in the family and previous illness in the same child. A particular stress is given to the definition and diagnosis of SIDS, according to the international literature, and to the criteria adopted to distinguish SIDS cases from accidents and homicides. A review of both the American and European literature shows that most articles do not include comparisons of data from both the autopsy and the scene. Additionally there is little standardization in the investigation and the extent of postmortem examinations performed. An international standardization of these methods appears necessary and the use of protocols to assure complete investigation and postmortem examination will allow more intensive evaluation of data. Here we give a brief presentation of the necropsy protocol for Sudden Unexpected Infant Death recently written and approved by the California Department of Health Services and used in the Chief Medical Examiner's Office in San Francisco.

**KEYWORDS:** pathology and biology, death of children, SIDS, sudden death, necropsy protocol

Although unexplained or violent infant death is a routine event for forensic pathologists around the world, it is always distressing. Even the most basic task of the pathologist, to ascertain the cause and manner of death, is difficult and frustrating when the child's death cannot readily be explained after a complete investigation, postmortem examination, and laboratory tests have been performed. This sense of frustration has been shared by researchers who have devoted a great deal of time and energy trying to elucidate the etiology, mechanisms, and risk factors for sudden infant death and particularly Sudden Infant Death Syndrome (SIDS).

Until recently, the following definition was the only universally accepted aspect of SIDS research. The definition "the sudden death of any infant, 1 week to 1 year of age,

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which is unexpected by history, and in which a thorough postmortem examination fails to demonstrate an adequate cause for death" did not solve all the problems and only partially contributed to uniformity in the management of SIDS cases. The definition was published [*1*] with a list of minimally acceptable requirements for a diagnosis of SIDS; nevertheless, although the definition of SIDS was widely used, the steps that the authors felt were necessary to exclude other causes of infant death were often ignored. In the state of California with 58 counties having widely varying population bases and many different systems of death investigation, no uniform standards existed for certification of a death as SIDS. In an effort to overcome this problem, the state of California enacted a law requiring all counties to follow uniform protocols in the investigation and autopsy of sudden unexpected deaths of children under one year of age. These protocols were based on the new definition of SIDS established by the 1990 National Institute of Child Health and Human Development Conference which reads, "The sudden death of an infant under one year of age which remains unexplained after performance of a complete postmortem investigation, including an autopsy, examination of the death scene, and review of the case history."

This paper will consider the new definition for SIDS, its application in California, and a review of some statistics for infant death in the City and County of San Francisco for the years 1989–1990.

## Literature Review

A review of the international literature reaffirms the number of different approaches and theories that abound in the field of infant death investigation, particularly relative to SIDS deaths. Some authors have presented pathogenic mechanisms, including central apnea [*3*], airway obstruction [*4–8*], cardiac abnormalities [*9–11*], and even infant botulism [*12,13*] as different etiologic theories. Pediatric clinicians and some pathologists have tried to define a pathologic indicator to identify those infants at risk for SIDS. Kariks [*14*] described focal acute muscle fiber necrosis in all of the 250 SIDS cases examined in Sydney in the years 1981 to 1985. A few authors have studied the relationship between pulmonary infections and infant death [*15–17*]. One group reported on herpes simplex infection and sudden death of a neonate [*18*]. Others [*19*] have described a profile of postmortem vitreous humor, finding a significant variation of potassium, calcium, phosphorus, GPT, SGOT, and LDH in SIDS babies compared to a pediatric control group. Finally, the investigative aspect of SIDS has been emphasized by many forensic pathologists. Sleeping arrangements and their relationship to SIDS have been investigated by American and British authors. While a relationship between bed sharing and infant death had already been examined in the past [*20*] Gilbert-Barness et al. [*21*] found a significant relationship between 20 unexpected infant deaths and waterbeds, sheepskin rugs, or overlying. Fleming et al. [*22*] examined different groups of children, finding that those who had died were significantly more heavily wrapped than the others. The prone position was also considered as contributory to the death because of the minor radiant heat loss. The separation of SIDS deaths from accidental or homicidal infant deaths has been the subject of many papers, including Perrot [*23*] who looked at eight cases that were thought to be SIDS but after thorough investigation proved to be homicide or accident. Similar papers have been written by others [*24–26*]. Emery et al. [*27*] observed two babies who died while under the care of the same babysitter. They were called SIDS deaths until a third baby died, and exhumation of the first two disclosed evidence of facial trauma. The authors imply that sometimes a preconceived idea that an infant death has to be SIDS can lead to the performance of a superficial autopsy.

## Materials and Methods

The City and County of San Francisco, California, has a population of approximately 733 300. The Office of the Medical Examiner investigates approximately 4500 cases a year (1989 to 90 Annual Report). Of these, 1575 (19%) cases were accepted as requiring Medical Examiner jurisdiction, and autopsies were performed on 1317 cases (84%).

Most of the statistical information was gathered from the Annual Reports of the Office of the Medical Examiner in San Francisco. Additional information was retrieved from specific cases. We have examined all of the unexplained and violent deaths of children less than one year of age in the City and County of San Francisco during the year 1989–1990. A total of 62 cases were collected and analyzed retrospectively. All deaths were examined with respect to the following parameters: sex, race, age, cause and manner of death, significant autopsy and microscopic findings; circumstances of death including place, the person discovering or reporting the death, the presence of siblings or previous child death in the family and previous illness in the same child. Information regarding live births was supplied courtesy of the Registry of Births and Deaths in the County.

## Results

The tables list the compiled statistics. Table 1 shows the total number of cases for the years 1989–1990 and the rate of SIDS per 1000 live births. The 1989 rate (0.88/1000) is lower than average [*28*] but is not significantly different from the Dade County report [*29*]. In 1990, the rate of 1.44/1000 is average. Sex distribution is reported in Table 2 and shows a slight predominance of males in the SIDS group. Age distribution (from Table 3) does not differ substantially from other authors when birth to the first week of life is considered as a separate category. The higher numbers in the third and fourth months (24.46% and 11.76%) are in line with Copeland's cases [*29*]. In the non SIDS group, the age distribution shows a similar pattern except for a later peak at the fourth and fifth months. The 34 SIDS cases have a rather uniform distribution in the 12 months of the year (Table 5) except for the peak noted in December (17.65%). The control (non SIDS deaths) is not significantly different.

Race distribution (Table 4), shows the rate with respect to the three main racial groups in San Francisco. Although these rates vary considerably by year, the black population consistently shows a higher rate than the white population. The Asian rates will need further study as that population group increases in number in the United States.

Table 6 lists all causes of death, while Table 7 shows the manner of death. This data is taken from the death certificate. In two cases the cause of death was determined to

TABLE 1—*Cases.*

| Year | Total | SIDS | Non SIDS | Live births | Rate/1000 |
|---|---|---|---|---|---|
| 1989 | 36 | 13 | 23 | 14587 | 0.889 |
| 1990 | 26 | 21 | 5 | 14697 | 1.440 |

TABLE 2—*Sex distribution.*

| Sex | Total | SIDS | Non SIDS |
|---|---|---|---|
| Male | 40 (64.52%) | 20 (58.82%) | 20 (71.42%) |
| Female | 22 (35.48%) | 14 (14.18%) | 8 (28.58%) |

TABLE 3—*Age distribution.*

| Age | SIDS | Non SIDS |
|---|---|---|
| 0-1 Week[a] | 5 (14.72%) | 5 (17.68%) |
| 1-2 Weeks | 0 | 2 (7.14%) |
| 2-3 Weeks | 0 | 1 (3.57%) |
| 3-4 Weeks | 2 (5.88%) | 0 |
| 4-5 Weeks | 1 (2.94%) | 0 |
| 5-6 Weeks | 0 | 0 |
| 6-7 Weeks | 1 (2.94%) | 2 (7.13%) |
| 7-8 Weeks | 2 (5.88%) | 0 |
| 8-9 Weeks | 4 (11.77%) | 1 (3.57%) |
| 9-10 Weeks | 2 (5.88%) | 3 (10.71%) |
| 10-11 Weeks | 1 (2.94%) | 0 |
| 11-12 Weeks | 2 (5.88%) | 0 |
| 4 Months | 6 (17.66%) | 6 (21.42%) |
| 5 Months | 2 (5.88%) | 3 (10.71%) |
| 6 Months | 2 (5.88%) | 2 (7.14%) |
| 7 Months | 2 (5.88%) | 0 |
| 8 Months | 0 | 3 (10.71%) |
| 9 Months | 1 (2.94%) | 0 |
| 10 Months | 0 | 0 |
| 11 Months | 1 (2.94%) | 0 |
| Total | 34 (100%) | 28 (100%) |

[a]At the time these deaths were certified, deaths in this age range could not technically be called SIDS since California law was based on the definition of SIDS as occurring only after the first week of life; these deaths were SIDS-like deaths which were certified as Sudden death in infancy.

TABLE 4—*Race distribution.*

| Race | SIDS | Non SIDS | Live births | SIDS Rate | Non SIDS Rate |
|---|---|---|---|---|---|
| White | 13 | 10 | 15883 | 0.82/1000 | 0.63/1000 |
| Black | 13 | 10 | 3655 | 3.56/1000 | 2.75/1000 |
| Asian | 8 | 8 | 6071 | 1.32/1000 | 1.32/1000 |
| Other | 0 | 0 | 3675 | N/A | N/A |

TABLE 5—*Distribution of cases in the year.*

| Month | SIDS | Non SIDS |
|---|---|---|
| January | 4 (11.77%) | 0 |
| February | 4 (11.77%) | 1 (3.57%) |
| March | 2 (5.88%) | 3 (10.72%) |
| April | 4 (11.77%) | 7 (25.00%) |
| May | 3 (8.82%) | 2 (7.14%) |
| June | 3 (8.82%) | 1 (3.57%) |
| July | 2 (5.88%) | 1 (3.57%) |
| August | 3 (8.82%) | 3 (10.72%) |
| September | 2 (5.88%) | 4 (14.28%) |
| October | 0 | 4 (14.28%) |
| November | 1 (2.94%) | 1 (3.57%) |
| December | 6 (17.65%) | 1 (3.57%) |
| Total | 34 (100%) | 28 (100%) |

TABLE 6—*Cause of death.*

| | |
|---|---|
| SIDS | 34 (54.84%) |
| Acute pneumonitis | 9 (14.52%) |
| interstitial | 7 |
| viral | 2 |
| Ac. broncopn. | 6 (9.68%) |
| Asphyxia | 5 (8.06%) |
| positional | 2 |
| mechanical | 2 |
| drowning | 1 |
| Trauma | 2 (3.23%) |
| Prematurity | 3 (4.84%) |
| Seizure | 1 (1.61%) |
| Hypothermia | 1 (1.61%) |
| Iatrogenic | 1 (1.61%) |

TABLE 7—*Manner of death.*

| | SIDS | Non SIDS |
|---|---|---|
| Natural | 32 (94.12%) | 18 (46.43%) |
| Accidental | 0 | 7 (25.00%) |
| Homicide | 0 | 2 (7.14%) |
| Undetermined | 2 (5.88%)[a] | 1 (3.57%) |

[a]See text (Results).

be Sudden Death in Infancy, which codes on the California death certificate as SIDS. However, at the discretion of the Chief Medical Examiner, these were moded as Undetermined. One of the babies had evidence of old unrelated, but unexplained injuries and the other had involved a focal nonlethal subarachnoid hemorrage in a four day old infant resuscitated after a SIDS-like episode. No findings were present that could explain the death and the circumstances and autopsy were otherwise consistent with the definition of SIDS.

Tables 8 and 9 list all the pathology and microscopic findings as described in the necropsy reports. The most common findings—pulmonary congestion (91.8%), pulmonary edema (61.76%) and intrathoracic petechiae (pleural, pericardial and thymic)—are similar to what is seen by other authors [*30*]. In the microscopic findings under the terms "pneumonitis" and "broncopneumonia" we have included cases with small pulmonary infiltrates which are insufficient to cause death and in some cases have developed during hospitalization for cardiac arrest occurring in the tipic SIDS scenario.

Subsequent tables show the data from the death scene investigation. The presence of siblings (Table 12) is similar to what was seen by Copeland. The history of a previous illness (Table 13) is very similar in both the SIDS and non SIDS groups. Table 10 shows the person finding the baby. Table 11 shows the place of death. One statistic that stands out, the percentage of SIDS babies who died in their parents' bed (26.47%, non SIDS 3.57%), seems to support Luke's conclusion [*20*] that adult/infant bedsharing, although not a cause of SIDS, should certainly be considered a risk factor. Of interest is the data referring to parental drug abuse and the toxicology results in the infant deaths (Tables 14 and 15). The significance of these findings will require larger numbers and further study to evaluated.

One interesting case shows that although the circumstances may seem unusual, complete investigation may still lead to a diagnosis of SIDS. A two-month-old black female

TABLE 8—*Pathology findings (autopsy).*

| | SIDS | Non SIDS |
|---|---|---|
| Pulmonary edema | 21 (61.76%) | 13 (46.43%) |
| P. congestion | 31 (91.18%) | 19 (67.86%) |
| P. consolidation | 1 (2.94%) | 8 (28.57%) |
| P. atelectasis | 3 (8.82%) | 7 (25.00%) |
| Pleural petechiae | 8 (23.53%) | 4 (14.29%) |
| Thymus petechiae | 17 (50.00%) | 7 (25.00%) |
| Epicardial pet. | 8 (23.53%) | 2 (7.14%) |
| Congenital abnormal. | 2 (5.88%) | 2 (7.14%) |
| Liver congestion | 3 (8.82%) | 1 (3.57%) |
| Cerebral edema | 4 (11.76%) | 1 (3.57%) |
| Cer. hemorrhage | 0 | 2 (7.14%) |
| Cer. ischemia | 1 (2.94%) | 1 (3.57%) |
| Pulmonary infarct. | 2 (5.88%) | 0 |
| Peritoneum inflamm. | 0 | 1 (3.57%) |
| Contusions | 0 | 8 (28.57%) |
| Fractures | 1 (2.94%) | 1 (3.57%) |

TABLE 9—*Microscopic findings*

| | SIDS | Non SIDS |
|---|---|---|
| Pulm. edema | 1 (2.94%) | 7 (25.00%) |
| Pulm. congestion | 11 (32.35%) | 2 (7.14%) |
| Pulm. consolidation | 2 (5.88%) | 6 (21.43%) |
| Pulm. atelectasis | 5 (14.71%) | 4 (14.29%) |
| Bronco-pneumonia | 1 (2.93%) | 4 (14.98%) |
| Pneumonitis | 3 (8.82%) | 6 (21.43%) |
| Pl.-Epic. Petechiae | 5 (14.71%) | 0 |
| Thym. petechiae | 5 (14.71%) | 0 |
| Thymus congestion | 3 (8.82%) | 0 |
| Liver congestion | 2 (5.88%) | 1 (3.57%) |
| Spleen congestion | 4 (11.76%) | 5 (17.86%) |
| Adrenal congestion | 1 (2.94%) | 1 (3.57%) |
| Adrenal hemorrhage | 1 (2.94%) | 4 (14.29%) |
| Cerebral congestion | 4 (11.76%) | 0 |
| Cerebral edema | 1 (2.94%) | 2 (7.14%) |

TABLE 10—*Person finding.*

| | SIDS | Non SIDS |
|---|---|---|
| Mother | 19 (55.88%) | 11 (39.28%) |
| Father | 1 (2.94%) | 3 (10.72%) |
| Both | 0 | 3 (10.72%) |
| Other | 14 (41.18%) | 11 (39.28%) |
| Total | 34 (100%) | 28 (100%) |

TABLE 11—*Place of death.*

| | SIDS | Non SIDS |
|---|---|---|
| Crib | 16 (47.06%) | 8 (28.57%) |
| Parent's bed | 9 (26.47%) | 1 (3.57%) |
| Sibling's bed | 2 (5.88%) | 1 (3.57%) |
| Hospital | 5 (14.71%) | 10 (35.71%) |
| Other | 2 (5.88%) | 8 (28.58%) |
| Total | 34 (100%) | 28 (100%) |

TABLE 12—*Presence of siblings in the family.*

| | SIDS | Non SIDS |
|---|---|---|
| Yes | 20 (58.28%) | 9 (32.14%) |
| No | 7 (20.59%) | 11 (39.29%) |
| Twins | 3 (8.82%) | 2 (7.14%) |
| Unknown | 4 (11.76%) | 6 (21.43%) |
| Total | 34 (100%) | 28 (100%) |

TABLE 13—*Previous illness.*

| | SIDS | Non SIDS |
|---|---|---|
| Yes | 18 (52.94%) | 17 (60.70%) |
| No | 16 (47.06%) | 9 (32.15%) |
| Unknown | 0 | 2 (7.14%) |
| Total | 34 (100%) | 28 (100%) |

TABLE 14—*Toxicology.*

| | SIDS | Non SIDS |
|---|---|---|
| Positive | 1 (cocaine) | 4 (cocaine) |
| Negative | 33 | 24 |
| Total | 34 | 28 |

TABLE 15—*Parental drug abuse.*

| | SIDS | Non SIDS |
|---|---|---|
| Positive | 5 (14.71%) | 8 (28.58%) |
| Negative | 29 (85.29%) | 16 (57.14%) |
| Unknown | 0 | 4 (14.28%) |

was found dead by her mother. The Office of the Medical Examiner was notified three days later. The mother stated that she had bathed the child, wrapped her in blankets, and placed her in a hanging crib where she left her for three days in order "to let her soul leave the body." There was evidence of postmortem decomposition but otherwise the autopsy and investigation were consistent with SIDS.

## Discussion

Although the San Francisco Medical Examiner's office previously had their own protocol for the investigation and autopsy examinations of SIDS deaths, the new state mandated program based on S.B. 1069, chaptered as 955-89 in Section 27491.41 of the California Government Code, requires that each county follow a standard protocol in the performance of death investigations and autopsies. The state mandated protocols were developed by a panel of experts in the fields of forensic and pediatric medicine, public health and law enforcement. The protocols consist of two parts. The first part of the protocol refers to investigative information, is approximately 23 pages long, and requires multiple short answers about the child's prenatal and postnatal medical history, the final medical therapy, the specifics of the death scene investigation, environmental factors, the maternal and paternal histories, and lists of witnesses and informants. The second part is an approximately 21-page autopsy protocol with diagrams and short answer questions with respect to external and internal examinations. There are also lists and explanations for required and recommended microscopic sections, toxicologic specimens, and microbiologic studies.

The investigative protocol requires significantly more time to complete than a simple one or two page report. However it was felt that the information was vital for a comprehensive examination of these cases since, by the new definition, the diagnosis of SIDS versus accident or homicide is dependent on adequate investigation of factors that may be rather subtle. In some cases, because of the family emotional responses, the investigators need to return a second time to complete the interview. On the average, the usual SIDS case will require at least an additional hour of interviewing either during the initial contact or at a later time. The autopsy protocol, in contrast, extends the time required to complete the case by only 20 to 30 minutes, depending on availability of assistance for transcribing the data onto summary pages. Most of the information required to complete questions in the autopsy section is a part of a good standard pediatric autopsy. The extra time commitments, however, may be felt in smaller urban or suburban offices with a small overworked investigative or medical staff, which covers an office on only a part time basis. The availability of easily accessible laboratory facilities may also be a problem in smaller jurisdictions. However, the importance of these protocols, which is to allow uniformity in methodology and terminology throughout the state clearly justifies the extra time, effort and money required in this critical area of medical investigation.

The protocols were distributed to all of the county Medical Examiners and Coroners. Training sessions were offered in their use. Compensation is to be made available to the counties to cover the increased costs of these investigations. The completed forms are then to be returned to the State of California, Department of Health Services, Maternal and Child Health Branch, where they are to be made available for future research efforts and rapid evaluation of health and demographic data.

The legislation in California that mandates the use of these new protocols attempts to standardize, in a large state, the way in which unexplained infant deaths are investigated and autopsied. This should allow the systematic collection of information about SIDS in California, allowing surveillance of public health problems, early detection of infectious or toxic conditions leading to death clusters, and improved child death investigation. Since the data is to be placed in a database within months of the child's death, monitoring

for clustering of child deaths and other public health issues is practical. Perhaps after all these years, a large database with information on both investigations and autopsies will finally give pathologists and researchers the information they need to determine the cause, manner, and mechanisms of sudden and unexpected deaths in infancy.

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