



Trends in the Incidence of Sudden Unexpected Infant Death in the Newborn: 1995-2014

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Objective To evaluate the epidemiology of sudden unexpected infant death (SUID) over a 20-year period in the US, to assess the potential frequency of sudden unexpected postnatal collapse in the early days of life, and to determine if SUID rates in the neonatal period (0-27 days) have changed in parallel with rates in the postneonatal periods, including the percentages attributed to codes that include accidental suffocation.

Study design Data from the US Centers for Disease Control and Prevention Linked Birth/Infant Death Records for 1995-2014 were analyzed for the first hour, day, week, and month of life. A comparison of neonatal and postneonatal data related to SUID, including accidental suffocation, was carried out.

Results Death records for 1995-2014 indicate that, although SUID rates in the postneonatal period have declined subsequent to the 1992 American Academy of Pediatrics sleep position policy change, newborn SUIDs have failed to decrease, and the percentage of SUIDs attributed to unsafe sleep conditions has increased significantly in both periods; 29.2% of the neonatal cases occurred within the first 6 days of life.

Conclusions The frequency of SUIDs during the neonatal period warrants ongoing attention to all circumstances contributing to this category of deaths. The development of a standardized definition of sudden unexpected postnatal collapse and a national registry of these events is recommended. Ongoing research on the effects of early neonatal practices on postneonatal SUID should also be encouraged. (*J Pediatr* 2018;196:104-8).

The US Centers for Disease Control and Prevention (CDC) define sudden unexpected infant death (SUID) as “the death of an infant less than 1 year of age that occurs suddenly and unexpectedly, and whose cause of death is not immediately obvious before investigation.”¹ A similar acronym that is often used is “SUDI,” for “sudden unexpected death in infants.”² The definition of SUID includes sudden infant death syndrome (SIDS), as well as accidental suffocation and strangulation in bed (ASSB) and unknown causes of death in infants less than 1 year of age.¹ Although the rate of SIDS peaks between 1 and 4 months of age, newborns are also vulnerable.³

Sudden unexpected postnatal collapse (SUPC) describes healthy infants born at greater than 35 weeks of gestation age, with a 10-minute Apgar score of greater than 7, who collapse suddenly and unexpectedly within the first postnatal week of life.⁴ Although not an official category in the *International Classification of Diseases* (ICD), newborn deaths after SUPC conform to the CDC definition of SUID.

After the implementation of the American Academy of Pediatrics (AAP) sleep position policy change in 1992,⁵ a 25% increase in the proportion of SIDS deaths occurring in the first month of life was reported.⁶ The authors suggested that some cases previously reported as SIDS are now classified in other SUID categories, including ASSB and unknown causes, a trend also noted by the AAP.⁷ To account for that possibility, we examined the incidence of SUID in the US, which encompasses all categories of sudden unexpected deaths in infancy, including SIDS, SUPC, and ASSB. The purpose of our report is to focus on the details of the evolving pattern of newborn SUID, including data on the early days of life that may reflect SUPC deaths.

Methods

The US National Vital Statistics System category of SUID⁸ combines conditions included in ICD-9 (1995-1998) and ICD-10 (1999-2014) codes 798.0, R95 (SIDS); E913.0, W75 Mechanical Suffocation Bed or Cradle (MSBC), Accidental Suffocation and

AAP	American Academy of Pediatrics
ASSB	Accidental suffocation and strangulation in bed
CDC	Centers for Disease Control and Prevention
ICD	<i>International Classification of Diseases</i>
MSBC	Mechanical Suffocation Bed or Cradle
SIDS	Sudden infant death syndrome
SSC	Skin-to-skin care
SUID	Sudden unexpected infant death
SUPC	Sudden unexpected postnatal collapse

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Strangulation in Bed (ASSB); and 799.9, R99 (Unspecified). We applied these codes to national data from the Linked Birth/Infant Death Records for the most recent 20-year period available on the CDC WONDER On-Line Database for both the neonatal period (<28 days) and the postneonatal period (28-364 days).⁹ Annual total SUID incidence rates per 100 000 births for 1995-2014 and percent of total SUIDs potentially related to unsafe sleep related circumstances MSBC and ASSB were identified separately for the neonatal and postneonatal periods. In addition, to gauge the potential impact of SUPC during the neonatal period, the number of deaths in the first hour, hours 1-23, and days 1-6 of life were also compiled, and a frequency distribution of average annual occurrences was developed. The percentage of cases in 2 gestational age groups (>35 weeks and ≤35 weeks) was also collected.

A logistic regression model was performed to evaluate the risk of SUID attributable to MSBC/ASSB associated with time period (2014 vs 1995) and neonatal population (neonatal vs postneonatal). Statistical analysis was performed using SAS v9.4 (Cary, North Carolina) and a type I error rate of 0.05. An exploratory interaction term was included to test whether the change in risk over time differed by neonatal status.

Results

From 1995 to 2014, 8869 SUIDs occurred in the first month of life in the US, including 2593 (29.2%) in the first 6 days, 1317 (14.8%) on the first day, and 625 (7%) in the first hour of life. The frequency distribution of average annual rates by time interval is presented in **Figure 1**. Neonates greater than 35 weeks of gestation accounted for 60.1% of the SUIDs in the first 6 days of life, of which there were 511 with SIDS codes (798/R95). The remaining 39.9% were 35 weeks of gestation or less, including 64 with SIDS codes.

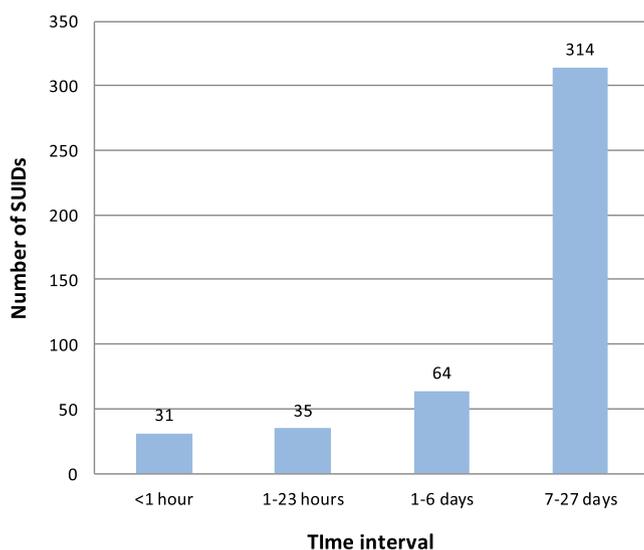


Figure 1. US average annual neonatal SUIDs, 1995-2014. (Source: CDC WONDER Linked Birth/Infant Death Records.)

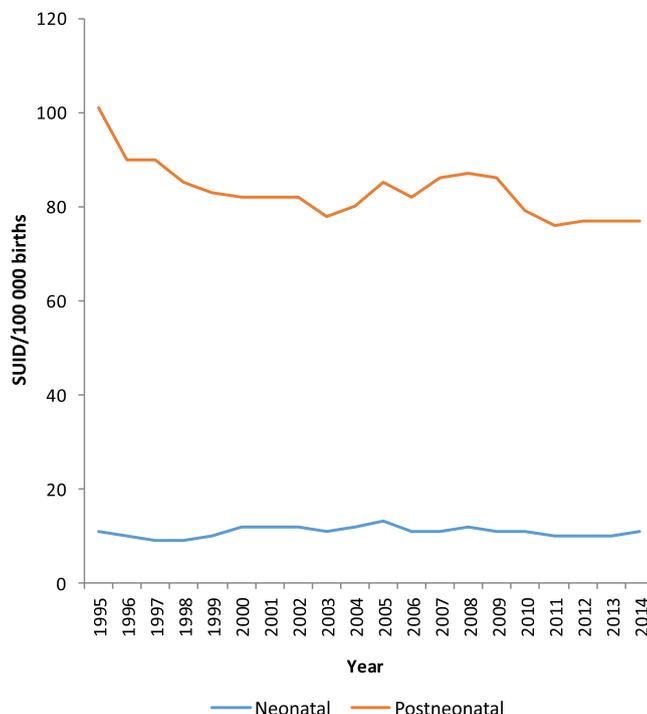


Figure 2. US postneonatal/neonatal SUID rates per 100 000 births, 1995-2014. (Source: CDC WONDER Linked Birth/Infant Death Records.)

During the same time period, rates of postneonatal (28-364 days) SUID decreased by 22.7%, from 101 in 100 000 births in 1995 to 78 in 100 000 births in 2002, after which rates did not show continuing decline, while rates of neonatal (<28 days) SUID in 1995 and 2014 remained stable at 11 in 100 000 births (**Figure 2**). The percentage of SUID attributed to the neonatal period increased from 9%-10% in 1995 to 1998 to 11%-13% from 1999 to 2014 (**Figure 3**).

The percentage of SUIDs attributed to MSBC/ASSB increased over time in both the neonatal and postneonatal populations, from 2.1% in the neonatal population and 3.4% in the postneonatal population in 1995, to 22.7% and 24.9%, respectively, in 2014, representing an 11-fold proportionate increase in the neonatal population and a 7-fold proportionate increase in the postneonatal population. Neonatal increases exceeded postneonatal increases in 13 of the 20 years. SUIDs attributable to MSBC/ASSB were significantly higher in 2014 compared with 1995 ($P < .0001$; OR 9.7; 95% CI 8.1-11.7). SUIDs attributable to MSBC/ASSB did not differ significantly between postneonatal and neonatal populations ($P = .14$; OR 1.2; 95% CI 0.9-1.5).

Discussion

This analysis documents the extent of SUID in the first day, week, and month of life, and shows that the decrease in the incidence of postneonatal SUID concurrent with implementation of the Back to Sleep Campaign in the mid-1990s did

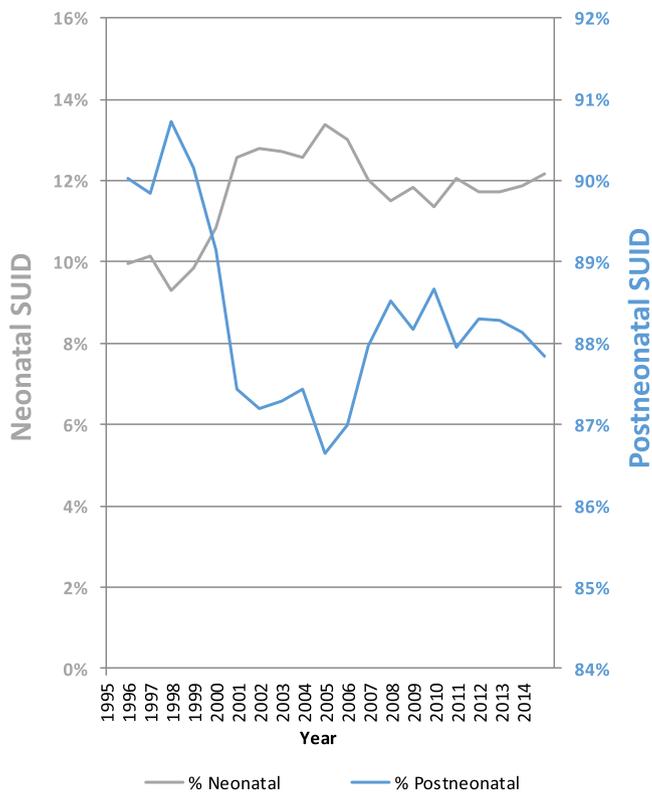


Figure 3. US percent SUID neonatal and postneonatal, 1995-2014. (Source: CDC WONDER Linked Birth/Infant Death Records.)

not occur in the neonatal period. In addition, a statistically significant increase in deaths attributed to unsafe sleep circumstances in both the neonatal and postneonatal periods has emerged since 1995, and the overall proportion of SUID in the neonatal period has increased by 22%, from 10% of all cases in 1995 to 12.2% in 2014. This finding is consistent with the previously reported 25% proportionate increase in neonatal SIDS from 1989 to 2001,⁶ and suggests a persistent trend in unexpected deaths in this time period that cannot be explained only on the basis of classification shift. It is possible that the now globally recognized condition of SUPC may be contributing to this shift as SUIDs reported in the first 6 days of life accounted for 29.2% of all neonatal SUIDs, of which 60.1% occurred in infants greater than 35 weeks of gestation.

SUPC has been described in detail in a comprehensive systematic review that identified 398 published case reports, mostly from the European Union.⁴ In that review, one-third of the cases occurred in the first 2 hours of life, one-half resulted in death, and one-half of survivors had neurologic sequelae. The authors estimated that, even using their lowest incidence numbers, extrapolation to the 5 million births in the European Union would predict 150 deaths annually. They noted that SUPC was frequently associated with prone position, skin-to-skin care (SSC), and/or co-bedding. In Spain, more than a 14-fold increase in the incidence of SUPC was associated with the introduction of SSC.¹⁰ A German case-control study identified potentially

asphyxiating positioning and primarity as major contributors to these events.^{11,12} A British population-based study of SUPC reported a strong association of events with SSC, prone position, and breastfeeding in the context of recent maternal sedation,¹³ and suggested that risk factors for SUPC were similar to those for conventional SIDS, even in patients with underlying conditions. In addition, population-based data have recently been reported from Australia, with risk profiles for SUPC similar to the German and British reports.¹⁴ The association between SSC and SUPC suggests a causal relationship using traditional criteria of causality,¹⁵ including temporality and consistency,^{4,10,12-14} strength of association,^{10,12} and biological plausibility.^{4,16}

In the US, the AAP was first to draw attention to the association of SUPC with SSC and other practices in maternity settings,¹⁷ citing the emergence of litigation related to these events and suggesting compliance with safe sleep recommendations^{3,18} when promoting breastfeeding. Similar observations were noted in a study including case descriptions of deaths related to accidental newborn suffocation on maternity units from the National Association of Medical Examiners.¹⁹ These reports are consistent with concerns expressed in a report that included population-based data from Massachusetts²⁰ as well as a recent AAP clinical report on SSC in the term newborn.²¹ The National Institute of Health and Human Development safe sleep recommendations¹⁸ advise that the infant be placed supine on a firm surface, not overheated, in a separate bed. This recommendation distinctly contrasts with the circumstances associated with a newborn in a prone position receiving SSC. The mother may also be exhausted during the postpartum period and fall asleep with the infant in a prone position on her, resulting in co-bedding, a known risk for SIDS,²² particularly in the first 3 months of life and in the presence of parental smoking and alcohol use.²³

Although SUPC occurs in the first week of life, SUID risk continues at home in the weeks after the birth hospitalization and throughout the first year of life. The rates of MSBC/ASSB codes we observed suggest that potentially unsafe sleep circumstances are identified in a large and growing fraction of both neonatal and postneonatal SUID. Although some of this increase may be the result of diagnostic shift and changes in the analysis and classification of SUID cases,^{6,7,24} we believe that our data suggest that, consistent with the “triple-risk” model of SIDS,⁷ unsafe sleep circumstances may represent an important contributing factor that interacts with known risks including race, sex, maternal tobacco and alcohol use, intrinsic biological processes,²⁴ and the effects of gestational age at birth²⁵ that result in SUID.

It is also possible that certain practices in the neonatal period may exert an influence on postneonatal outcomes. For example, parents may continue to implement unsafe prone positioning if it is observed or practiced in the hospital.⁷ Because advice from physicians has been shown to have a positive impact on the mother’s choice to implement a supine sleep position,²⁶ the birth hospital stay offers an important early opportunity for safe sleep messaging. Lactation support in the perinatal period also provides an important early opportunity to rein-

force safe sleep messages. Because breastfeeding is associated with a reduced risk of SIDS,⁷ this is a logical context to provide early safe sleep education.

Failure to introduce a pacifier in the neonatal period is another factor that could adversely affect postneonatal SUID rates. Although there is considerable evidence that pacifier use at bedtime is associated with a substantially reduced risk of SIDS,^{3,7,27} the AAP currently suggests that pacifier use be deferred until breastfeeding is established⁷ and breastfeeding mothers are often advised to avoid pacifier use because of concerns that pacifiers may interfere with breastfeeding.²⁸ This advice, however, is based on observational studies and is not supported by evidence from clinical trials.⁷ A recent study found that pacifier use in the newborn nursery is a strong predictor of pacifier use later in infancy and that starting a pacifier before hospital discharge was associated with greater use and lower discontinuation in the following year.²⁹ In addition, a case-control study that explored the interaction of pacifier use and unsafe sleep conditions demonstrated a markedly attenuated SIDS risk in the presence of unsafe sleep conditions, including bed sharing, sleeping in the prone/side position, using pillows, and using soft bedding.³⁰ A recent British study also suggests that pacifier use is associated with a lower risk of SIDS in cosleepers.²³ Further research is needed to determine to what extent postneonatal SUID rates might decrease if safe sleep practices and pacifier use were more consistently implemented in the neonatal period.

Because SUPC and newborn SUID are problems that are international in scope, the experience of different nations with the problem may provide a perspective on alternative approaches to prevention. The New Zealand Ministry of Health issued a consensus statement that specifically identified the problem of sudden unexpected early neonatal deaths in the immediate postnatal period, and provided guidelines addressing the risks associated with maternal exhaustion and sedation and the need for staff supervision of SSC.³¹ In addition, in response to firmly established practices in the Maori population, in-bed bassinets were developed to encourage safe sleep positioning for breastfeeding mothers who chose to co-bed despite counseling. By using a multimodal approach combining culturally sensitive practices with intensive sudden unexpected death in infants education and supportive government policies, these investigators demonstrated a 29% decrease in postperinatal mortality.³²

Our data have limitations. Although the deaths reported in the included age range and ICD codes assigned to them are consistent with the most commonly accepted definition of SUPC,⁴ the lack of a single specific ICD code for SUPC is a limitation. Miscoding of inpatient deaths during the birth admission could result in failure to capture SUID/SIDS cases. Location (hospital or home) is not available in the CDC WONDER database. In addition, because the detailed circumstances of the reported deaths cannot be ascertained from the CDC WONDER site data, MSBC/ASSB codes may be an imperfect marker for deaths owing to unsafe sleep conditions. However, statewide data from Kentucky, using alternate sources including state vital statistics, death certificate files, medical

examiners, coroners, and child fatality review team reports³³ found that 93.9% of ASSB cases had sleep-related risk factors, including prone position, bed sharing, use of soft objects in the bed, and loose bedding. Furthermore, more than 80% of cases coded as SIDS and Undetermined were also associated with sleep-related risk factors. This finding suggests that our results may actually underestimate these risks.

The importance of quantifying early newborn deaths has been recognized in a report of the Every Newborn Study Group.³⁴ The authors' statement "to count deaths is crucial to change them" is particularly relevant to the issue of SUID, because deaths related in whole or in part to unsafe sleep circumstances are potentially preventable. To more accurately classify these deaths, the US needs to develop a standard definition for identification and investigation of SUPC, as has been accomplished in the UK.³⁵ Because many SUPC events do not result in death, but have significant morbidity, it would also be useful for the CDC to develop registries to track and analyze those events with detailed data including gestational age, location, and pacifier presence. This step could serve to identify populations at greatest risk and in need of focused intervention, enhance the public health value of the existing CDC SUID case registry,³⁶ and support the SUID prevention mission of the US Child Death Review Teams.³⁷ In addition, although previous reports have documented the increased risk for SUID/SIDS associated with prematurity,^{25,38} they have included only postneonatal deaths. Our identification of 64 SIDS cases in premature newborns at 35 weeks of gestation or less in the first 6 days of life, when they are most likely in closely supervised settings, was an unanticipated finding that merits further research.

Ongoing research on SUID prevention is essential. A recent report showed that the use of mobile interventions (text, email, and video) based in the birth hospital improved adherence to safe sleep practices related to sleep position, sleep location, soft bedding, and pacifier use.³⁹ This approach is promising and could potentially have a positive impact on prevention, particularly if the populations at greatest risk can be effectively included.⁴⁰ ■

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