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Original Article

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What risk factors for sudden infant death syndrome are preterm and term medically complex infants exposed to at home?

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Abstract

Objectives: Risk factors for sudden infant death syndrome include premature birth, maternal smoking, prone or side sleeping position, sleeping with blankets, sharing a sleeping surface with an adult, and sleeping without an adult in the room. In this study, we compare parents' responses on sleep patterns in premature and term infants with medical complexity.

Methods: Parents of children enrolled in the Canadian Respiratory Syncytial Virus Evaluation Study of Palivizumab were phoned monthly regarding their child's health status until the end of each respiratory syncytial virus season. Baseline data were obtained on patient demographics, medical history, and neonatal course. Responses on adherence to safe sleep recommendations were recorded as part of the assessment.

Results: A total of 2,526 preterms and 670 term infants with medical complexity were enrolled. Statistically significant differences were found in maternal smoking rates between the two groups: 13.3% (preterm); 9.3% (term) infants (χ^2=8.1, df=1, P=0.004) and with respect to toys in the crib: 12.3% (term) versus 5.8% preterms (χ^2=24.5, df=1, P<0.0005). Preterm infants were also significantly more likely to be placed prone to sleep (8.8%), compared with term infants (3.3%), (χ^2=18.1, df=1, P<0.0005).

Conclusion: All the infants in this study had frequent medical contacts. There is a greater prevalence of some risk factors for sudden infant death syndrome in preterm infants compared to term infants with medical complexity. Specific educational interventions for vulnerable infants may be necessary.

Keywords: *Infant; Medical complexity; Premature; Sudden infant death syndrome; Term.*

The term sudden infant death syndrome (SIDS) was first used in 1969 at an international conference on infant death. SIDS is defined as the unexpected death of an infant less than 1 year of age that remains unexplained after a full medical investigation (1). Sudden Unexpected Death in Infancy (SUID) is the overarching term that includes infant deaths due to SIDS, ill-defined/unspecified causes, and accidental suffocation or strangulation in bed (2). Whatever name is applied, the rate of SIDS decreased from 5.7 to 2.7 per 100,000 live births between 2014 and 2018 (3). The decline in incidence began following safe sleep campaigns initiated by the Government of Canada in 1993 (4). Death rates peak between the second and fourth month of life. Infants who incur SIDS are predominantly found lying face down in the prone position and die in their sleep (5).

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The criteria for a SIDS diagnosis must eliminate potential alternate causes, including infection and suffocation.

In 1993, the Government of Canada recommended that infants be placed to sleep on their backs and introduced the *Back to Sleep* campaign in 1999 (4). Current recommendations for parents include putting their infant to sleep in the supine position, limiting pre- and postnatal exposure to smoke, breastfeeding their infant, sleeping in the same room as their infant, and not sharing a sleeping surface (4). One study found that among 497,000 women, 33% reported frequent bed sharing, while 27% reported occasional bed sharing (6).

Preterm infants have an increased risk of SIDS. The rate of sudden unexpected death in preterm infants is at least double that of term infants (7). A study reviewing all 11.9 million infants born between 2005 and 2007 in the USA found that infants born <28 weeks of gestation have odds ratios of 2.57 and 2.59 of dying from SIDS and suffocation, respectively, compared to term infants (8). A Canadian study also found that small-for-gestational-age (SGA), as well as preterm birth, were risk factors for SIDS (9). During a possibly prolonged initial hospital stay, preterm infants receive enhanced medical supervision. If these parents were offered consistent, understandable, and acceptable advice about SIDS one would expect a heightened adherence to safe sleep recommendations.

As part of a follow-up study of palivizumab use across Canada (Canadian RSV Evaluation Study of Palivizumab-CARESS) (10), we asked parents additional questions on safe sleep patterns employed following initial discharge of their infants from hospital after birth. The primary objective was to compare parents' responses on sleep patterns in premature and term infants with medical complexity within the CARESS population.

METHODS

CARESS was a prospective, longitudinal, nonrandomized, observational, open-cohort study. It included any child receiving at least one dose of palivizumab in any respiratory syncytial virus (RSV) season from 2005 to 2017. Individual children were recruited by their treating physician, and the registry investigators played no role in determining who would be included in the registry. The registry monitored usage and adherence patterns to the palivizumab protocol of monthly doses during the respective RSV season. The registry also recorded determinants of respiratory illness in children at high risk of complications from RSV infection. Children born prematurely or with medical complexities were included in the study. Data regarding sleep questions were included in the 2013 to 2014 and 2015 to 2016 RSV seasons that spanned November to March of the following year. For each sleep question, the interviewer assembled responses based on appropriate choices that were provided as part of the questionnaire (Appendix 1).

Inclusion in the study required the parent or legal guardian to communicate in English or French. Any child who had received palivizumab or other similar monoclonal antibody as part of a clinical trial during the study period was excluded. After consent was obtained, baseline data were gathered on patient demographics, prior medical history including any underlying diagnosis, neonatal course, exposure to tobacco, and details of current palivizumab administration. Follow-up telephone interviews were conducted monthly until the end of each RSV season. This allowed for longitudinal data collection on sleep patterns and adherence to safe sleep recommendations. The research ethics board of each participating institution approved the study.

Preterm infants were defined as those ≤35 weeks completed gestational age who were <6 months of age at the time of enrollment and were considered at moderate to high risk of RSV infection based on a validated risk scoring tool and received palivizumab prophylaxis (11). Term infants were those who were administered prophylaxis for other medical complexity such as neuromuscular impairment, congenital airway anomalies, and immunodeficiency, and were <6 months of age at the time of enrollment.

Statistical analysis

Data were analyzed using IBM SPSS Statistics v25.0 (IBM Corp., Armonk, NY). Descriptive statistics were conducted on the variables extracted. Differences in baseline demographics, neonatal characteristics, and the sleeping habits of preterm and term infants were compared using χ^2 test for categorical variables and t-test or Kruskal–Wallis H test for continuous variables. A binary logistic regression was conducted with prone position as the dependent variable, and group and site as covariates. A P value of less than 0.05 was considered statistically significant.

RESULTS

In this component of CARESS, 2,526 preterm infants and 670 term infants with medical complexity were enrolled across 32 Canadian sites. Acceptance of this substudy was 95%, tracked in one centre (Alberta Children's Hospital). Demographic characteristics between preterm and term infants are listed in Table 1. A significantly greater proportion of preterm infants had siblings (69.4% versus 61.8%, χ^2=14.0, df=1, P<0.0005), a mother who smoked (13.3% versus 9.3%, χ^2=8.1, df=1, P=0.004) and smoked during pregnancy (13.3% versus 9.4%, χ^2=7.3, df=1, P<0.007), household crowding (24.4% versus 18.2%, χ^2=11.4, df=1, P=0.001), and were of multiple birth (37.0% versus 9.4%, χ^2=187.6, df=1, P<0.0005). As expected, gestational age, enrollment age, birth weight, and enrollment weight were all greater in the term group compared to the preterm group.

Of the parents or guardians who answered the subsequent SIDS questions in the survey (n=2,582; 80.1%), the majority of infants slept in either a bassinette or a crib. More preterm

Table 1. Demographic characteristics of infants enrolled (n=3196)

	Preterm (n=2,526)	Term (n=670)	χ^2 or F	df	P
Male, n (%)	1,451 (57.4)	357 (53.3)	3.7	1	0.054
Caucasian, n (%)	1,567 (65.6)	478 (71.3)	7.9	1	0.005
Daycare attendance, n (%)	15 (0.6)	6 (0.9)	0.7	1	0.418
Has siblings, n (%)	1,753 (69.4)	414 (61.8)	14.0	1	<0.0005
Mother smokes, n (%)	337 (13.3)	62 (9.3)	8.1	1	0.004
Mother smoked during pregnancy, n (%)	335 (13.3)	63 (9.4)	7.3	1	0.007
Smokers in the house, n (%)	689 (27.3)	164 (24.5)	2.1	1	0.154
≥2 smokers in the house, n (%)	263 (10.4)	58 (8.7)	1.8	1	0.193
History of atopy, n (%)	985 (39.3)	261 (39.1)	0.009	1	0.929
Multiple birth, n (%)	934 (37.0)	63 (9.4)	187.6	1	<0.0005
Mean enrollment age (months ± SD)	2.6 ± 1.7	2.9 ± 1.7	16.7	1	<0.0005
Mean gestational age (weeks ± SD)	30.7 ± 2.7	37.9 ± 2.3	3,815.0	1	<0.0005
Mean birth weight (g ± SD)	1,578 ± 551	2,994 ± 690	3,126.2	1	<0.0005
Mean enrollment weight (g ± SD)	3,511 ± 1,556	4,950 ± 1,717	432.7	1	<0.0005

P<0.05 is statistically significant.

Table 2. Sleeping environments in premature and term infants with medical complexity (n=2,582)

		Preterm (n=2,040)	Term (n=542)	χ^2	df	P
Bed type*	Bassinette, n (%)	767 (37.6)	150 (27.7)	18.4	1	<0.0005
	Crib, n (%)	809 (39.7)	290 (53.5)	33.6	1	<0.0005
	Adult bed, n (%)	136 (6.7)	49 (9.0)	3.6	1	0.057
	Couch, n (%)	5 (0.2)	0	1.3	1	0.591
	Car seat, n (%)	3 (0.1)	0	0.8	1	>0.999
	Hospital bed, n (%)	46 (2.3)	6 (1.1)	2.9	1	0.091
	Other bed, n (%)	250 (12.3)	42 (7.7)	8.7	1	0.003
	Multiple beds, n (%)	24 (1.2)	5 (0.9)	0.2	1	0.618
Items in bed*	Bumper pads, n (%)	119 (6.4)	33 (6.6)	0.03	1	0.854
	Pillows, n (%)	106 (5.7)	44 (8.9)	6.5	1	0.011
	Stuffed toys, n (%)	108 (5.8)	61 (12.3)	24.5	1	<0.0005

*Includes environments associated with an increased risk for Sudden Unexpected Death in Infancy (SUID). P<0.05 is statistically significant.

infants slept in a bassinette compared to term infants (37.6% versus 27.7%, $\times^2$=18.4, df=1, P<0.0005), and more term infants slept in a crib compared to preterm infants (53.3% versus 39.7%, $\times^2$=33.6, df=1, P<0.0005). Only a small number of infants used an adult bed: 6.7% of preterm infants and 9% of term infants, but there was no statistically significant difference between the two groups (Table 2). About 0.2% and 1% of the preterm infants used either a couch or a car seat for sleeping, respectively, while one of the term infants used a couch or car seat for sleeping. Again, there was no statistically significant difference between the groups.

Less than 10% of both preterm and term infants used bumper pads or had pillows in the crib (Table 2). Term infants were more likely to have pillows (8.9% versus 5.7%, $\times^2$=6.5, df=1, P=0.011) or stuffed toys (12.3% versus 5.8%, $\times^2$=24.5, df=1, P<0.0005) than preterm infants.

Table 3 shows more details regarding sleeping practice, with 74.9% of preterm infants and 79.8% of term infants sleeping alone which was statistically significant ($\times^2$=5.6, df=1, P=0.018). Less than 90% followed the recommendation to place the infant supine, though significantly more term infants were placed on their backs compared to preterm infants (88.7% versus 83.5%, $\times^2$=8.9, df=1, P=0.03). Similar numbers of infants were noted to sleep in the side position: 7.7% of preterm and 8.0% of term subjects. Preterm infants were more likely to be placed prone to sleep compared with term infants (8.8% versus 3.3%, $\times^2$=18.1, df=1, P<0.0005). None of the infants involved in the survey died from SIDS or SUID.

Table 3. Details regarding sleeping position provided by parents in the surveyed population

		Preterm (n=2,040)	Term (n=542)	χ^2	df	P
Slept alone, n (%)		1,525 (74.9)	431 (79.8)	5.6	1	0.018
Sleep position	Overall	2,039	539	18.1	2	<0.0005
	Supine, n (%)	1,702 (83.5)	478 (88.7)	8.9	1	0.003
	Prone, n (%)	180 (8.8)	18 (3.3)	18.1	1	<0.0005
	Side, n (%)	157 (7.7)	43 (8.0)	0.046	1	0.830

P<0.05 is statistically significant.

The number of infants who slept in the prone position varied significantly between the 32 Canadian sites (χ^2=109.2, df=24, P<0.0005). However, the binary logistic regression with prone position as the dependent variable and group and site as covariates showed that preterm infants were still more likely to be placed prone than term infants (odds ratio [OR]=2.8, 95% confidence interval [CI] 1.7 to 4.6, P<0.005) even after controlling for site.

DISCUSSION

The established risk factors for SIDS include prematurity especially younger gestational age, maternal smoking, and unsafe sleeping practices (9,12,13). Preterm infants are at increased risk for SIDS compared to full-term infants and this is inversely related to gestational age (13,14). This in part has been ascribed to practices that parents have adopted through observation of their infants during their stay in neonatal intensive care units, which can be altered through structured educational programs. Additionally, infants who are small for gestational age compared with infants who are appropriate for gestational age are at greater risk for SIDS across all gestational age categories (15–18). Anderson et al. reported that maternal smoking during pregnancy more than doubled the risk of sudden unexpected infant death (OR=2.44; 95% CI 2.31 to 2.57) and increased two-fold between no smoking and smoking one cigarette daily throughout pregnancy (19). Maternal smoking and unsafe sleeping practices are modifiable, and health care professionals are urged to inform parents about these factors. In this study, there was a significant difference seen in some of the risk factors (20,21). Preterm infants more commonly slept in the prone position, and had a mother who smoked and smoked during pregnancy. This finding has been previously reported (22,23). In our study, fewer preterms slept without an adult in the room. While some of the risk factors were more prevalent in preterm infants, reduced prevalence of other risk factors was also seen in the preterm infants, including sleeping in their cribs without additional blankets and pillows, and not sharing an adult bed.

Canada's Back to Sleep campaign in the 1990s was successful in educating parents about the benefits of placing infants to sleep in the supine position, and may have contributed to the reduced incidence of SIDS during that period of time (4). Our study shows that there is a continued need for educational campaigns on safe sleeping practices for all infants. Educational campaigns on safe sleeping habits should continue to be emphasized throughout pregnancy, while the infant is in hospital, and during checkups. The increased time with and exposure to health care practitioners that medically complex infants have could be an opportunity to further educate families on ways to reduce the risk of SIDS.

A limitation of our study is the exclusion of immigrant families who could not communicate in either English or French. This may have led to the enrollment and investigation of fewer families with low socioeconomic status. As increased maternal education is correlated with a decreased risk of all infant deaths, including SIDS and suffocation (8), our study may underestimate SIDS risk factors among certain populations. However, given the high uptake (95%) among families recruited for the study, it is likely that our study does have representation from across different socioeconomic populations.

Another limitation of our study involves the differences in teaching practices that exist between the 32 Canadian sites. The significant differences seen for prone sleeping between sites may be due to differences in teaching practices that may exist between hospitals.

CONCLUSION

None of the infants in the study died from SIDS or SUID, but the results are nonetheless concerning. We encourage all health care professionals to offer parents information on improving the sleep environment. When children spend extended time in hospital, there is an opportunity to model safe sleep patterns and to communicate this information to parents.

This study shows that there is a greater prevalence of some—but not all—SIDS risk factors seen in preterm infants when compared to term infants with medical complexity. Specific educational interventions may be necessary for vulnerable infants.

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