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REVIEW ARTICLE

The factors contributing to the risk of sudden infant death syndrome

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Abstract
Sudden infant death syndrome (SIDS) is defined as the sudden death of an infant under one year of age which remains unexplained after a thorough case investigation, including performance of a complete autopsy, examination of the death scene and review of the clinical history. SIDS is one of the leading causes of infant mortality and occurs from the first month, until the first year of life for newborns and infants.
The aim of this review was to identify and examine risk factors responsible for causing the sudden infant death and to propose certain measures in order to protect newborns and infants from sudden death.
The potential factors that contribute to the occurrence of SIDS include inadequate prenatal care, low birth weight (<2499gr), premature infants, intrauterine growth delay, short interval between pregnancies and maternal substance use (tobacco, alcohol, opiates). Moreover, factors related to infant's sleep environment such as the prone or side sleeping position and thick coverlet increase the risk of sudden death in infants. Also, the combination of risk factors such as that of prone sleeping position and soft bed mattress are linked to a 20-fold increased risk of death. Finally, polymorphisms in the serotonin transporter gene (5-HTT), viral respiratory infections, long Q-T (responsible for the presence of fatal arrhythmia) are related to the SIDS.
Literature review indicates that each individual risk factor contributes to the appearance of SIDS and the establishment of certain protective measures for parents and health professionals has reduced its prevalence. But the precise identification of the SIDS causes and how these contribute to the occurrence of sudden death in neonates and infants, remains a challenge for health professionals. Hippokratia 2011; 15 (2): 127-131

Key words: sudden death, newborn, infant, risk factors, prevention, review

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Willinger et al., (1991) first described the sudden infant death syndrome (SIDS), as ″the sudden death of an infant under one year of age which remains unexplained after a thorough case investigation, including performance of a complete autopsy, examination of the death scene and review of the clinical history″[1]. SIDS appears in newborns and infants, without any indication that their life is in danger[2].

The annual incidence rate of SIDS in '80s was 1.53% per 1000 live births in the USA, while in 2004 it decreased to 0.51%[3]. Deaths due to SIDS, in the general population amounted to 2200 per year[4]. Moreover, SIDS is classified by the Center of Disease Control (CDC) as the third leading cause of overall infant mortality in the USA[5].

SIDS occurs between the first month and before the first year of an infant's life. Infants aged 2-4 months endanger greater risk of SIDS, while most deaths occur in infants during the sixth month of their life[6].

The differential diagnosis of SIDS in neonates and infants includes asphyxiation or drowning, heart disease (arrhythmia), electrolyte disturbances or dehydration, poisoning, trauma, infections (pneumonia, sepsis, meningitis) and congenital metabolic disorders[7].

Few researchers proposed the specification of diagnostic criteria for sudden death in neonates. Beckwith B. (2003), proposed three categories related to SIDS, which classified the neonate or infant in the relevant category. The first category includes infants aged from three weeks to eight months, without the previous appearance of SIDS in the family environment, infants without evidence of abuse, trauma or accident and neonates with a significant degree of anxiety in the thymus, adrenal glands or other organs. The second category consists of infants who exhibit the criteria of the above category, except those that are >1 year old, who have history of sudden death in the family environment and inflammatory disorders. Finally, the last category concerns cases of deaths of infants, which made an autopsy after their death[1].

According to the literature review, the possible risk factors that contribute to the incidence of SIDS are demo-

graphic, relevant to the pregnancy and the birth, the sleep environment, genetic, infective and cardiovascular.

Demographic factors

Low socioeconomic status, maternal young age, low maternal education and single marital status, are associated with the occurrence of SIDS[1]. Infants who did not live with their father were 50% higher sensitive in sudden death, unlike those who grew up with their father[8]. Also, several studies have reported that male infants present 30-50% more chances to die from sudden death[9,10].

Factors related with pregnancy and birth

Pregnancy related factors (mothers with inadequate prenatal care[11], intrauterine growth retardation, short intervals during pregnancies, second pregnancy or after) are connected with increased incidence of SIDS. The sudden death of a second child in a family comes 80-90% natural. Also, birth related factors such as premature [10] and low birth weight infants (infants that were borned at 1000-1499 gr are threatened 4 times higher to die from SIDS and those borned at 1500-2499 gr are threatened 3 times more respectively)[12,13].

Substances abuse like tobacco, drugs and alcohol, in pregnancy period, are correlated with SIDS. Tobacco use in pregnancy affects the intrauterine fetal development. During an antismoking campaign, infants borned by mothers who smoke during pregnancy, have 3 times more risk to appear SIDS before the campaign[14]. The avoidance of smoking during pregnancy estimated that could have reduce SIDS cases by almost 21%.[15] The effect of passive smoking was higher in infants <10 weeks and seems to doubles the possibility of SIDS[16]. Whereas, a home environment free of tobacco use, reduces the chances of SIDS[6].

The chances of sudden death increased by 2-5 times in neonates whose mother have used drugs (opiates)[17,18], 6-8 times in cases of maternal alcohol use (particularly the first 3 months of pregnancy), 2-8 times when mothers had drunk alcohol in the last 24 hours before the neonate death[19]. Infant's siblings with fetal alcohol syndrome reported 10 times more chances of sudden death[20].

Sleep environment

The environment of sleep concerns the infant's sleep position, the bed's quality, the sharing of the bed and the occurrence of smoking during infant's sleep.

Newborns vulnerable to sudden death are those who change position during sleep and remain in prone position[21]. The SIDS risk was 37 times higher at infants who changed position during sleep compare to those who remained in this position throughout the whole sleep duration[22,23]. Infants who sleep in lateral position provoke twice the risk of sudden death, in contrast to those sleeping in supine position[24]. Instantly, many parents and health professionals may notice that supine sleeping position impairs neonatal respiratory system and increases the risk of gastro-esophageal reflux[25].

Soft, old pillows and sleeping mats from polystyrene have been shown to increase by 2-3 times the risk of sudden death[9,17,25]. Also, heavy comforters covering the baby's head, implicate to be associated with sudden death[26,27]. When the newborn's body temperature increases, due to increased room temperature, fever, sweating or excessive clothing the chances of SIDS is increased[16]. While combinations of risk factors such as the prone position and soft layer or increased body temperature and sleep in prone position, are associated with the risk of sudden death, 2 and 6 times, respectively[28,29].

Also, infant's sharing bed with parents or siblings (twins) has been implicated with a high risk of SIDS[30]. Babies under <13 weeks who sleep with their parents are in greater risk[13].

Genetic factors

Polymorphism serotonin transporter gene (5-HTT) was observed at infants who developed sudden death. This gene is affected by the functions of the autonomic nervous system[31].

Infections

Viral respiratory infections are mainly responsible for the occurrence of sudden death. Mild degree of respiratory viral infection was observed by investigators in cases of sudden death infants up to 80%[32].

Toxins produced from bacteria like s.aureus and e.coli, pose a particular risk to the life of infant. The toxins of such bacteria are absorbed by mucosal surfaces, or indicate an upcoming bacteremia, affecting principally the cardiovascular and respiratory systems, creating "channels" in cell membranes, which disrupts the smooth ions[33].

Cardiovascular factors

Long Q-T syndrome is associated with changes in the Na+/K+ pump. Abnormalities shown in ion heart channels, are related to the sudden death and hence the baby is at risk of potentially fatal arrythmia[34]. According to American Academy of Pediatrics, rare genetic disorders are result to mutations of the cardiac tissue, like fatal loss of cardiac function[35].

Protective measures against SIDS

Although the causes of SIDS are not precisely identified, it seems that the above factors have positive effects in sudden death. American Academy of Pediatrics has already established protective measures to decrease the incidence of SIDS. These measures are:

• The position of the infant at bedtime is the most modifiable factor. It is suggested that the appropriate sleep position for infants is the supine one. The side sleeping position is a risk factor for sudden death for this reason it is not recommended[35].

• It is preferred to avoid the high temperature of the infant, keeping tolerable room temperature, avoiding excessive clothing[35].

Table 1: Characteristics of the research studies (during the period 1996-2010), that introduced in this review.

Author's name & Year of Publication	Study Aim	Study's Population	Results
Blair et al. (1996)	To record the effects of substance (tobacco, alcohol, drugs) and correlate them with SIDS	195 SIDS cases and 780 controls	There is increased risk for SIDS when substance use had been done by mother during pregnancy
Mitchell et al. (1996)	To examine if soft cot mattresses is a risk factor of SIDS	105 SIDS cases and 828 control	The relation between SIDS and the soft cot mattresses is strongly positive
Fleming et al. (1996)	To identify the role of sleeping arrangements as risk factors of the SIDS	195 SIDS cases and 780 controls	Risk factors of SIDS were: bed-sharing, the covering of head during sleep and the side sleeping position.
Williams et al. (1996)	To analyze the relation between excessive insulation during the infant's sleep and the risk of SIDS	393 SIDS cases and 1592 controls	Excess temperature during the infant's sleep, increases the risk of SIDS.
Brooke et al. (1997)	To investigate the association between the daily care practices of infants and the occurrence of SIDS	477 infants, 201 cases and 276 controls	Positive correlation between prone sleeping and parental smoking with SIDS. It is proposed that old mattresses increased the risk for SIDS.
Øyen et al. (1997)	To investigate if the combination of prone sleeping position and other risk factors increase the risk of SIDS	244 SIDS cases and 869 controls	Not only prone and side sleeping position, increase the risk of SIDS, but also preterm infants, low birth weight infants and those at the age of 13 to 24 weeks.
Mitchell et al. (1999)	To identify if prone sleeping position causes SIDS	485 SIDS cases and 1800 controls	Infants sleep in prone position account 8% of all deaths.
Malloy et al. (2000)	To estimate the changes in birth weight and gestational age and the mortality due to SIDS	Comparison SIDS rates in 1991 (4871 deaths) to 1995 (3114 deaths)	The SIDS occurrence in postneonatal period decreased significantly in all groups
Nunes et al. (2001)	To identify the socio-epidemiologic factors of the infants with SIDS	335 died infants, only 21 of them fulfilled SIDS criteria	The infants died during cold months, slept in supine position, 71% & 42% of mothers were smokers and alcohol users respectively-during pregnancy.
Hauck et al. (2002)	To examine if the prone sleeping position is a risk factor for SIDS in urban African American population	260 infants, case-control study	Prone sleeping position is a significant risk factor for the occurrence of SIDS, in the population study.
Li et al. (2003)	To record the infant sleeping position and the risk of SIDS	185 SIDS cases and 312 controls	Infants that sleeps always at prone or on the side position had lower risk of SIDS.
Hauck et al. (2003)	To analyze risk factors of SIDS	260 SIDS cases	Etiology factors of SIDS: prone sleep position, soft surface, pillow use, bed sharing.
Carpenter et al. (2004)	To examine the sudden unexplained death in 20 regions in Europe	745 SIDS cases and 2411 live controls	48% of infants cases were sleeping in the side or prone position. Tobacco use by mother correlates with bed-sharing, particularly at the 1 week of life.
Burd et al. (2004)	To record the SIDS rates when there are siblings with FAS	Not mentioned	SIDS death rates increased when there are siblings with FAS
Vennemann et al. (2005)	To identify the modifiable risk factors for SIDS in Germany	333 cases, 3 controls	Prone sleeping position among controls was 4%. Other modifiable factors were maternal smoking during pregnancy, breastfeeding for less than 2 weeks and co-sleeping, while using a pacifier during the last sleep reduced the risk.
Shah et al. (2006)	To investigate the relation between SIDS and the maternal smoking during pregnancy	438 SIDS cases	20.7% of SIDS could have been prevented if maternal smoking was absent. 61.3% of the SIDS cases was relevant with maternal smoking during pregnancy.

SIDS: Sudden Infant Death Syndrome, FAS: Fetal Alcohol Syndrome

• It is recommended that the sleep surface should be firm and hard[30].

• Research studies confirm that the pacifiers help to reduce the risk of sudden death when they are administered at the beginning of sleep. The American Academy of Pediatrics recommends that parents should provide pacifiers to their infants from the first month of their life[35]. However, pacifier use is implicated in the creation of medium otitidas[37] and airway obstruction[37].

• The baby crib is recommended to be located in the same room with the parent's bed and is advised not to make changes in the environment of sleeping infants, at least for the first year of the infant's life[38,39].

• Immunization in time seems also to be protective from SIDS[40].

• The education of parents and health professionals are equally important, contributing decisively in reducing the risk of SIDS[41].

Conclusions

Concluding, the SIDS seems to be a multifunctional syndrome, without a clear etiologic mechanism. For this reason, exploring the way each risk factor contributes to the occurrence of sudden death in newborns and the establishment of certain protective measures for parents and health professionals, still remain a challenge.

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