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Nighttime parenting strategies and sleep-related risks to infants

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ABSTRACT

A large social science and public health literature addresses infant sleep safety, with implications for infant mortality in the context of accidental deaths and Sudden Infant Death Syndrome (SIDS). As part of risk reduction campaigns in the USA, parents are encouraged to place infants supine and to alter infant bedding and elements of the sleep environment, and are discouraged from allowing infants to sleep unsupervised, from bed-sharing either at all or under specific circumstances, or from sofa-sharing. These recommendations are based on findings from large-scale epidemiological studies that generate odds ratios or relative risk statistics for various practices; however, detailed behavioural data on nighttime parenting and infant sleep environments are limited. To address this issue, this paper presents and discusses the implications of four case studies based on overnight observations conducted with first-time mothers and their four-month old infants. These case studies were collected at the Mother-Baby Behavioral Sleep Lab at the University of Notre Dame USA between September 2002 and June 2004. Each case study provides a detailed description based on video analysis of sleep-related risks observed while mother–infant dyads spent the night in a sleep lab. The case studies provide examples of mothers engaged in the strategic management of nighttime parenting for whom sleep-related risks to infants arose as a result of these strategies. Although risk reduction guidelines focus on eliminating potentially risky infant sleep practices as if the probability of death from each were equal, the majority of instances in which these occur are unlikely to result in infant mortality. Therefore, we hypothesise that mothers assess potential costs and benefits within margins of risk which are not acknowledged by risk-reduction campaigns. Exploring why mothers might choose to manage sleep and nighttime parenting in ways that appear to increase potential risks to infants may help illuminate how risks occur for individual infants.

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Introduction

The infant sleep literature has been driven by concern about sleep-related causes of mortality, particularly accidental deaths and Sudden Infant Death Syndrome (SIDS). A substantial body of research has identified key risk factors, most notably the prone sleeping position as well as smoking, specific aspects of the sleep environment, and other risks (see Ball & Volpe, in this issue). In the U.S. SIDS-risk reduction campaigns have encouraged parents to place their infants supine for sleep and in the parents' room, keep their infants smoke-free, and ensure bedding and clothing cannot cover airways or cause infants to overheat; parents are also advised to avoid bed-sharing and sofa-sharing (American Academy of Pediatrics (AAP), 2005; AAP, 2008). These recommendations are

based on findings from large-scale epidemiological studies that generate odds ratios or relative risk statistics for various practices; however, detailed behavioural data on nighttime parenting practices and infant sleep environments are limited. Furthermore, in spite of widely disseminated messages about eliminating known risks, risky practices persist. As we discuss in Ball and Volpe (in this issue) message exposure alone is insufficient to ensure parental compliance.

Over the past two decades, social scientists have examined infant sleep behaviour and physiology through the lens of evolutionary medicine, addressing the intersection between culturally-influenced caregiving practices and the evolved biology of infancy. Combining behavioural observations with the theoretical framework of evolutionary medicine (see Trevathan, Smith, & McKenna, 2008), social scientists are able to address both proximate (immediate or mechanistic) and ultimate (adaptive) causes for individual behavioural strategies (Tinbergen, 1963). The present study provides detailed descriptions based on video analysis of four

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sleep-related risks that occurred to infants sleeping in a sleep lab with their mothers. The cases depict sofa sleeping; unsafe bed-sharing; use of unsafe materials in the sleep environment; and excessive use of soft bedding. These case studies provide examples of mothers engaged in the strategic management of nighttime parenting who displayed compromises in infant care compared to established risk reduction guidelines (AAP, 2005; AAP, 2008). As parents are neither provided with the odds ratios for particular factors, nor told which practices to prioritise, the guidelines present all potential risks as uniformly hazardous, yet parents know that the majority of cases where risks occur do not result in infant mortality. Therefore, mothers assess potential costs and benefits of infant care practices within margins of risk that are not acknowledged by risk reduction campaigns. Social science-based research may prove useful for clinicians and public health professionals by helping to explain how risks impact individual infants and what motivates mothers to engage in particular forms of infant care.

Background

An extensive literature has focused on risk factors for SIDS and other causes of unexpected infant death. This literature and the public health messages that have been developed as a result have been reviewed elsewhere (see Ball & Volpe, in this issue). Current policies about infant sleep focus on encouraging parents to eliminate all known risk factors. However, despite the widespread dissemination of this advice, public health recommendations are not uniformly adopted. Observational studies are needed to clarify how these risk factors play out for infants in a variety of environments. Furthermore, observational data are important where the aetiology of risk factors remains poorly understood. For example, although sofa sharing has been identified as a risk factor for SIDS (Blair et al., 2009), the exact mechanisms remain unclear.

Understanding sleep-related risks to infants using social science research

Anthropological discourse has much to offer public health policy and practice, particularly by suggesting a framework for why individuals engage in potentially risky behaviour and how they weigh costs and benefits in forming their behavioural strategies. Life-history theory is a clinically-relevant lens for addressing how individuals strategically plot their life course and continually negotiate trade-offs. One of the key categories of trade-offs related to parental effort involves investing in one's own growth and maintenance versus a child's growth and maintenance (Borgerhoff Mulder, 1992). Parents must plot the best way to invest in their children, weighing the benefits of efforts extended for a particular offspring against the costs incurred by the parent in undertaking such efforts (Clutton-Brock, 1991).

As part of the continual negotiation between parent and child, life-history theory recognises that conflict arises about how, when and to what degree to invest in an individual offspring (Trivers, 1972). Such conflict occurs because parents and offspring are not genetically identical, and therefore have overlapping but different interests and agendas about such investment (Clutton-Brock, 1991). It behoves offspring to obtain greater investment than the parent is able to provide, while it is in the mother's best interest to limit investment (Clutton-Brock, 1991; Trivers, 1972). The way mothers manage the dispersal of their parenting resources demonstrates a finely-tuned "maternal response system" that is calibrated to particular contexts and conditions (Hrdy, 1997, p. 414).

The role of evolutionary theory

It is important that infant sleep be understood within the context of parental investment strategies, since mothers expend parenting effort in ways that impact the degree of risk or protection to which infants are exposed. McDade (2001) used an evolutionary framework to explore the balance between benefits and costs of continued lactation. This approach offered a unique perspective on maternal behaviour and child outcomes, and challenged the idea that maternal and child interests coincide. This study showed the predictive value of life-history theory for understanding health-related behaviour and for informing interventions, and acknowledged that women cannot be expected to engage in a behaviour that is more expensive than their circumstances allow them to tolerate.

An extensive literature has detailed additional factors that cause parents to alter or withdraw investment. These include socio-environmental conditions, such as living in high-risk environments and experiencing unstable material or socio-emotional resources (Chisholm & Coall, 2008), or engaging in specific forms of work and food production (Hewlett, Lamb, Leyendecker, & Scholerich, 2000; Lancaster & Lancaster, 1987). Maternal characteristics such as substance use or mental illness (Soltis, 2004), the availability of alloparents (Borgerhoff Mulder, 1992) or co-resident female kin (Flinn, 1989), the presence of non-biologically related males (Daly & Wilson, 1997; Lancaster & Kaplan, 2000), and paternal support (Quinlan, Quinlan, & Flinn, 2003) also influence capacity for investment. Furthermore, infants are more likely to experience diminished investment if they are extremely ill (Soltis, 2004), are low birth weight (Berezckei, 2001), or are viewed as unlikely to survive harsh living conditions (Scheper-Hughes, 1985).

In the area of infant sleep, existing studies have demonstrated the utility of anthropological perspectives and methods (e.g. Ball, 2002; Ball, Hooker, & Kelly, 1999; McKenna, Mosko, & Richard, 1999). These studies have documented how the complicated prospect of providing care to infants during the night causes parents to adopt strategies and behaviours that they had not planned (Ball, 2007). The manner in which parents approach infant sleep balances infant physiology and temperament with parental goals and desires within a particular social and behavioural context (Anders & Taylor, 1994). The present study adds a detailed description of nighttime parenting behaviour for four mothers and their infants, with a specific focus on how sleep-related risks to infants occurred in the context of nighttime parenting strategies.

Methods

Participants

Participants were drawn from a longitudinal, multi-site parenting study. Primiparous mothers were recruited during the last trimester of pregnancy from prenatal clinics, health care offices, and school-age mothers programs. Participants at the South Bend, Indiana site were invited to complete a sleep study when infants were approximately four months old (see Volpe (2010) for additional details). Overnight infra-red video-recordings for 45 mother–infant dyads were obtained at the Mother-Baby Behavioral Sleep Lab at the University of Notre Dame. Videos were quantitatively analysed, and results for the entire sample have been presented elsewhere (Volpe, 2010). For this paper, four sleep studies were selected as case studies based on the occurrence of sleep-related practices identified as risks in the clinical literature. The four participants presented here include two adolescent and two adult mothers and their infants who completed sleep studies between September 2002 and June 2004.

Data collection procedures

Participants arrived at the sleep lab before they normally began preparing their infants for sleep, and departed after final awakening the following day. The lab resembled a home environment, with two bedrooms containing an adult bed, a bedside bassinet, and a cot, as well as a living room with television. Infra-red cameras collected continuous video and audio recordings. Participants were encouraged to maintain their normal home sleeping arrangement and parenting routines.

Ethics

The Human Subjects Institutional Review Board of the University of Notre Dame reviewed the study protocol and granted full ethics approval.

Case studies of sleep-related risks to infants

Case studies of sleep-related risks to infants were selected based on the occurrence of key risk factors that have been identified in the literature. The sleep studies are summarised here, and a description is provided of the infant sleep environment, maternal and infant behaviour during the sleep period, and a description of potential sleep-related risks to infants as they occurred.

Results

Case study 1: mother and infant sleeping on sofa (Fig. 1)

The participant in this sleep study was a 22 year old mother of African American ethnicity. Her son was 22.3 weeks old at the time of the sleep study. During this sleep study, the mother and infant spent their sleep period together on a small sofa in the living room area.

Overnight sleep study

The sleep study began with the mother changing the infant's clothes and engaging in affectionate interactions. The baby frequently was placed on the sofa in the living room, with his body touching the back of the sofa, while the mother arranged her belongings. The mother also fed the baby a bottle, and held him in her arms until he fell asleep. Once the baby was asleep, the mother placed the infant in a supine position on the sofa, on top of one baby blanket and covered by a second. When the baby woke and began fussing, the mother brought the baby onto her chest, covered both of them with a blanket, and settled back onto the sofa to watch television. Several minutes later, she placed the infant on her lap while she wrapped her hair in a scarf in preparation for sleep. She then settled into a reclining position on the sofa and brought the infant back onto her chest, holding him in the arm closest to the edge of the sofa. By the time the mother fell asleep in this position the baby was centred on her chest.

The mother and infant both spent the entire night on this small sofa, and altered their body positions several times during the course of the sleep period. Throughout this time, the baby was located either on the mother's body, or on the baby blanket the mother had previously placed on the sofa cushions. At various times, the infant slept in the following arrangements: on the mother's chest as she reclined on the sofa, or with her body on the sofa and her legs propped on the coffee table in front of her; cradled in the crook of the mother's arm as she reclined crosswise on the sofa, always with his body along the outside edge of the sofa; positioned in the corner of the sofa so that the side of his body was touching the back of the sofa, in a supine position and as far away

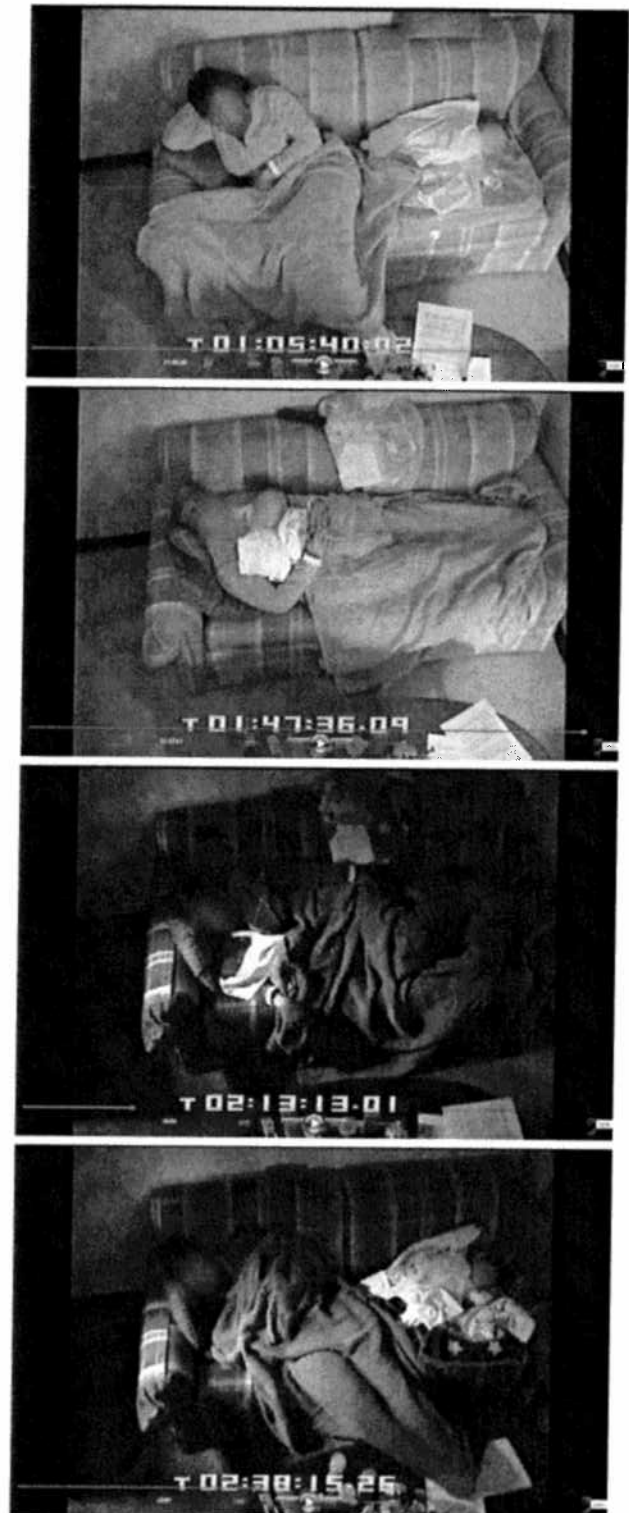


Fig. 1. Pictures of case study 1.

from the edge of the sofa as possible, and having no direct contact with the mother's body; lying supine in the corner of the sofa while the mother reclined in a semi-supine position with the baby's head near to and occasionally touching the mother's feet; and with the mother on her side with her knees pulled up, so that the baby was

located in the L-shaped space made by the mother's knees and legs. In all instances, the mother and baby were covered with one blanket each, the infant was never placed in a non-supine position, and there were no materials in the immediate vicinity of the infant's nose or mouth.

Throughout this sleep study, the mother woke numerous times to inspect her infant, and responded promptly to infant cues although infant vocalisations tended to provoke a more immediate response from the mother compared to infant body movements without vocalisations. In addition to visual inspections, the mother also engaged in three infant feeding sessions between the time she first fell asleep and her final awakening the following morning.

Notable features of the sleep study

- The mother selected this sleep environment for herself and her infant (she did not fall asleep there accidentally) despite the presence of a bedroom a few feet away, and both spent their entire sleep period on the sofa.
- The infant's face was never orientated towards the back of the sofa, nor was it obscured by cushions, blankets, or the mother's body.
- While sleeping on the sofa, a number of body positions and physical arrangements existed, including those where the infant was sleeping directly on the mother's body and those where the mother and infant were not in direct contact.
- The mother was sensitive to infant cues, and responded relatively quickly to every instance of nighttime awakening. However, infant vocalisations were slightly more effective in prompting the mother to awaken and respond compared to infant movement that occurred without vocalisations.
- The mother positioned herself in a number of seemingly uncomfortable positions on the small sofa. With other possible sleeping arrangements offered in the sleep lab, it is noteworthy that she elected to sleep on the sofa.

Case study 2: unsafe bedsharing practices (Fig. 2)

This participant was an 18 year old of non-Hispanic white ethnicity. Her daughter was 20.9 weeks at the time of the sleep study. The mother had extremely long hair which reached almost to her waist, and she wore her hair tied back in a ponytail including during the sleep period.

Overnight sleep study

The overnight sleep study began with the mother feeding the infant baby cereal and a bottle of formula, as well as ongoing affectionate and vocal interactions. The mother settled onto the sofa to watch television while holding the infant, and twice offered the infant a potato crisp although the infant refused the crisp both times. As the mother began arranging her belongings and preparing for sleep, she set the infant on her back on the adult bed, with a pillow on either side of the infant's body, while the mother moved in and out of the room. The mother read the baby a book, and then picked her up and sat in a rocking chair and rocked her to sleep, repeatedly kissing the infant's head. After the infant was asleep, both mother and baby returned to the adult bed, where the mother placed the infant supine on top of a baby blanket, with the infant's head on a pillow, and pulled the bed covers up to the level of her own waist and the baby's chin. The mother fell asleep curled around the infant, with her arm under the infant's head.

After several hours, the mother woke and repositioned herself, which left the baby supine on the mattress with her head in the space between the two full-sized pillows at the head of the bed. The



Fig. 2. Pictures of case study 2.

edge of one pillowcase covered the infant's ear and part of her forehead. The remainder of the study was marked by changes in the mother's body position that had her alternately facing the infant or facing away, including times where the mother lay in the prone position with her head turned away from the infant. The infant

frequently made multiple body movements during the sleep period, including some that were vigorous, but many of these infant arousals did not prompt the mother to awaken or respond. Whenever the infant cried or fussed loudly, the mother did respond and often readjusted the position of the pillowcase or the corner of the baby blanket which were falling into the infant's head and face. However, given the position of the infant in bed and the arrangement of bedding near the infant's head, these items often returned to covering portions of the infant's head soon after the mother returned to sleep.

Many of the instances in which portions of the infant's head were covered by items of bedding did not involve nose or mouth covering. However, several movements of the mother as she adjusted her position while asleep did result in nose and mouth covering for the infant. During the sleep period, the mother often pulled the bed covers up to her own neck, leaving the infant's head and body covered by blankets, although at times these items were tented over the infant's head by the mother's body and were not lying directly across the infant's nose or mouth. When the mother adjusted the position of her own pillow, the pillowcase ended up covering the infant's nose and mouth for an extended period of time. Additionally, during periods when the mother faced away from the infant, her very long ponytail repeatedly covered the infant's face. The position of the bedding items tended to move frequently during the sleep period, and the infant was exposed to arrangements of bedding, including those touching or directly over her head and face, that were not deliberately placed but rather occurred as a result of the mother repositioning herself throughout the night.

Notable features of the sleep study

- The infant experienced several instances of head covering with a pillowcase, a baby blanket, and the bed covers, several of which were caused by the mother's movement in the bed.
- The infant was able to resolve some of the head coverings on her own, but many of the head coverings lasted for an extended period of time and were not promptly addressed by the mother.
- Some maternal night wakings, including those prompted by infant movement, were not accompanied by a visual inspection of the infant and/or adjustments to the infant's bedding.
- The mother displayed high levels of affection and responsiveness at certain times, and slow responsiveness and some lack of awareness of the infant at other times.

Case study 3: use of multiple blankets and items of soft bedding in the infant's sleep environment (Fig. 3)

This participant was a 35 year old mother of non-Hispanic white ethnicity, and her daughter was 23.7 weeks old at the time of the sleep study. The mother was dressed in jeans and a short-sleeved t-shirt for the first portion of the sleep study, and wore a pair of shorts and a t-shirt for sleep. The infant wore an undershirt plus warm zippered pyjamas with feet. The average temperatures for South Bend, Indiana in the month of September, when the sleep study took place, include a high of 23 °C (74 °F) and a low of 12 °C (53 °F) (Weather Channel, 2009). The sleep lab had central heating and the mother adjusted the temperature of the infant's bedroom, although the setting of the thermostat was not recorded.

Overnight sleep study

The sleep study began with the baby in a car seat holding multiple toys, with a small cloth loosely draped around the front of her neck. The car seat was placed on the sofa, facing the television



Fig. 3. Pictures of case study 3.

playing a video designed for infants. After arranging her belongings, the mother held the infant on her lap, fed her a bottle of formula, and engaged in multiple affectionate interactions. Subsequently, the mother carried the infant into the infant bedroom, swaddled the infant tightly in a blanket, and breastfed the infant while seated

in a rocking chair. When the infant fell asleep, the mother placed the infant supine in the cot, still swaddled, on top of one baby blanket and with the infant's head on a very small, baby-sized pillow. The infant still had the cloth draped around the front of her neck. Once the infant was in the cot, the mother covered her with an additional baby blanket, pulling it up to the middle of the infant's torso. The mother left the room momentarily, and when she returned and visually inspected the infant, the infant woke up and began kicking vigorously and moving the covers, and pulled the cloth off her neck and began chewing on it. The mother gave the infant a pacifier, re-placed the small cloth across the front of the baby's neck, and then left the room. The infant remained awake but content.

Several minutes later, the baby's movement was sufficient to move the blankets higher onto her body, covering her chin. With continued kicking, the blanket periodically covered the infant's face, but the infant was able to pull it back down to her neck level. Shortly thereafter, the mother went to speak to the sleep lab technician and both she and the technician observed on the monitors that the infant's face had become obscured by the bedding. The mother returned to the infant's room and said in an affectionate tone, "You're not even tired, look at you! I thought you were asleep!" The mother then brought the infant to the living room and again placed her in the car seat on the sofa. The mother placed a blanket over the infant's body, re-established the neck covering with the same cloth, and then placed multiple toys on top of the infant's body and said to her, "There you go, you can play." The mother reinserted the pacifier into the infant's mouth, and then sat down next to the car seat. The baby remained active and alert, moving vigorously, but was content.

When the mother was ready to try again to settle the infant for sleep, she carried the infant back to the infant bedroom, and breastfed the infant and rocked her to sleep. Once the infant was asleep, the mother placed her in the cot with the same arrangement of blankets (swaddled, on top of one baby blanket and covered by a second, with the infant's head on a baby-sized pillow, and a small cloth covering the front of the infant's neck). The mother got into bed in the adjacent bedroom, and fell asleep quickly.

Both the mother and infant slept soundly, and the baby remained in virtually the exact same position, for more than 6 h. When the infant awoke, her vocalisations prompted the mother to enter the room, breastfeed the infant, and rock her in the rocking chair. The mother returned the infant to the cot, re-swaddled the infant, and arranged all of the items of bedding in the same manner. The infant woke very briefly upon being placed in the cot, and moved the blankets up over her own nose, so the mother quickly moved the blankets back down to her neck level. Once the infant had settled to sleep, the mother left the room and returned to bed. Both slept for another hour, after which time the infant awoke again and her fussing alerted the mother, who picked the baby up out of the cot and brought her into the adult bed. The infant was still swaddled, lying on the mattress, with an additional baby blanket covering her entire body up to her neck. The mother was lying on her side, turned away from the infant, covered with the adult bedding. They remained in this position until the infant's final awakening for the day, after which they remained in bed together for several minutes, engaging in affectionate interactions. The mother then got out of bed and began packing her belongings prior to the end of the sleep study.

Notable features of the sleep study

- The mother used multiple items of soft bedding for her infant, including blankets below and on top of the infant's body, a swaddling blanket, and a small infant-sized pillow.

- The mother kept a small cloth around the front of the infant's neck virtually at all times during the overnight sleep study.
- In addition to the numerous items used to prepare the infant's sleep space, a large number of toys and other items were also placed on or near the infant during times she was awake.
- The mother persisted in using multiple items of soft bedding for the infant even after witnessing these items covering the infant's head and face on the sleep lab monitor.

Case study 4: bottle propping on items of bedding across multiple sleep locations (Fig. 4)

The participant in this sleep study was an 18 year old of non-Hispanic white ethnicity. Her daughter was 19.6 weeks old at the time of the sleep study. Throughout her sleep study, she positioned the infant in immediate proximity to multiple items of soft bedding in order to prop a bottle in the infant's mouth. This behaviour stands in contrast to the mother's own self-reports about what she knew about infant sleep safety. She reported that to maximise safety for her daughter during sleep she should "put her on her side and do not have anything in her cot with her."

Overnight sleep study

The study began in the living room, where the mother watched television while engaging in multiple verbal and affectionate interactions with the infant. In preparation for sleep, the mother bathed the infant and changed her clothes. This caused the infant to fuss loudly, so the mother gave her a bottle containing water and the infant's fussing resolved immediately. The mother then held the infant in her arms and fed her a bottle of formula for several minutes, after which time she placed the infant supine in the bassinette and gave the bottle of formula to the infant. The mother proceeded to make several additions of soft bedding items in the infant's immediate environment, and when she was done the infant was tightly swaddled in a baby blanket, lying on her side, with a throw pillow from the sofa placed between the infant's back and the side of the cot, with a folded baby blanket between the top of the infant's head and the upper side of the cot, and with a folded baby blanket near the infant's face that supported the bottle, which was propped into the infant's mouth. The mother made repeated visual inspections of the infant as she moved in and out of the room arranging her own belongings, and the infant fell asleep. Infant body movements caused the bottle to dislodge, and when the infant awoke in this position and cried, the mother resolved the crying by placing the bottle back in the infant's mouth, and replacing the throw pillow with a full-sized pillow from the adjacent adult bed parallel to the infant's body so that the bottle was now propped onto the pillow. The infant returned to sleep, and the mother shortly fell asleep in the adjacent adult bed.

The infant's sleep environment changed again during a subsequent sustained awakening by the infant. The mother did not respond to the baby's initial fussing, which became progressively louder. The mother repositioned her body, but showed no signs of waking. The infant's fussing subsided, but the baby remained awake and continued to actively move in every possible way, limited by the small and confined sleep space in which she was located between the pillow and the cot side. The infant dozed off intermittently for a couple of minutes at a time, but woke up again each time and eventually her fussing resumed and she worked herself into a sustained cry. After several minutes of crying, the mother lifted the infant out of the bassinette, and the baby stopped crying as soon as she was in contact with the mother. The infant was brought into bed with the mother and was fed a bottle of formula. The mother again used items of soft bedding to prop the bottle in the infant's mouth, bunching the bed covers up near the



Fig. 4. Pictures of case study 4.

infant's head so the bottle was supported, and placed a full-sized pillow close to the infant's face to keep the bottle from rolling to the side.

The infant was shifted to another sleep environment later in the night, again in response to an awakening with sustained amounts

of fussing that was not resolved by offering the infant a bottle of water. The mother relocated the infant into a car seat placed on the floor near the adult bed. She then placed two folded baby blankets on top of the infant's chest, and put the bottle in the infant's mouth and rested it on top of the folded blankets. The top blanket was partially covering the infant's face, but was tented enough that it was not in direct contact with the infant's nose or mouth. The mother returned to bed and quickly fell asleep. The infant was returned to the mother's bed towards the end of the sleep period, again with the bottle propped on soft bedding piled near the infant's face, and stayed there until both mother and infant awoke for the final time and departed the sleep lab.

Notable features of the sleep study

- Multiple episodes of bottle propping were created by the mother to settle the infant to sleep with minimal maternal involvement.
- A bottle of water was given to the infant for many of the feeding sessions.
- The presence of a bottle in her mouth settled the infant immediately each time, regardless of what type of liquid was in the bottle, and even at times when the angle of the bottle in the infant's mouth meant that little or no liquid was being consumed.
- The infant spent the entire night surrounded by a large number of soft bedding items.

Discussion

These cases are offered to supplement large-scale, epidemiological studies that lack detailed behavioural observations. They depict mothers pursuing strategies for handling the intensive care required by infants at night. All tolerated some risk to their infants and displayed compromises in infant care. Each case study illustrates the complexity of nighttime parenting, and highlights the difficulties in identifying discrete risk factors in a multifaceted behavioural context. Although Reduce the Risk guidelines and other public health messages focus on eliminating known risks that are potentially lethal to infants whenever they occur, in reality infants may be exposed to these risks with no adverse outcomes. Parents therefore may weigh the perceived likelihood of these risks to their infants against real or perceived benefits to themselves or their infants in ways that are not yet acknowledged.

Together, the case studies document a variety of infant-care practices, and challenge the homogeneity of infant-care implied by many epidemiological studies. Even in a uniform sleep lab environment, these four mothers displayed quite different trade-offs in caring for their infants at night; in their diverse home environments these differences may have been even more pronounced. While epidemiological models characterise sleep-related risks on a population level, how risks are managed on an individual level is a vital and understudied component of understanding risk-management. Sleep-related risks to infants may not always arise as the result of negligent maternal choices, but may form a functional and rational (whether conscious or not) strategy to negotiate the complex compromises that are inherent to parenting.

Specific implications regarding infant sleep-related risks

A primary finding of this study is that strategies to minimise maternal sleep disruption may be particularly relevant to understanding sleep-related risks to infants. The fourth case study illustrates some of the more extreme measures to reduce parental

effort undertaken by mothers in this study. This involved the construction of an unsafe sleeping environment that minimised maternal involvement with the infant, especially during nocturnal feedings. The case study provides a concrete example of the trade-off made by the mother in using soft bedding to prop a bottle in her infant's mouth. It is possible to understand how maternal benefit received from shorter sleep interruptions might outweigh the potential threat to infant safety caused by the presence of soft bedding near the infant's face.

In addition to maternal sleep needs, other motives require consideration. Sleep-related risks occur even in the context of high-investment strategies involving considerable attention to infant needs and preferences. As illustrated in the third case study, the construction of sleep environments involving multiple items of warm clothing and soft bedding may reflect maternal investment in their infants during sleep. This may be particularly relevant where mothers who sleep apart from their infants attempt to provide a warm and comfortable sleep environment while the infant is alone, even though such environments increase risk for overheating and/or suffocation.

The present study also offers insights into the risk to infants conferred by sleeping on a sofa with a parent compared to sharing an adult bed. The sleeping arrangement and body orientation of the mother and infant in the first case study were substantively different from those observed during bedsharing (see Baddock, Galland, Taylor, & Bolton, 2007; Ball, 2003, 2007; McKenna et al., 1999). The mother and infant were less often arranged with their bodies parallel, spent less time facing each other, and the available space in which the mother and infant were arranged was substantially smaller. This suggests that an important taxonomic distinction should be made between shared sleep that occurs on an adult mattress compared to other surfaces, including sofas, as the behavioural and physical arrangement of the dyad is necessarily different. However, the first case study lacked any acute instance of danger to the infant and it remains unclear how sleeping on a sofa poses such a substantial threat to infant safety. It would be useful to further explore why a mother might choose to sleep on a sofa with her infant where alternative sleeping locations exist. It is possible that maternal condition, infant characteristics such as temperament or illness, or other factors that themselves confer risk may prompt mothers to select a sofa for sleep.

The present study also indicates that the absence of breast-feeding may translate into a different bedsharing relationship for some dyads in ways that potentially impact sleep-related risks. The second case study illustrates a different picture of mother–infant bedsharing than those found by previous researchers (e.g. Ball, 2003, 2007; McKenna & Mosko, 1993; McKenna et al., 1999) where adult breastfeeding mothers placed their infants at breast level in bed and spent a majority of time orientated towards their infants. Previous work by Ball (2006) has shown that adult mothers who never breastfed shared a bed with their infants in a manner that more closely resembled sleeping with another adult. The adolescent mother in the second case study engaged in a similar practice, placing her infant higher in the bed at the mother's head level and with the infant's head on a pillow. In this case, the position of the infant and the use of a pillow resulted in periods of head covering, which were sometimes resolved by the mother and sometimes by the infant herself, and which at times occurred for extended periods. The degree to which this resulted in physiological stress to the infant was not measured here, however previous research has suggested that not all episodes of head covering affect infant physiology in negative ways (see Ball, 2009). The sleep-related risks observed for this dyad occurred alongside affectionate and responsive interactions, demonstrating that mothers can exhibit behaviours exposing infants simultaneously to both protective and risk factors.

Broader applications

Overall, this study supports the idea that sleep environments can be made safe or unsafe based on maternal strategies for investing in infants, and that such behaviours are ultimately informed by life-history strategy. The significance of this for clinical practice is that trade-offs are a reality for all mothers, and that such trade-offs must be acknowledged in intervention programmes or public health campaigns. Risk reduction efforts often focus on education and message exposure, but mothers do not operate under ideal or uniform conditions, and may have a compelling reason for not acting on the advice they are given. Clinicians may use this awareness of maternal trade-offs to inform conversations with mothers, such as by asking them if there are specific barriers that prevent them from implementing safe sleep guidelines or by exploring how they prioritise their own needs with different aspects of infant care. Furthermore, understanding and acknowledging the complexity of maternal strategies and the reality of negotiating trade-offs suggests that if clinicians want mothers to adopt specific risk-reduction behaviours, they must assist mothers in figuring out how to tolerate the potential “costs” of these behaviours and help them implement strategies to ameliorate such costs. Finally, risk reduction efforts will benefit from ongoing research that allows safe sleep messages to be more fine-tuned and elastic, enabling mothers to apply such recommendations more easily in a variety of contexts. Until the benefit to mothers of tolerating certain degrees of risk is understood, efforts to improve infant health and safety outcomes will not realise their full potential.

Limitations

These case studies were collected in a laboratory environment, and therefore cannot capture the complex home lives and behavioural repertoires of the mothers in the study. Furthermore, the setting may produce an underestimate of risk because the sleep lab was an environment in which safety precautions were taken and infants were monitored at all times. Future home-based studies will help to address these issues.

A major limitation was that mothers were not interviewed about the behaviours in which they engaged. These sleep studies were collected during a larger research project on transition to parenting, and although mothers were interviewed at various times about infant care and other issues, these interviews did not explore the events observed during the sleep study. Future research on maternal perceptions that incorporates qualitative methods would further illuminate the rationales that inform an individual's parenting strategy.

Future directions

As the present study did not explore whether mothers were conscious or unconscious of the trade-offs they were making, these case studies could inform the design of research to clarify the extent to which mothers are aware of their night-time parenting strategies and the trade-offs involved. Future studies, incorporating observational data and ethnographic interviews, will further clarify how and why sleep-related risks to infants occur and pinpoint their effects on infant behaviour and physiology. These types of in-depth studies are well-suited to the methods and conceptual models of the social sciences, and clinical research and epidemiological modelling will be enhanced by incorporating social science research wherever possible.

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