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### Deposited in DRO:

07 November 2017

### Version of attached file:

Accepted Version

### Peer-review status of attached file:

Peer-reviewed

### Citation for published item:

Bartick, Melissa and Tomori, Cecília and Ball, Helen L. (2018) 'Babies in boxes and the missing links on safe sleep : human evolution and cultural revolution.', *Maternal child nutrition.*, 14 (2). e12544.

### Further information on publisher's website:

<https://doi.org/10.1111/mcn.12544>

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Title: Babies in boxes and the missing links on safe sleep: Human evolution and cultural revolution

Running title: The missing links on safe sleep

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1 **Abstract:**

2 Concerns about bedsharing as a risk for Sudden Infant Death Syndrome and other forms  
3 of sleep-associated infant death have gained prominence as a public health issue.

4 Cardboard “baby-boxes” are increasingly promoted to prevent infant death through  
5 separate sleep, despite no proof of efficacy. However, baby-boxes disrupt  
6 “breastsleeping” (breastfeeding with co-sleeping), and may undermine breastfeeding.

7 Recommendations enforcing separate sleep are based on twentieth century Euro-  
8 American social norms for solitary infant sleep and scheduled feedings via bottles of  
9 cow’s milk-based formula, in contrast to breastsleeping, an evolutionary adaptation  
10 facilitating the survival of mammalian infants for millennia. Interventions that aim to  
11 prevent bedsharing, such as the cardboard baby box, fail to consider the implications of  
12 evolutionary biology or of ethnocentrism in sleep guidance. Moreover, the focus on  
13 bedsharing neglects more potent risks such as smoking, drugs, alcohol, formula feeding  
14 and poverty. Distribution of baby boxes may divert resources and attention away from  
15 addressing these other risk factors and lead to a false sense of security wherein we  
16 overlook that Sudden Unexplained Infant Deaths (SUID) also occur in solitary sleep  
17 environments. Recognizing breastsleeping as the evolutionary and cross-cultural norm  
18 entails re-evaluating our research and policy priorities, such as providing greater  
19 structural support for families, supporting breastfeeding and safe co-sleeping,  
20 investigating ways to safely minimize separation for formula-fed infants, and mitigating  
21 the potential harms of mother-infant separation when breastsleeping is disrupted.  
22 Resources would be better spent addressing such questions rather than on a feel-good  
23 solution such as the baby box.

24

25 Keywords: Sudden Infant Death, Breast Feeding, Infant Formula, Sleep, Infant Behavior,

26 Mothers

27

28

29 Key Messages:

30 Cardboard “baby-boxes” are increasingly promoted to prevent infant death through

31 solitary sleep, despite no proof of efficacy. Such interventions are based on recent

32 cultural innovations of solitary infant sleep and scheduled bottle-feeding with cow’s

33 milk-based formula. However, boxes disrupt the evolutionary adaptation of breastfeeding

34 with co-sleeping - “breastsleeping”, may undermine breastfeeding, and divert resources

35 away from addressing more potent risk factors for infant death. Instead of distributing

36 boxes, we should consider sleep and breastfeeding as one integrated evolutionary

37 process, develop support for safe breastsleeping, and examine the consequences of

38 mother-infant separation.

39

40 **Text:**

41 Concerns about bedsharing as a risk for Sudden Infant Death Syndrome and other forms  
42 of sleep-associated infant death have gained prominence as a public health issue. Most  
43 recently, interest in the cardboard “baby box” as a way to promote separate sleep has  
44 grown enormously, with baby box distribution programs now being instituted in several  
45 US states. However, the baby-box and guidelines around infant sleep must be re-  
46 evaluated when placed in an evolutionary and socio-historical context. The baby boxes  
47 and current infant sleep guidelines that emphasize the avoidance of bedsharing fail to  
48 consider the potential harmful consequences of mother-infant night-time separation,  
49 including its impact on breastfeeding.

50

51 For generations, conventional wisdom has held that “sleeping like a baby” means that  
52 babies sleep long, deeply, and alone. These assumptions, and expert medical advice  
53 around infant sleep, were predicated upon and reinforced by nighttime separation of  
54 mothers and babies and scheduled infant feeding via carefully measured amounts of  
55 formula in bottles derived from the milk of the cow. These practices, however, are recent  
56 Euro-American historical inventions (Wolf, 2003, Tomori, 2014). The species-specific  
57 norm for infant feeding is breastfeeding, and breastfeeding comprises a sum total of  
58 human behavior that is more than just nutrition. Indeed, anthropologists James McKenna  
59 and Lee Gettler have argued that “The mother’s body provides the only environment to  
60 which the human neonate infant is adapted” (McKenna and Gettler, 2015). Breastfeeding  
61 cannot be separated from other infant activities such as sleeping, or being held or carried.

62 Drawing on data showing the mutually reinforcing relationship of breastfeeding and  
63 shared mother-infant sleep, McKenna and Gettler coined the term “breastsleeping” to  
64 connote that breastfeeding and (safe) co-sleeping are part of the same process (McKenna  
65 and Gettler, 2015). By recognizing breastsleeping as an evolutionary adaptation that has  
66 contributed to the survival of our species, and the ethnocentrism entailed in much of  
67 current U.S. and western infant sleep guidance, we must completely reframe how we  
68 examine current public health interventions and research questions on this topic.

69

70 The distribution of “baby boxes,” cardboard boxes filled with baby supplies which, when  
71 emptied, can be used as an infant sleeping environment, is an increasingly popular  
72 intervention introduced in North America and elsewhere to promote separate sleep, and is  
73 generally paired with some form of education on safe sleep. Baby box programs are  
74 based on a Finnish government program initiated in the 1930s in which baby clothes and  
75 related items were given to mothers who attended prenatal appointments. The boxes also  
76 provided a safe place outside of parents’ beds for infants to sleep, especially in homes  
77 that might have only rudimentary furniture (Rosenberg, 2016), as poverty was common.

78

79 Although U.S. initiatives assume that sleeping in the boxes has resulted in lower infant  
80 mortality, no evidence to date supports this assumption. Experts in recent media reports  
81 have questioned the underlying reasons for the significant drops in infant mortality in  
82 Finland which were observed over the period since the boxes were introduced (Hafner,  
83 2017, Cassin, 2017) and note that less than half of Finnish babies currently sleep in the  
84 boxes (Hafner, 2017). Indeed, the nearby nations of Sweden, Norway, and Iceland never

85 introduced baby boxes but have had similarly low infant mortality rates (Organisation of  
86 European Co-operation and Development, 2016). They share with Finland universal  
87 health care systems, social safety nets, and paid maternity leave policies. Moreover, while  
88 many baby box initiatives claim that the Finnish program was designed to combat  
89 poverty-associated infant mortality, it was actually designed to incentivize women to get  
90 screened and treated for prenatal syphilis, which was an epidemic at that time (Weeks,  
91 2016). Furthermore, in most U.S. programs it is assumed the distribution of baby boxes  
92 for infant sleep only confers advantages. Few questions have been raised about how these  
93 boxes may affect breastfeeding mothers and infants, or introduce new hazards. The  
94 distribution of baby boxes also fails to consider the evolutionary context of normal  
95 nighttime infant behavior, reinforces cultural historical norms about nighttime mother-  
96 infant separation and artificial feeding, and may inadvertently undermine breastfeeding.  
97

98 Baby boxes promote a separate sleep surface, following longstanding guidelines from the  
99 American Academy of Pediatrics (AAP) against bedsharing, even though AAP experts  
100 are not necessarily endorsing the boxes (Cassin, 2017). In its most recent infant sleep  
101 guidelines from October 2016, the AAP continues to recommend separate sleep surfaces  
102 for all mothers and babies, including those who are breastfeeding (Task Force On Sudden  
103 Infant Death, 2016). The AAP guidelines are historically predicated on the assumption  
104 that the normative culture is one where infants sleep alone and are fed artificially. These  
105 assumptions are reflected in the fact that the AAP issues separate guidelines for  
106 breastfeeding and for infant sleep. The AAP has recently acknowledged that proximity to  
107 mother matters for health (Feldman-Winter et al., 2016, Task Force On Sudden Infant

108 Death, 2016), and that breastfeeding matters for health (American Academy of Pediatrics  
109 and Section on Breastfeeding, 2012), but they are each discussed only as risk reduction  
110 strategies in guidance on reducing childhood morbidity and mortality. If breastsleeping  
111 were treated as the norm, these guidelines would be integrated, and instead, we would be  
112 asking about the risks of separation from mother, not solely the risks of sleeping with  
113 one's infant. The AAP is considering mother-infant behavior in the context of only the  
114 last century or so of U.S. and Western European history, not in an evolutionary context  
115 where breastsleeping has been the norm and a survival strategy for not only humans but  
116 also primates and many other mammals. However despite a cultural revolution, maternal-  
117 infant biology that was forged in our evolutionary past has not altered in the most recent  
118 100 years.

119

120 Much of the attention on preventing sleep-associated infant deaths has focused on  
121 bedsharing, despite this being of debatable to no increased risk when other risk factors  
122 are absent (Bartick and Smith, 2014, Blair et al., 2014, Blabey and Gessner, 2009). The  
123 leading risk factors for sleep-associated sudden and unexpected infant deaths include  
124 parental smoking, sleeping prone, falling asleep with an infant on a sofa or recliner,  
125 sharing a bed with an adult who is under the influence of drugs or alcohol, and formula  
126 feeding (Bartick and Smith, 2014). If it is an independent risk factor at all, the risk of  
127 bedsharing is tiny in comparison to the above-mentioned risks (Bartick and Smith, 2014,  
128 National Institute of Health Care and Excellence, 2015). In an attempt to reduce Sudden  
129 Infant Death Syndrome (SIDS), the U.S. medical establishment has come down hard on  
130 bedsharing, with multiple public health campaigns aimed at discouraging the practice.



131 The “ABC” campaigns are especially popular: infants should sleep Alone, on their Back,  
132 in a Crib. Attention to the other risk factors is essentially neglected, even though they  
133 carry more substantial risks for infant death. In contrast, the latest UK guidance  
134 acknowledges that there is insufficient evidence to say that bed-sharing causes SIDS and  
135 offers information on the elimination of bed-sharing hazards, not of bed-sharing itself  
136 (Ball, 2017 (in press)).

137

138 The “Back to Sleep” campaign (to place babies in the supine position for sleep) has been  
139 associated with a reduction in sleep-related infant deaths, a decline that began even prior  
140 to the 1992 campaign (Pelligra et al., 2005). Yet it is important to note that sleeping  
141 prone is not in the behavioral repertoire of normal human breastsleeping infants  
142 (McKenna and Gettler, 2015, Richard et al., 1996), and this important recommendation  
143 arose out of the recent cultural context of solitary sleep and artificial feeding, in which  
144 infants were frequently placed prone alone in their cribs. In the only video study done  
145 comparing bedsharing formula feeding and breastfeeding infants, the formula feeding  
146 infants were more likely to have their heads placed level with their mother’s face, while  
147 the breastfeeding infant’s head was placed at breast-level, and the breastfeeding mothers  
148 spent more time turned towards their infants, who also faced their mothers, whereas the  
149 formula fed infants spent more time sleeping on their backs (Ball, 2006). Despite what  
150 appears to be potential risks for suffocation from pillows in this small study among the  
151 formula fed bedsharing infants, another recent study found that bedsharing (even with  
152 formula feeding infants included) was not associated with increased risk of death in the  
153 absence of other risk factors (alcohol, drugs, sofa-sleeping) (Blair et al., 2014). More

154 research is needed to know if the different bedsharing positioning contributes to any  
155 increased risk of SUID in formula feeding infants, and, if so, if bedsharing with formula  
156 feeding infants could be done in such a way that could minimize such risk.

157

158 In addition, because separate sleep can undermine breastfeeding, and baby boxes promote  
159 separate sleep, the boxes could hinder contact between breastfeeding mothers and infants  
160 and lead to early weaning. Research shows that bedsharing breastfeeding mothers nurse  
161 their infants 5.75 times during the night (often without realizing it), compared to 2.5  
162 times a night for moms and babies who do not share a bed (McKenna et al., 1997). This  
163 increased breastfeeding is especially important for mothers to maintain a robust milk  
164 supply (Hartmann et al., 1998) and remain anovulatory so that her children are widely  
165 spaced (Labbok et al., 1997). The perception of low milk supply is one of the most  
166 important reasons women give for stopping breastfeeding (Ball et al., 2016). Persuading  
167 mothers not to breastfeed through separate sleep and baby boxes may thus undermine  
168 milk supply, and result in difficulty attaining breastfeeding goals (Ball, 2003). Early  
169 weaning puts both the mother's and the infant's health at risk (Bartick et al., 2016,  
170 Chowdhury et al., 2015, Victora et al., 2016).

171

172 It is important to look at current infant sleep recommendations in their historical,  
173 physiological and cultural context. Human milk is digested very quickly, and the rapidly  
174 growing infant needs to eat every two to three hours (De Carvalho et al., 1983, Casiday et  
175 al., 2004). Such a feeding pattern would be difficult if the infant were not in constant  
176 contact with his breastfeeding mother, day and night. Indeed, ethnographic studies have

177 shown that in traditional cultures all over the world, mothers and babies are in prolonged  
178 contact, being carried by day, sleeping together at night, and nursing at will for the first  
179 several months (Barry and Paxson, 1971). After that, infants remain in contact with other  
180 caregivers. Even with the return to breastfeeding over the last few decades in the US and  
181 the growing emphasis on breastfeeding in the public health literature, we have often  
182 grown focused on how formula differs from the components of breast milk, and on the  
183 delivery of expressed milk. In doing so, we miss the connection that breastfeeding is  
184 about physical and emotional contact as much as it is about the milk itself.

185

186 Contrast the human physiologic pattern of frequent feeding with that of cows, the primary  
187 source of food upon which artificial feeding is based. On some farms, nursing calves are  
188 separated from their mothers and are routinely allowed to suckle only two or three times  
189 a day (Conneely et al., 2014, Bar-Peled et al., 1997, Alvarez-Rodriguez et al., 2009). The  
190 higher protein in the cows' milk allows these calves to grow normally while nursing far  
191 less frequently than a human infant would require. Having one-fourth the protein content  
192 of cows' milk (Hernell, 2011), human milk is digested very quickly, and the rapidly  
193 growing infant needs to eat every two to three hours, and will awaken to do so.

194 Differences in milk composition may be why we see that baby humans fed cows' milk  
195 products are less arousable from sleep than babies who nurse from their mothers  
196 (Tikotzky et al., 2010). This difference in arousal levels may partly explain the higher  
197 risk of Sudden Infant Death Syndrome in infants who are fed formula (Horne et al.,  
198 2004). The differences between breastmilk and the composition of cow's milk based

199 formula may also explain why parents of formula fed infants report more consolidated  
200 sleep (Ramamurthy et al., 2012).

201

202 Concerns about infant sleep, which were virtually absent in the 17<sup>th</sup> and 18<sup>th</sup> centuries,  
203 seem to have arisen as a result of the development of solitary infant sleep in the late 19<sup>th</sup>  
204 and especially the early 20<sup>th</sup> centuries as an ideal among certain middle class cultural  
205 groups, facilitated by medical experts (Stearns, Rowland and Giarnella 1996). Medical  
206 experts also played a crucial role in the normalization of scheduled artificial feeding,  
207 cemented by the growing number of mothers giving birth in hospitals and the industrial  
208 production and marketing of cows' milk based breast milk substitutes. In the 1917 edition  
209 of a popular manual (Holt, 1917) which became the basis of the Infant Care pamphlet  
210 distributed by the government to millions of parents, Dr. Emmett Holt recommended that  
211 babies sleep in nurseries separate from their mothers, and that they be fed only once or  
212 twice during the night through the first four months, and then once between four and  
213 seven months (Tomori, 2017 (in press)-b). Thereafter, they were not to be fed at all  
214 during the nighttime. If infants awoke during the night, and were not scheduled for a  
215 feeding, they were to "cry it out" for up to two to three hours. Experts like John Watson  
216 and Benjamin Spock further developed these ideas about "training" infant to sleep alone  
217 by "crying it out." As late as 1976, Dr. Benjamin Spock (first published in 1946) wrote  
218 that a healthy one-month old infant should be able to sleep through the night, and should  
219 be left to cry for up to half an hour if he woke; and as late as 1992, wrote about the  
220 "tyranny" of children who would not fall asleep when put down alone in the crib (Spock  
221 and Rothenberg, 1992). Dr. Richard Ferber further popularized sleep training starting in

222 1980, purposely leaving infants alone for progressively longer periods to “cry it out”  
223 (Ferber, 2006, Tomori, 2014).  
224  
225 “Crying it out” occurs in a context in which western parents have come to seeing crying  
226 infants as normal, in a society where infants are routinely separated from direct physical  
227 contact with their caregivers both at night and in daytime. Yet anyone who has spent time  
228 in the developing world, particularly Africa, where infants are carried and strollers are  
229 not a part of life, will have witnessed that it is rare to see a baby crying in public (Bleah  
230 and Ellett, 2010). Even in the US, as hospitals become Baby-Friendly and infants are kept  
231 in proximity and skin-to-skin, one of us (MB) frequently hears staff at many hospitals  
232 make remarks such as, “we never hear crying any more. Our unit is so much more quiet  
233 now.” Hospital staff frequently note that the unusual sound of baby crying on units that  
234 have eliminated maternal-infant separation will trigger their immediate concern, whereas  
235 before such crying was often disregarded and thought of as normal. Such observations  
236 illustrate the cultural context in which acceptability of crying and infant distress occurs  
237 where separation of mothers and infants is also considered normal; it is not until mothers  
238 and babies are routinely together that one realizes that crying appears unusual and people  
239 become more sensitized to the sound of a distressed, crying infant.  
240  
241 While “cry it out” is hotly contested among parents, various forms of “sleep training” and  
242 the emphasis on “self-soothing” and “sleeping through the night” remain prominent in  
243 parenting advice in 2017. SIDS is now added to the list of reasons why infants should not  
244 share a bed with their parents, and other reasons have taken more of a back seat. At the

245 same time, cultural worries also linger in many parents' discomfort with sharing a bed  
246 with their babies and their concerns about needing to get their babies to sleep through the  
247 night in their own room (Tomori, 2014). In the 2016 AAP guidelines, room-sharing has  
248 been emphasized as a risk reduction for SIDS, but even this recommendation has  
249 received some backlash (Fallon, 2016) in a context where "sleeping through the night" in  
250 the baby's own room is considered necessary to achieve "independence" (Tomori, 2014).

251

252 Finally, in addition to safety concerns about the need for separate sleep, most public  
253 health guidelines, including the AAP guidelines, ignore the role of poverty in sleep-  
254 related infant death. The risk of such death is higher in socioeconomically disadvantaged  
255 families in the UK, although they are less likely to share a bed with their infants (Blair et  
256 al., 2010). In the US, rates of SIDS are higher among black and Hispanic infants than in  
257 whites, groups who have lower income levels on average, and the higher SIDS rate that is  
258 partially explainable due to lower rates of any and exclusive breastfeeding in both groups  
259 after the post-partum period (Bartick et al., 2017).

260

261 Thus, given that breastsleeping is the evolutionary and cross-cultural norm, we must ask  
262 another fundamental question: What, if any, are the consequences of separating parents  
263 from infants? Does it harm children and/or parents when we assume that babies can and  
264 should sleep apart from their parents? Could a separate sleep surface cause other harms  
265 besides the undermining of breastfeeding? Could sleeping in a baby box cause harm just  
266 from mother-infant separation itself?

267

268 We know that separation from maternal skin-to-skin contact for even an hour can have  
269 profound physiological stress on two-day old infants (Morgan et al., 2011). Research in  
270 a small study of 4 to 10 month old infants also shows that after separation in a separate  
271 room for sleep, infant and maternal levels of the stress hormone cortisol are high and the  
272 mothers respond to the infant's cries and signs of distress. However after a few nights of  
273 separation for sleep, the infant cortisol levels remained high, indicating physiologic  
274 stress, even though they were no longer crying and appeared to "self-settle." In  
275 contrast, the mothers' cortisol levels decreased and were no longer correlated with those  
276 of their infants – reflecting that they were unaware of their infants' stress and were out of  
277 sync with them (Middlemiss et al., 2012). Prolonged childhood stress can create long  
278 term changes in brain architecture, and behaviors that could even be passed on to the next  
279 generation, in a phenomenon known as "toxic stress" (Shonkoff et al., 2012). We do not  
280 know if the stress caused by separation, such as that seen in newborns, would abate over  
281 time, or how much stress would need to occur in an infant to result in brain changes  
282 associated with "toxic stress." At the very least, we cannot assume that enforced separate  
283 sleep is without harm to the infant through the repeated stress of being separated from the  
284 only environment he has ever known and to which he is uniquely adapted. Finally,  
285 separation may also make it difficult for parents to address other potential threats. For  
286 instance, research shows anecdotal reports of parents saving their children from acute life  
287 threatening events that would have gone undiscovered had the children been sleeping  
288 alone (McKenna and Volpe, 2007).

289

290 In addition to safety concerns about bedsharing, modern questions have arisen around the  
291 values surrounding parenting that affect assumptions about sleep practices: Should the  
292 parents' needs be subsumed by those of their children? When we look cross-culturally,  
293 not every culture sees keeping the child in contact with the parent as a conflict.  
294 Breastsleeping does not inherently constitute a greater burden on parents, nor does it have  
295 to correspond with a parenting philosophy where mother's needs are subsumed to those  
296 of the child. Parents just get more rest (Doan et al., 2007, Montgomery-Downs et al.,  
297 2010), even though co-sleeping mothers may experience more sleep fragmentation  
298 (Volkovich et al., 2015). Many breastsleeping mothers are simply not aware of how many  
299 times they nursed their babies throughout the night, since they were not fully awake  
300 (Gottlieb, 2004, Morelli et al., 1992, Tomori, 2014). Bedsharing breastfeeding mothers  
301 spend more time in stage 1 and 2 sleep (lighter sleep) and less time in stage 3 and 4 sleep  
302 (deeper sleep) than solitary sleeping breastfeeding mothers (Mosko et al., 1997), which  
303 may facilitate responsiveness to the infant. When some babies awaken frequently to  
304 nurse, mothers may find it unpleasant, but do not perceive it as problematic (Gottlieb,  
305 2004, Tomori, 2017 (in press)-a). Mothers are also not usually left to care for their infants  
306 alone and to be completely responsible for all other tasks right after birth. There may be  
307 periods of mandated rest for the first 40 days or so and often there are others to help  
308 support mothers and care for infants and young children (Eberhard-Gran et al., 2017).  
309  
310 Breastfeeding helps mothers and infants both quickly fall asleep due to hormones  
311 released in the in the mother's brain (oxytocin) and hormones in the milk itself, yet both  
312 mother an baby are easily aroused, which is not the case if the pair are not breastfeeding



313 (Blyton et al., 2002, Horne et al., 2004). In breastsleeping dyads, their sleep cycles are  
314 synchronized, and the infants' airway is naturally protected from blankets and pillows by  
315 the infant's position with his head across from mother's breasts, her arm and shoulder  
316 forming a natural barricade from a potentially smothering pillow (Ball, 2006).

317

318 We see that breastsleeping is an elegant dance between mother and infant. Both mother  
319 and child benefit from the close physical contact and increased breastfeeding, physical  
320 warmth and emotional connection. This process, honed through millennia, cannot happen  
321 with a baby in a box. While it may seem like a simple, if costly, solution to give out baby  
322 boxes, we should not expect this to solve sleep-related infant mortality problems, when  
323 the key underlying problems are access to health care, poverty, and lack of support for  
324 breastfeeding, or for smoking and substance use cessation programs. Spending  
325 proportional resources on the most important risk factors for infant death, such as  
326 smoking, substance use, and formula feeding are likely to have greater impact than a feel-  
327 good solution like a box. If resources are diverted from these efforts to baby boxes, and if  
328 emphasis on sleeping in the boxes comes at the expense of breastfeeding, the boxes may  
329 have the potential to increase both maternal and child morbidity and mortality if they  
330 result in early weaning (Chowdhury et al., 2015, Victora et al., 2016, Bartick et al.,  
331 2016). Further, discouraging breastsleeping may have other developmental harms to the  
332 infant from stress that have not yet been studied.

333

334 Moving forward, our frame of reference in determining risk and public policy to manage  
335 risk must be normative human physiology, not an artificial intervention based on the

336 physiology of solitary sleeping infants being fed the milk of another species in a bottle.  
337 We should address how we can better support safe breastsleeping, and investigate the  
338 potential harms of disrupting breastsleeping and mother-infant separation. We should  
339 also develop advice specific for parents of formula feeding infants and support them in  
340 safely achieving closer human contact. Moreover, we need to be able to offer flexible  
341 guidance for families who combine breastfeeding and formula feeding and who are  
342 transitioning from breastfeeding to formula feeding. Finally, we must address the role of  
343 poverty and lack of paid family leave in supporting new parents and the roles these may  
344 play in infant and maternal mortality related to breastfeeding and sleep-related infant  
345 death. Instead of getting more babies into boxes, nighttime infant care guidance informed  
346 by evolutionary theory and cross-cultural practices should foster greater opportunities for  
347 safe connection for all infants and their families.

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