Crying as a trigger for abusive head trauma: a key to prevention

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Abstract The devastating and for the most part irremediable consequences for an infant, his or her family, and society in cases of abusive head trauma have spurred research into ways of preventing it. In the last four or five decades, increasing interest in infant crying and its clinical manifestation of colic has led to a reconceptualization of crying in early infancy, such that most of the characteristics of colic can be understood as manifestations of the crying typical of normal infants. This includes an early increase and then decrease in the amount of crying, the unexpected and unpredictable appearance of prolonged crying bouts, and the presence of inconsolable crying that occurs in the early months of life. When these concepts are merged with anecdotal clinical experiences, perpetrator confessions and epidemiological evidence of abusive head trauma, it is clear that these crying characteristics — and caregiver responses — are the predominant, and potentially modifiable, risk factors for abusive head trauma. This unfortunate but understandable relationship between early crying, shaking and abuse has opened windows of opportunity for primary, universal prevention efforts that are appropriate for — and support — all parents and may be able to prevent at least some of these tragic cases.

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Is there a key to prevention?

Not many clinical situations are more tragic than a 3-month-old on respiratory support in a pediatric intensive care unit whose neuroradiologic findings confirm significant brain destruction secondary to an episode of violent shaking by the infant's parents or caregivers [1]. This clinical condition, formally known as abusive head trauma and previously known as shaken baby syndrome [2], is among the most serious injuries it is possible to inflict on infants. The outcomes are devastating. Up to 80% of victims who survive have significant long-term morbidity in terms of brain injuries [3, 4], and 18–25% of victims die [5, 6]. The damage — as severe as it usually is — occurs not just to the infant, but to the infant's family and caregivers in terms of disrupted emotional and family lives. No one wins.

By the time the neuroradiology images are taken in these infants, it is too late to prevent the neurological compromises that ensue. And, to be clear, although prevention is always desirable, the track record of efforts to prevent all forms of child maltreatment has been limited, if not completely discouraging [7]. One of the reasons prevention is so difficult is the paucity of replicable, targetable and preventable risk factors associated with abusive head trauma. Not surprisingly, risk factors such as socioeconomic status, societal and family stresses, prematurity, multiple births, developmental delay, prior military service and a childhood history of abuse in the perpetrator have all been reported [6, 8–12]. However, none of these is easily amenable to modification or change. It is important to note that race and ethnicity are typically not risk factors [9, 13, 14]. However in the last few years two lines of research have converged to support the importance of normal infant crying as a major, and potentially modifiable, risk factor (or trigger) for abusive head trauma. More accurately, it is not the crying itself, but the caregiver response to the crying that is a major, and possibly modifiable, risk factor. This assumes, of
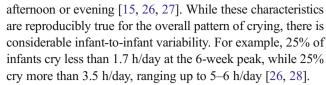
course, that education about normal infant crying could be a pathway to prevention of these tragedies.

The characteristics of normal crying

For most clinicians, crying usually comes to their attention as the complaint of colic, which is usually understood as an increase in, or excessive amount of, crying that is extremely distressing to the parents [15, 16]. Understandably, this often initiates a clinical evaluation for organic causes or diseases that have the potential for causing the excessive crying, under the assumption that the increased crying reflects something wrong or abnormal with the infant. However, most clinical series substantiate organic causes in less than 5% of cases, even from tertiary care referral centers [17, 18]. Until recently what has been missing from the clinical assessment has been an understanding of infant crying unrelated to disease. In recent years, this gap has been increasingly filled by phenomenological studies of otherwise well infants in nonclinical settings [15, 19, 20]. These studies have led to a reconceptualization of early increased crying (and colic) as being a typical manifestation of the development of normal infants. In the relatively rare instances (probably <1% in infants prior to referral to treatment centers) where organic disease is diagnosed, the condition can still be referred to appropriately as colic.

Convergent lines of evidence from many nonclinical studies have supported the description of six reproducible properties of crying in normal infants in the first few months of life. Unfortunately, one or all of these properties have the potential to increase caregiver frustration, anxiety and anger despite whether the crying is typical of healthy infants. First, overall crying per day (including fussing, crying and inconsolable crying) typically increases weekly, peaks in the 2nd month, and recedes to lower more stable levels by the 4th or 5th month. This pattern is now commonly referred to as the "normal peak pattern" or the "normal crying curve" [21]. Second, many if not most of the crying bouts are unexpected and unpredictable, unrelated to feeding or wet diapers and begin and end for no apparent reason. Given that all caregivers are seeking a reason for the crying, this feature can be very frustrating, no matter how caring and understanding the parent is. Third, a portion of the crying bouts (typically 5–10%) is resistant to soothing, or inconsolable [22, 23]. It is becoming increasingly clear that although all crying and fussing can be frustrating, the unsoothable crying bouts are especially so [24]. Fourth, the infant looks as if it is in pain, even when it is not [25]. Fifth, these crying bouts last longer than at any other time in the infant's life, and often average 40 min in duration, while individual bouts may go on for 1–2 h before stopping [23]. Finally, although these bouts may happen at any time of the day or night, they typically cluster in the late

afternoon or evening [15, 26, 27]. While these characteristics are reproducibly true for the overall pattern of crying, there is considerable infant-to-infant variability. For example, 25% of infants cry less than 1.7 h/day at the 6-week peak, while 25% cry more than 3.5 h/day, ranging up to 5–6 h/day [26, 28].

For clinicians reading this description, it is not difficult to understand how the clinical significance of these crying behaviors — in the absence of organic disease — is largely a function of how the caregiver perceives, and responds to, the crying. Although all crying can be frustrating, recent work has increasingly focused on the prolonged, hard-to-soothe, unpredictable and unexplained bouts that make caregivers feel helpless and guilty in the face of uncontrollable crying in their infant [22, 24]. These alarming inconsolable crying bouts are almost unique to the first few months of life [22, 23]. They are much more strongly associated with caregiver frustration than are the overall frequency or duration per day of crying or fussing [24]. Unfortunately, the evidence is robustly clear that these completely normal if frustrating characteristics of crying are exactly what contribute to the majority of cases of shaking and abusive head trauma in early infancy.

Crying as a trigger for abusive head trauma

To understand how crying can act as a trigger for abusive head trauma, it is important to appreciate that infant crying is an ambiguous signal. In a seminal early article, Kempe [29] astutely described a growing cascade of frustration and anger when crying is inconsolable:

"The baby cries and the mother feeds it, it cries more, the mother changes it, it still cries, and there comes that dreadful moment in every parent's life when love and desire to care for the child is mixed with incredible disappointments, anger, and even hate. It is surprising not that there are so many battered babies, but that there are so few."

Similarly, Murray [30] has argued that human infant crying is a nonspecific, graded signal. Because of this nonspecificity, caregivers do not know what the crying means. This provokes an ambivalent response: either an altruistic (helping the baby) response or an egoistic (helping the caregiver) response [30]. Even if the caregiver's initial response is altruistic, the response can be transposed into an egoistic one if the unresponsive crying continues, culminating in the worst cases in abuse.

At this point, the outcome may depend on the form of abuse that is inflicted. One of the very unfortunate results when the response is violent shaking (shaken baby syndrome) is that the infant becomes calm and stops crying. Alternatively, if the infant is thrown against the wall or punched in the stomach, the infant increases its crying. This particular feature of reduced crying in response to shaking has long been recognized but its clinical significance has probably been underappreciated. The fact that the infant calms down is likely to

increase the probability that shaking will be used again when the infant cries, because it was successful the first time. Traditionally, it has been assumed that shaken baby syndrome was a "one-off" event where parents or caregivers "lost it" and shook their infant. However, in a chilling article of 29 perpetrator confessions in France, Adamsbaum and her colleagues [31] reported that crying was described as the stimulus in 63% of the cases, shaking was repeated in 55% of the cases, repeat shaking ranged from 2–30 times (a mean of 10 times), shaking occurred daily for several weeks in 20% of the cases, and shaking was repeated because it stopped crying in all cases.

Because of potential guilt and legal consequences, perpetrator confessions are difficult to obtain, and when they are, they are subject to bias. To provide a more objective assessment of the likely importance of crying as a stimulus for abusive head trauma, we exploited the characteristic developmental timing of the normal crying curve (beginning at about 2 weeks, peaking in the 2nd month, declining thereafter [21]) as a means of obtaining indirect evidence that crying is an important stimulus. The hypothesis was that, if crying were an important stimulus for shaking/abusive head trauma, then the shape of the age-specific incidence curve for shaking/abusive head trauma should be similar to that of the normal crying curve. This was confirmed in two studies. In one in which we examined the discharge abstract databases from California hospitals [32], the age-specific incidence curve began to increase at 2–3 weeks, peaked at 10–13 weeks, and then declined steadily until 36 weeks of age. In another study based on the victim database collected by the National Center on Shaken Baby Syndrome in the United States using cases reported in public newspapers and judicial reports [33], an almost identical curve was generated. In addition, in the subgroup of cases in which the stimulus was specifically described as crying (data that were not available in the hospital discharge study), the shape of the curve was identical [33]. Perhaps not surprisingly, this typical asymmetrical age-specific incidence curve of abusive head trauma has been replicated four other times [34–37], and a similar asymmetrical age-specific curve has been shown to characterize hospitalizations for infant abusive fractures [38]. Together with the accumulating evidence from confessions, this is pretty compelling evidence of the importance of infant crying as a major risk factor for abusive head trauma, shaken baby syndrome and infant abuse generally.

Moving from risk factors to prevention methods

Prevention efforts require that one or more target risk factors are common and modifiable. The extant evidence that crying is a risk factor for abusive head trauma has experiential, prima facie validity as well as considerable perpetrator confession and epidemiological support. At least in principle, there are two pathways by which this risk factor can be addressed. One, were it possible, would be to change the pattern of or reduce the amount of crying. The second would be to reduce parental or caregiver responses to the crying that results in abuse or shaking of the crying infant.

Efforts to reduce crying can be partly effective. One of the more compelling illustrations of this is the comparison of direct behavioral observations of crying and fussing in samples of hunter–gatherer mother–infant dyads and Dutch mother-infant dyads [39, 40]. In !Kung San hunter–gatherer infants, caregivers do virtually everything that has been shown in experimental studies to be calming. As part of their normal caregiving, they maintain constant mother–infant contact, carry their infants constantly in a kaross (sling), breastfeed on average four times an hour, and respond within 10 s to virtually every fret and whimper [39, 40]. Despite all of these potentially calming behaviors, !Kung San infants have the same pattern of increasing and then decreasing crying as Western infants in the first few months of life [39]. This is fairly compelling evidence that this pattern of crying behavior would be very difficult to change. They also have the same frequency of crying and fretting episodes; however !Kung San infants do have about 50% less overall crying/fretting duration compared to Western infants [39]. This is mostly from decreased fretting duration rather than decreased crying or inconsolable crying.

This has not stopped entrepreneurs from recommending everything from various forms of formula to recorded heart sounds to specific caregiver behaviors as solutions to so-called colic or excessive crying. The evidence supporting such solutions is usually limited to ecstatic testaments from parents for whom it is claimed to work. This testamentary support far exceeds the rare or nonexistent randomized trials supporting their effectiveness. Furthermore, what evidence exists rarely takes account of the developmental age-related normal crying curve that results in infant crying improving once the peak for that infant has been passed. The popularity of such solutions speaks to the frustration and anger that caregivers can experience. However, the danger is that such promises raise unrealistic and potentially dangerous expectations. If the techniques that are supposed to be effective in all babies then fail in their baby, the frustration and anger and potentially the likelihood of abuse could increase rather than decrease.

An alternative pathway is to educate parents and caregivers about the typical developmental characteristics of crying in normal infants. This has the aims of (1) supporting caregivers in their understanding of the characteristics of crying in normal infants and (2) reducing the incidence of abusive head trauma and shaken baby syndrome. One of the advantages of educating parents about crying is that it is a topic about which new parents want to be educated, whereas many parents are reticent or even uninterested in being educated about the dangers of

shaking their infants because they believe that they themselves would never do that. Because of the increasing recognition of the importance of crying as a stimulus for shaking, organizations such as the American Academy of Pediatrics [41] and the Canadian Joint Statement on Shaken Baby Syndrome [42] recommend including education about crying in efforts at prevention. Indeed, a discussion about crying is common in almost all available prevention programs [43–46].

Evidence is emerging that education of parents can make a difference in preventing cases of abusive head trauma. In an important seminal report from upper New York state, Dias and colleagues [45] reported a 47% reduction in cases (from 41.5 cases per 100,000 births to 22.2 cases per 100,000 births) when comparing the incidence in the years pre- and post-implementation for a parent education program delivered during maternity hospitalization. This occurred despite there being no change in incidence in the comparison state of Pennsylvania during a similar time period. These results were supported by a small-scale replication using similar materials in lower New York state [47].

Capitalizing on the importance of crying as a stimulus, the National Center on Shaken Baby Syndrome (NCSBS) in the United States has developed a program that educates parents specifically about the typical features of normal infant crying, called the Period of PURPLE Crying © (www.dontshake.org/purplecrying) [48]. The program includes a 10-page booklet and a DVD that goes home with the parents. Two randomized controlled trials supported the program materials' effectiveness in producing changes in parental knowledge about features of typical crying as well as some behaviors (such as sharing information with other caregivers) relevant to prevention of shaken baby syndrome [43, 44]. The NCSBS program includes three so-called doses of prevention. Dose 1 is similar to the New York program in that it is delivered during the maternity stay but has the foci of educating parents specifically about crying as well as the dangers of shaking. It also provides the PURPLE materials to parents to take home to review when the infant cries and to share with other caregivers. Dose 2 is reinforcement of the message by other care providers pre- and post-maternity. Dose 3 is a public education campaign to reinforce the program among parents, nurses, relatives and other caregivers in society (see Click for Babies at www.clickforbabies.org).

Currently, jurisdiction-wide trials are coming to completion in North Carolina (Period of PURPLE Crying), Pennsylvania (Dias program) and British Columbia, Canada (Period of PURPLE Crying). However, evaluations of such large-scale programs are challenging. Because of the large year-to-year variability and relatively rare incidence rates, a big effect is required to satisfy criteria that any changes were not a result of chance [49]. This is compounded by the unpredicted recession that occurred during the trial years that appears to have been associated with increased rates of abusive head trauma-like admissions in some areas of the United States [50–52]. Nevertheless, many important lessons are being learned that will inform current and future public health prevention efforts.

Conclusion

For nearly four decades, shaken baby syndrome (now abusive head trauma) and infant crying and colic were studied on parallel but nonintersecting pathways. Two outcomes have shifted the importance of abusive head trauma and infant crying, resulting in a tighter and more interwoven relationship. First, studies of the phenomenology of infant crying outside of clinical settings has led to a reconceptualization of infant crying such that the characteristics of what is termed colic are now understood as manifestations of the crying typical of normal infants. Second, although it was recognized anecdotally and in small case series that crying could be a stimulus for abusive head trauma, the systematic importance of crying and parental responses to crying as a risk factor — and very importantly, a potentially modifiable risk factor — of infant shaking and abuse opened windows of opportunity for prevention. Although many of the common risk factors for abuse in general can also be risk factors for abusive head trauma from shaking, it is now clearer why abusive head trauma can occur with any infant-caregiver pair in the absence of abnormalities or other risk factors in the infant or the caregiver. These opportunities for prevention have shown some early signs of promise, although much more remains to be learned about the most effective way to prevent shaking and abusive head trauma. Meanwhile, parents receiving prevention programs are learning not to be as frustrated by infant crying and learning more about their infants and themselves as supportive, positive caregivers who can help to provide their infants with a good start in life.

Conflicts of interest   None

References

1. Tung GA (2010) Imaging of abusive head trauma. In: Jenny C (ed) Child abuse and neglect: diagnosis, treatment and evidence. Saunders, St. Louis, pp 371–389
2. Christian CW, Block R, Committee on Child Abuse and Neglect (2009) Abusive head trauma in infants and children. Pediatrics 123: 1409–1411
3. Ewing-Cobbs L, Kramer L, Prasad M et al (1998) Neuroimaging, physical, and developmental findings after inflicted and noninflicted traumatic brain injury in young children. Pediatrics 102:300–306

4. Bonnier C, Nassogne MC, Saint-Martin C et al (2003) Neuroimaging of intraparenchymal lesions predicts outcome in shaken baby syndrome. Pediatrics 112:808–814

5. King WJ, MacKay M, Sirnick A et al (2003) Shaken baby syndrome in Canada: clinical characteristics and outcomes of hospital cases. CMAJ 168:155–159

6. Keenan HT, Runyan DK, Marshall SW et al (2003) A population-based study of inflicted traumatic brain injury in young children. JAMA 290:621–626

7. Olds DL (2002) Prenatal and infancy home visiting by nurses: from randomized trials to community replication. Prev Sci 3:153–172

8. Ellingson KD, Leventhal JM, Weiss HB (2008) Using hospital discharge data to track inflicted traumatic brain injury. Am J Prev Med 34:S157–S162

9. Keenan HT (2011) Epidemiology of abusive head trauma. In: Jenny C (ed) Child abuse and neglect: diagnosis, treatment, and evidence. Saunders, St. Louis, pp 35–38

10. Minns RA, Jones PA, Mok JYQ (2008) Incidence and demography of non-accidental head injury in southeast Scotland from a national database. Am J Prev Med 34:S126–S133

11. Rentz ED, Marshall SW, Loomis D et al (2007) Effect of deployment on the occurrence of child maltreatment in military and nonmilitary families. Am J Epidemiol 165:1199–1206

12. Gillham B, Tanner G, Cheyne B et al (1998) Unemployment rates, single parent density, and indices of child poverty: their relationship to different categories of child abuse and neglect. Child Abuse Negl 22:79–90

13. Hymel KP, Deye K (2011) Abusive head trauma. In: Jenny C (ed) Child abuse and neglect: diagnosis, treatment and evidence. Saunders, St. Louis, pp 349–358

14. Sinal S, Petree A, Herman-Giddens M et al (2000) Is race or ethnicity a predictive factor in shaken baby syndrome? Child Abuse Negl 24:1241–1246

15. Barr RG (2000) Excessive crying. In: Sameroff AJ, Lewis M, Miller SM (eds) Handbook of developmental psychopathology, 2nd edn. Kluwer Academic/Plenum Press, New York, pp 327–350

16. Ghosh S, Barr RG (2004) Colic and gas. In: Walker WA, Goulet O, Kleinman RE et al (eds) Pediatric gastrointestinal disease, 4th edn. Decker Inc., Hamilton, Ontario, pp 210–224

17. Gormally SM, Barr RG (1997) Of clinical pies and clinical clues: proposal for a clinical approach to complaints of early crying and colic. Ambul Child Health 3:137–153

18. Freedman SB, Al-Harthy N, Thull-Freedman J (2009) The crying infant: diagnostic testing and frequency of serious underlying disease. Pediatrics 123:841–848

19. Barr RG (2012) Preventing abusive head trauma resulting from a failure of normal interaction between infants and their caregivers. Proc Natl Acad Sci U S A 109:17294–17301

20. Barr RG (2006) Crying behavior and its importance for psychosocial development in children. In: Tremblay RE, Barr RG, Peters RD (eds) Encyclopedia on early childhood development. Centre of Excellence for Early Childhood Development, Montreal, Quebec, pp 1–10

21. Barr RG (1990) The normal crying curve: what do we really know? Dev Med Child Neurol 32:356–362

22. St James-Roberts I, Conroy S, Wilsher K (1996) Bases for maternal perceptions of infant crying and colic behaviour. Arch Dis Child 75:375–384

23. Barr RG, Paterson J, MacMartin L et al (2005) Prolonged and unsoothable crying bouts in infants with and without colic. J Dev Behav Pediatr 26:14–23

24. Fujiwara T, Barr RG, Brant R et al (2011) Infant distress at 5 weeks of age and caregiver frustration. J Pediatr 159:425–430

25. White BP, Gunnar MR, Larson MC et al (2000) Behavioral and physiological responsivity, sleep, and patterns of daily cortisol production in infants with and without colic. Child Dev 71:862–877

26. Brazelton TB (1962) Crying in infancy. Pediatrics 29:579–588

27. Barr RG, McMullan SJ, Spiess H et al (1991) Carrying as colic 'therapy': a randomized controlled trial. Pediatrics 87:623–630

28. Hunziker UA, Barr RG (1986) Increased carrying reduces infant crying: a randomized controlled trial. Pediatrics 77:641–648

29. Kempe CH (1971) Paediatric implications of the battered baby syndrome. Arch Dis Child 46:28–37

30. Murray AD (1979) Infant crying as an elicitor of parental behavior: an examination of two models. Psychol Bull 86:191–215

31. Adamsbaum C, Grabar S, Mejean N et al (2010) Abusive head trauma: judicial admissions highlight violent and repetitive shaking. Pediatrics 126:546–555

32. Barr RG, Trent RB, Cross J (2006) Age-related incidence curve of hospitalized shaken baby syndrome cases: convergent evidence for crying as a trigger to shaking. Child Abuse Negl 30:7–16

33. Lee C, Barr RG, Catherine N et al (2007) Age-related incidence of publicly reported shaken baby syndrome cases: is crying a trigger for shaking? J Dev Behav Pediatr 28:288–293

34. Fujiwara T, Barr RG, Brant R et al (2012) Using international classification of diseases, 10th edition, codes to estimate abusive head trauma in children. Am J Prev Med 43:215–220

35. Talvik I, Alexander RC, Talvik T (2008) Shaken baby syndrome and a baby's cry. Acta Paediatr 97:782–785

36. Barlow KM, Minns RA (2000) Annual incidence of shaken impact syndrome in young children. Lancet 356:1571–1572

37. Leventhal JM, Martin KD, Asnes AG (2010) Fractures and traumatic brain injuries: abuse versus accidents in a U.S. database of hospitalized children. Pediatrics 126:104–115

38. Leventhal JM, Martin KD, Asnes AG (2008) Incidence of fractures attributable to abuse in young hospitalized children: results from analysis of a United States database. Pediatrics 122:599–604

39. Barr RG, Konner M, Bakeman R et al (1991) Crying in !Kung infants: a test of the cultural specificity hypothesis. Dev Med Child Neurol 33:601–610

40. Barr RG (1990) The early crying paradox: a modest proposal. Hum Nat 1:355–389

41. Committee on Child Abuse and Neglect of the American Academy of Pediatrics (2001) Shaken baby syndrome: rotational cranial injuries — technical report. Pediatrics 108:206–210

42. Canadian Association of Chiefs of Police, Canadian Institute of Child Health, Canadian Paediatric Society (2001) Joint statement on shaken baby syndrome. Paediatr Child Health 6:663–667

43. Barr RG, Rivara FP, Barr M et al (2009) Effectiveness of educational materials designed to change knowledge and behaviors regarding crying and shaken-baby syndrome in mothers of newborns: a randomized controlled trial. Pediatrics 123:972–980

44. Barr RG, Barr M, Fujiwara T et al (2009) Do educational materials change knowledge and behaviour about crying and shaken baby syndrome? A randomized controlled trial. CMAJ 180:727–733

45. Dias MS, Smith K, deGuehery K et al (2005) Preventing abusive head trauma among infants and young children: a hospital-based, parent education program. Pediatrics 115:470–477

46. Bechtel K, Le K, Martin KD et al (2011) Impact of an educational intervention on caregivers' beliefs about infant crying and knowledge of shaken baby syndrome. Acad Pediatr 11:481–486

47. Altman RL, Canter J, Patrick PA et al (2011) Parent education by maternity nurses and prevention of abusive head trauma. Pediatrics 128:1164–1172

48. Barr RG, National Center on Shaken Baby Syndrome (2004) Period of PURPLE crying® shaken baby syndrome prevention program. National Center on Shaken Baby Syndrome. Framingham, UT

49. Shanahan ME, Zolotor AJ, Parrish JW et al (2013) National, regional, and state abusive head trauma: application of the CDC algorithm. Pediatrics 132:1546–1553

50. Berger RP, Fromkin JB, Stutz H et al (2011) Abusive head trauma during a time of increased unemployment: a multicenter analysis. Pediatrics 128:637–643

51. Huang MI, O'Riordan MA, Fitzenrider E et al (2011) Increased incidence of nonaccidental head trauma in infants associated with the economic recession. J Neurosurg Pediatr 8:171–176

52. Wood JN, Medina SP, Feudtner C et al (2012) Local macroeconomic trends and hospital admissions for child abuse, 2000–2009. Pediatrics 130:358–364