

SECTION 3. MANAGEMENT OF CLINICAL PROBLEMS AND EMOTIONAL CARE

Colic and Crying Syndromes in Infants

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ABSTRACT. Colic or excessive crying is one of the most frequent problems presented to pediatricians by new parents. Organic disease accounts for <5% of infants presenting with colic syndrome. Colic may be best viewed as a clinical manifestation of normal emotional development, in which an infant has diminished capacity to regulate crying duration. *Pediatrics* 1998;102:1282–1286; *colic, crying syndromes, excessive crying, regulators of crying, reactivity, regulation, transient responsiveness, sucrose.*

Of all infant behavior, crying is perhaps the one most familiar to clinicians. Colic, or excessive crying, is one of the most frequent complaints brought to physicians in the infant's first 3 months.¹ It is associated with maternal anxiety and emotional lability;² it often causes premature weaning because mothers think that crying is attributable to insufficient milk^{3,4}; it can be the presenting complaint of almost any disease in infants; and it rarely, but too often, triggers abuse or even death in infants.⁵

There are four clinical "crying" syndromes in the first year of life:

- colic
- persistent mother–infant distress syndrome
- the temperamentally "difficult" infant
- the dysregulated infant

These four syndromes are challenging to clinicians for at least two reasons. They are all difficult to define, manage, and treat. There also is surprisingly little guidance in the literature about how they may be related to each other.

For researchers studying emotional development, crying also is a central behavior. However, it must be clearly understood that there is a difference between infant emotions (or emotionality) and crying behavior. That is to say we are concerned with the overt, observable behavior of crying rather than with the inferred negative emotion for which crying may be the overt expression.

To help bridge the gap between infant emotional research and clinical practice, I propose the following. In general, the crying syndromes most clinicians deal with are best understood as clinical manifestations of normal emotional development rather than

of organic pathophysiologic processes. Better understanding of these syndromes will come from both clinical and child development researchers. Clinical research can provide careful, systematic, and controlled descriptions of the clinical syndromes; normative child development research can provide empiric support for the reasons why babies cry.

The following article presents these themes with available evidence from clinical, developmental, cross-cultural, and experimental studies regarding the syndrome of colic. Although this may not complete the job of making the transition from the probable knowledge of groups of infants to the complete and certain knowledge of individual infants in the clinical context, it may at least allow us to take the first steps across the bridge.

CLINICAL CRYING SYNDROMES

Colic is defined by excessive crying. Although there are many hypotheses, there is no established etiology (or set of etiologies) for this syndrome.⁵ It is usually characterized by the following features.

- Timing—It typically begins at approximately 2 weeks of age and resolves by 4 months. Within the day, crying is concentrated in the late afternoon and evening hours.
- Associated behaviors—The bouts of crying are prolonged and unsoothable, even by feeding. The infant usually is described as having clenched fists, legs flexed over its abdomen, arching back, flushing, a hard distended abdomen, regurgitation, passing of gas, and an active, grimacing, or "pain" face.
- Paroxysmal crying—The word paroxysmal usually describes unpredictability or apparent spontaneity of the crying bouts, unrelated to events in the environment, including soothing attempts by the parents.

Persistent mother–infant distress syndrome refers to a clinical situation in which infants present after the early crying peak at 2 months and show no decrement in the amount of crying.^{6–8} The infants and families typically have a number of additional at-risk characteristics. The infants often have disturbances in feeding and/or sleeping, mild developmental delay, and organic risk factors. The parents may have significant psychosocial risk factors, prenatal emotional distress, maternal psychopathology, and postnatal parental conflicts. Although the exact

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pathogenesis is unknown, Papousek and colleagues propose that the combination of significant parental, infant, and familial risk factors serves to disrupt the normal interactive and co-regulatory behaviors of infants and caregivers (intuitive parenting).

Temperamentally difficult infants refer to one of a number of possible individual differences, characterized by a predisposition to negative affect, poor adaptability, greater intensity of reactions, and unpredictability. Strictly speaking, it does not represent a clinical classification, but rather a normal variant of early development. It is presumed to capture behavioral differences that are primarily constitutional or biological in origin, present early in life, and relatively stable across time and situations, although expressed differently at different developmental stages.^{9,10}

Dysregulated infants are those with disturbances in many behavioral domains (affect, feeding, motor activity, and attention), presumably secondary to some central regulatory dysfunction. Clinically, they present in the second half of the first year of life with fussiness, irritability, poor self-calming, intolerance to change, and a hyperalert arousal.¹¹ The presumed regulatory deficit includes hypo- and hypersensitivity to sensory stimuli in any channel and possibly an atypical vagal system responsiveness.¹² In the Zero to Three Diagnostic Classification,¹³ there are four sub-categories of this descriptive clinical syndrome: 1) hypersensitive, 2) underreactive, 3) motorically disorganized-impulsive, and 4) processing-behavior undefined.

COLIC AS A CLINICAL MANIFESTATION OF NORMAL EMOTIONAL DEVELOPMENT

For understandable reasons, clinicians and parents alike have tended to see colic (excessive crying in the first 3 months of life) as a distinct behavioral syndrome, probably indicating something wrong with the infant, the caregiver, or the infant-caregiver interaction. After all, when crying continues to increase despite the best mothering one can provide, when crying bouts continue despite every soothing technique one can think of, and when the infant looks for all the world like it is in pain, it is reasonable to think something is wrong or abnormal. The impression that colic is a distinct behavioral syndrome, rather than a manifestation of normal development, may be because the most extreme cases are seen in clinical settings, so that any continuity with normative crying behavior is unlikely to be observed. Also, crying can be the presenting complaint of virtually any organic disease process, thus, organic disease will sometimes be found that "explains" the colic syndrome.

However, a number of recent lines of evidence have contributed to a reinterpretation of the behavioral syndrome of colic. This literature is growing rapidly and has been reviewed recently.¹⁴⁻¹⁸ Only a few examples of each type of evidence will be used here for purposes of illustration.

Organic Disease

The first line of evidence is that organic diseases are likely to account for <5% of cases of infants presenting with colic syndrome. In a recent review of the literature over the past 30 years, Gormally and Barr reported that the number of disease entities documented to have caused colic syndrome was fewer than expected; in those diseases that can present as colic syndrome, the prevalence of organic disease as a cause was low; evidence for organic disease was not often very strong or well-documented.¹⁵ Table 1 lists the organic diseases thought to cause colic syndrome and their judgment of the strength of the evidence supporting it.

Although Table 1 is based on the best available current evidence, it is possible that the incidence and causes of colic are more numerous than reported. Also, the rarity of organic causes does not make detection of organic disease unimportant. Indeed, it illustrates the difficulty faced by clinicians in identifying infants who have an organic etiology from those who do not.

Normal Crying Behavior

Most and perhaps all of the defining clinical manifestations of colic syndrome also are characteristic of the crying behavior of normal infants. For example, the colic crying pattern (late afternoon and evening onset, peak crying at 2 months) also is characteristic of crying behavior in normal infants. The importance of this was actually anticipated by Morris Wessel and colleagues in the 1950s,¹⁹ when they wrote that "... the time distribution and frequency of diurnal regularity are similar for the mild fussy periods of the 'contented babies,' and for the more prolonged periods of the 'fussy infants.'" Subsequently, Brazelton documented this early peak crying pattern in 80 healthy infants from his clinical practice in Massachusetts.²⁰ The same result was confirmed approximately 25 years later in a Montreal study in healthy infants.²¹ Indeed, most studies with sufficient sample sizes have found a similar pattern.²²

Cross-cultural and Premature Studies

!Kung San hunter-gatherers' caregiving practices differ considerably from our own Western industrialized child care practices. These include constant carrying, direct body contact, upright positioning,

TABLE 1. Organic Etiologies for Colic Syndrome Classified According to Strength of Evidence That It is Causal of Colic Syndrome

Strong	Moderate	Weak
Cow's milk protein intolerance	Reflux esophagitis	Lactose intolerance
Isolated fructose intolerance	Infant abuse	Glaucoma
Fluoxetine hydrochloride		Central nervous system abnormalities (Chiari type I malformation)
Infantile migraine		Urinary tract infection

“continuous” feeding (4 times per hour for 1 to 2 minutes per feed), and contingent responsiveness. Compared with Western babies, !Kung San infants cried half as long, but the frequency and the 2-month peak were similar.²³ Other studies have contributed convergent evidence for the normality of the early increased crying in the first 3 months.^{24–26} In a cohort of relatively healthy preterm infants born an average of 8 weeks early, the increase in crying tended to occur at 6 weeks corrected age. This also was true for the evening clustering. Furthermore, the timing of the peak was unrelated to a variety of postnatal medical complications, implying that the timing of this pattern was quite resilient to postnatal experience altogether.²⁷ Similar results have been reported in another study of preterm infants from Ireland.²⁸

Colic Crying Is Hard to Stop

Compared with normal infants, the crying of infants with colic is relatively difficult to stop once it is started. In a controlled study of infant crying characteristics, those with colic cried longer than other infants, but surprisingly had the same frequency of crying bouts. In short, what was different was the length of the crying bouts; it wasn't that they cried, but rather that when they cried, they did not stop.²⁹

This dissociation between frequency and bout length has been observed in normal infants. Among the !Kung San, the crying frequency was the same, but the crying duration was about half that observed in separated Western-style caregiving.²³ This frequency–duration dissociation also was apparent in a randomized controlled trial of increased carrying and holding.²¹ When these Western mothers held their infants 3 hours per day, they cried ~43% less, but the frequency of crying bouts remained the same. This leads to the not unreasonable hypothesis that infants with colic may cry longer because caregiving maneuvers are not especially effective in helping them regulate their crying. Alternately, they may be receiving less caregiving than they need, or a combination of both.

Hidden Regulators

Evidence from a number of experimental studies suggests that within normal caregiving maneuvers, there exist a variety of “hidden regulators” of infant crying behavior. These regulatory principles can operate through at least two pathways, the contact pathway and the nutrient pathway. In everyday life, these pathways often are intertwined. Thus, when an infant is fed, both contact and nutrient pathways are being accessed. It also is apparent that they will be accessed more frequently in a !Kung San-style caregiving context than in a Western-style, more separated, context.

Increased contact can be powerful in regulating crying behavior. However, recent evidence suggests that nutrient pathways also are impressively effective. Following the lead of Elliott Blass and colleagues, we have been examining the effectiveness of sucrose tastes in calming crying infants. In our model, infants are observed before or after feeding until they cry for 15 consecutive seconds. Then a

sucrose taste stimulus (24% or 50%) is provided to the anterior midline of the tongue, and the infant is observed for up to 5 minutes. In newborn infants, the effect is impressive. Crying infants that receive 250 μ L of 24% sucrose solution once stop crying within 10 seconds. Furthermore, relative to a water taste, this reduction in crying is significant for 5 minutes or more.³⁰ Interestingly, the sucrose effect is still present, but much weaker at 6 weeks of age, the time of peak crying.³⁰ In summary, both contact and nutrient pathways are likely to be important in regulating crying once it is started.

Access to Regulation

Infants with colic (those who cry like normal infants, but once started, continue crying longer) may be different in the extent to which these regulatory processes are accessed or are able to be accessed. Stated another way, normal regulatory processes inherent in caregiving activity are less effective in them. Two studies are particularly relevant in this regard. The first is a randomized, controlled trial of increased carrying as a treatment for infant colic.³¹ The design was similar to that of the carrying study with healthy infants,²¹ except that mothers were asked to increase their carrying time by 50%. Despite the increased carrying time in the experimental group, there was no difference from the control group in the amount of crying after treatment started. This suggests that caregiving contact that is an effective crying regulator in normal infants is not as effective in infants with already established colic.

This also may be true for calming systems accessed by nutrient pathways. We compared the responsiveness of crying infants with and without colic to sucrose tastes.³² Because sucrose tastes are less effective in 6-week-old infants than in newborns, we provided three 250- μ L tastes of 50% sucrose 30 seconds apart in already crying infants. Interestingly, the immediate (first minute) response to sucrose was similar for infants with and without colic, but the calming response continued to be relatively effective for up to 4 minutes after the taste in infants without colic, whereas it was almost completely gone after the first 2 minutes in infants with colic. This suggests that infants with and without colic are equally reactive to sucrose taste, but that it is less effective in regulating the crying state in infants with colic.³³ These studies suggest that infants with colic may differ in regard to the ease with which caregiving can access these regulatory processes.

COLIC IN TERMS OF EMOTION REGULATION AND TEMPERAMENT

Findings from the study of emotional development are likely to be important to understand better clinical crying syndromes. Given that these syndromes are described in terms of emotionally salient behaviors, it is surprising that more convergent research has not been performed previously.

Three important themes in the field of temperament and emotional regulation are responsiveness, reactivity, and regulation.^{34–36} Responsivity is a term usually used as a superordinate category that refers

to three conceptually distinguishable response properties (Table 2). Behaviorally, humans can differ on type and/or dynamics of response. In infants, type of response usually refers to whether the response is positive (smiling) or negative (crying). Dynamics refers to the quality, intensity, and timing characteristics of the response. It includes reactivity, as reflected in threshold, intensity, and time of onset; and regulation (or inhibition) as reflected in duration or rate of recovery of response. One of the helpful features of these concepts is that they can be applied to different levels of description (eg, behavior and physiology) of individual responsiveness, even though these different levels may not always act in association with each other.

Together these concepts can be used to describe the transient responsivity hypothesis of colic syndrome. In this model, infants with colic syndrome will manifest increased responsivity (increased reactivity and/or decreased regulation) compared with infants without colic, but this responsivity will be transient (present at 2 months but absent by 5 months).

Investigating colic syndrome in this way is potentially interesting and valuable for a number of reasons. First, it permits the use of measures already available in the temperament and emotional regulation literature to investigate the clinical syndrome. Second, this hypothesis differs from the traditional temperament hypothesis that holds that colic is an early manifestation of a stable temperamental predisposition. (The traditional model would predict that infants with colic will show increased responsivity both at 2 and 5 months.) Third, stating the hypotheses in these terms permits us to look independently at both behaviorally and physiologically responsive systems relevant to emotion regulation and temperament. Previous research has been limited by the fact that the mother is reporting both the manifestations of the clinical syndrome and the ratings of temperament. In the case of colic and the "difficult" infant especially, this results in an obvious confound, because crying behavior is defining for both. Fourth, using these concepts permits us to make even more specific predictions on the basis of previous clinical findings that then can be subject to empiric verification or rejection.

As an example, we have suggested that infants with colic are not just generally more responsive, rather that they are normally reactive, but have diminished regulatory capacity. For example, controlled clinical observation has shown that what differentiates the crying of infants with colic from those without colic is not that they cry, but that they cry longer; that is, the frequency of crying bouts is the same, but the bout lengths are longer.²⁹ Another important observation was the infant's response to

sucrose. The initial quieting response to sucrose represents a reactivity to the presence of the stimulus in the mouth, whereas the duration of the response represents access to a central distress regulation system mediated by endogenous opioid release.³³ These data support the model that infants with colic differ from those without in regard to physiologic regulation, but not in regard to reactivity.

These concepts may be valuable as a way of testing whether or not the four clinical crying syndromes of the first year of life are, or are not, related to each other. On the basis of available clinical descriptions it may be possible to classify crying syndromes in terms of responsivity concepts (reactivity and regulation). These are represented in the Table. For example, we have characterized infants with colic as normally reactive, but poorly regulated. Temperamentally "difficult" infants would likely have increased reactivity AND difficulty with regulation.

Further specification of the hypotheses can be undertaken if one adds developmental stage of the infant as well. For example, if the transient responsivity hypothesis for colic syndrome holds, then infants with colic will be characterized by normal reactivity and decreased regulation early, but normal reactivity and normal regulation later. By contrast, infants with difficult temperament would have increased reactivity and decreased regulation both early and later. Infants with regulatory disorders, at least in terms of currently described criteria, would have normal reactivity and regulation early, and increased reactivity and decreased regulation later.

CONCLUSIONS

In sum, I have argued that increasingly systematic, careful, and controlled studies of clinical phenomenology are critically important for providing constraints that guide hypothesis testing concerning underlying processes that help to explain these clinical syndromes. In the case of colic, such work has led to a reinterpretation of the syndrome from behavior that primarily reflects distinct pathological (usually gastroenterologically mediated) processes to behavior that primarily reflects normal behavioral (probably central nervous system-mediated) development, except that there is more of it. By bringing core concepts from the study of emotional development to bear on this (and other) clinical crying syndromes, we can generate relatively specific predictions that are subject to empirical test. In so doing, we may be able to dispel some of the "mystery" that is associated with these clinical syndromes, to the benefit both of harried parents and harried clinicians whose calling and responsibility it is both to diagnose and, hopefully, to treat.

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TABLE 2. The Concept of Responsivity

Type: positive (smiling) or negative (crying) response
Dynamics: quality, intensity, timing of the response
Reactivity: threshold, intensity, time of onset
Regulation (or inhibition): duration, rate of recovery

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