Early identification of infants at risk for problems in neurobehavior and development is an ongoing challenge in pediatric care. Detection of subtle differences in the nursery is challenged by the transient nature of many neurobehavioral signs and by short lengths of stay which limit the ability of pediatricians to perform serial assessments. Most efforts at formal developmental screening in the medical home begin at the 9-month visit, when variations in the progression of motor skills can be reliably detected. Since early intervention optimizes outcomes, the current practice of postponing formal screens until the 9-month visit could result in missed opportunities for developmental support.

**INFANT ASSESSMENT TOOLS**

The tools traditionally available for pediatricians’ screening in early infancy are known to be poor predictors of long-term developmental outcome. The recent Neonatal Intensive Care Unit (NICU) Network Neurobehavioral Scale (NNNS) detects subtle characteristics of infants at risk during their first month, and may reliably predict preschool-age outcomes. The NNNS uses Brazelton’s Neonatal Behavioral Assessment Scale (NBAS) as a foundation, thus, habituation, orientation, motor and reflex items are included, and items are administered according to the infant’s states of arousal. Within this framework, additional NNNS assessment items tap the capacity of high-risk infants to cope with stress and challenge, including preterm infants and those with neonatal abstinence. In a sample of 1248 one-month old infants, NNNS Summary Scores were used to derive five discrete behavioral profiles which related, not only with pre-existing factors like birthweight, gestational age (GA), and prenatal drug exposure status, but also with abnormal cranial ultrasounds and neurologic findings. More remarkably, these summary scores were found to be associated with atypical behavioral, school readiness, language and IQ scores through 4 ½ years of age. The five profiles represent a range of performance, from well-regulated infants who are not easily stressed, to disorganized, excitable infants with poor quality of movement. Infants in Profile 1 (n=276; 22.1%) scored well on focused attention, self-regulation, and quality of movement, required minimal handling to obtain these results, and were not easily stressed. Profile 2 infants (n=409; 32.8%) also had high quality of movement, but otherwise typical scores. Profile 3 infants (n=217 17.4%) required more handling to maintain attention, had higher arousal and excitability and were more easily stressed with handling. Profile 4 (n=274; 22.0%) had average attention and regulatory abilities, but had poor quality of movement, poor tone, and atypical reflexes. Finally, Profile 5 (n=72; 5.8%) had the most atypical scores, with lowest attention, self-regulation and quality of movement, high tone, highest percentage of atypical reflexes, and the most stress signs. Profile 5 infants also had more externalizing behavior at age 3, more conceptual and language problems at age 4 and lower IQ at 4.5 years. In combination, the infants in Profiles 4 and 5 were more likely to have such medical risk factors as: abnormal head ultrasound reading, chronic neurological abnormalities, disease with risks to the brain and diagnosis of cerebral palsy (CP), even when controlling for the influence of GA and socioeconomic status (SES). It is unlikely that the primary care physician would overlook or miss the need for close developmental follow up with risk factors such as GA. However, the NNNS also identified infants with neurobehavioral risks whose medical histories were noncontributory. Traditionally these infants would have a much higher probability of having these less obvious risk factors realized, representing missed opportunities for identification.

A recent study demonstrated that when pediatricians relied on their “developmental impression” (PDI) of an infant at 12 and 24 month office visits, they identified only 9.5% of preterm and 5.6% of term infants who went on to qualify for early intervention services on the basis of developmental and/or behavioral disorders. This rate increased to 31% of preterm and 12.9% of term infants when a combination of PDI and a parent-report developmental questionnaire were utilized. These findings raise the questions:

1) If those same infants were evaluated during their first month using a more sensitive instrument, might they begin intervention in their first year, with greater potential for successful outcome?
2) If so, what form might this early supportive intervention take, and what is the evidence that intervention so early in infancy is beneficial?

Early developmental support emphasizes “goodness of fit” between the infant, the caregiver and the environment, and identification of elements of protection such as maternal education, maternal sensitivity and social support, as well as sources of risk. The goals of intervention with the infant are to optimize comfort, feeding, and sleep, conserve energy for growth and development, foster infant responsivity, and promote engagement with the environment. When the “fit” between infant needs (or even preferences) and caregiving style is enhanced, routines become mutually pleasurable. Thus, strategies for intervention include engaging the infant and parent in positive interactions that have the potential to improve developmental and behavioral outcomes.

**INFANT INTERVENTIONS**

One such strategy is nurturing touch. Early touch exerts an essential, profoundly positive influence on infant adaptation and maternal well-being. Skin-to-skin holding, also termed kangaroo care (KC), maintains thermal and physiologic regulation, enhances sleep, reduces reactivity to painful procedures such as heel-lance, and conserves energy.
for growth and healing, not only for term infants, but for low birth weight (LBW) infants who require ventilatory support. In a randomized controlled trial (RCT) of preterm infants, KC during hospitalization was associated with higher cognitive and motor scores on the Bayley Scales of Infant Development. Additionally, KC for term and preterm infants can increase a mother’s feeling of well-being, enhance maternal attachment with her infant, increase production of breastmilk, and offer a greater likelihood that breastfeeding will continue beyond the newborn period (which is also associated with higher IQ scores). Thus, mothers are encouraged to hold their babies skin-to-skin as early as possible after delivery and frequently during early infancy. Another touch-related intervention that has demonstrated value in early infancy is containment or “facilitated tucking”, which has been shown through randomized trials to be a non-pharmacological intervention for procedural pain. Pediatricians often encounter reluctance on the part of the parent to assist in holding their infant during blood draws, IV placement and injections. However, evidence in the pain literature supports parent participation as a comforting influence, particularly when a parent is holding the infant.

Infant massage entails moderate touch pressure and slow, rhythmic stroking of the extremities, chest, abdomen, back and face. Parents are instructed not only in the technique, but to be mindful of the infant’s behavioral and physiologic responses, and to modify their approach according to their infant’s tolerance and preferences. For infants who are highly reactive or fragile, massage is incorporated gradually into their care. RCT’s with preterm infants have shown that the proprioceptive input, and range of motion inherent in infant massage have direct benefits for preterm infant bone mineralization. Moreover, massage has indirect effects in supporting infant weight gain, presumably by promoting sleep, digestion and appetite.

In general term infants are thought to sleep better and to have less irritability when massage is part of their care routine; however, on systematic review, only weak evidence supports these claims. Additionally, study is needed before infant massage can be widely recommended as a complementary intervention for infants with colic and fussiness. However, one could theorize that an intervention that provides moderate proprioceptive and tactile input in accordance with the infant’s cues of receptivity would have the potential to promote overall relaxation and should be beneficial for any irritable infant, including infants with Neonatal Abstinence Syndrome (NAS). In a randomized clinical trial (N=73), Lee and McNamara studied the effects of developmental intervention (DI) with and without infant massage (M), administered by occupational therapists, on the dosing schedule for withdrawal of methadone-exposed infants. They hypothesized that infant massage could promote relaxation, as well as overall neurobehavioral organization. For withdrawal symptoms, infants were treated initially with the standard pharmacologic intervention regimen of morphine with added phenobarbital. Once the patient’s symptoms were captured the patients were randomized to receive either the research intervention of M plus DI or DI alone. Care providers were blinded to the interventions, which occurred in a secluded room for about 35 minutes once a day, 5 times a week. Weaning of morphine was carried out according to NAS scores. There were differences in outcomes between preterm and full term infants. Massage shortened the length of stay (LOS) for 35-36 week preterm infants (22±9 vs.30±17 days, P=0.003) but LOS did not differ with the addition of M among full term infants. All infants were tested at the same intervals with the NNNS. On the NNNS, massage improved attention for preterm and full term infants while DI alone did not.

The evidence is stronger for positive effects of infant massage on the interaction between infant and parent. Benefits of infant massage for new mothers include lower rates of depression and anxiety, and greater sensitivity as caregivers. Engagement in nurturing touch practices such as KC and infant massage can result in an infant-caregiver dyad that is more comfortable with giving and receiving touch, and with face-to-face interaction. Through these experiences, which parents often perceive as intensely pleasurable, caregivers may become more attuned to communicative facial expressions and behavioral cues of the infant – a powerful element in healthy attachment, and in social-emotional and language development.

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**CHANGING TRENDS IN DEVELOPMENTAL SUPPORT IN RI**

During the hospital stay, maternal history often drives referrals for developmental intervention. Consistent with a traditional definition of risk, infants of mothers with high risk pregnancies, difficult deliveries, or prenatal substance abuse may be referred for in-hospital developmental assessment and support. These families also are more likely to be referred to early intervention at discharge. Increasingly, though, it is the infant’s neurobehavioral presentation that drives the referral process. Infants for whom the range of states of arousal are limited, who are difficult to console, or appear tremulous or disorganized in their behavioral presentation are now more likely than before to be referred for additional neurobehavioral assessment and intervention. Among these are infants born to the increasing numbers of women taking selective serotonin reuptake inhibitors (SSRIs) who present with variations in sleep architecture and neurobehavioral performance, increasing the potential for developmental sequelae. This trend in referral reflects a shift in our local understanding of development in RI, representing a lower threshold for differences in newborn behavior and development, and a broader definition of risk.

The Newborn Nurseries and NICU at Women & Infants Hospital (WHI) has used the NNNS since its inception in
1992. Initially the NNNS was used as a research instrument, but increasingly it is being utilized for the clinical assessment of newborns with a variety of presenting problems, including atypical feeding and/or disorganized behavior. As a clinical tool, the NNNS can be used to discern aspects of infant performance that may reflect current vulnerabilities and needs. Like its predecessor, the NBAS, the NNNS is best administered with the parent(s) to highlight strengths as well as areas of concern. Parents are drawn into a discussion of modifications that they can make in the amount or type of stimulation during routine care to optimize the infant’s comfort and responsiveness.

Current trends in infant referral for assessment also reflect an expanded view of what constitutes protection in the life of the child. For some parents, the transition to parenthood is laden with anxiety. These parents may appear detached, ambivalent, hyper-vigilant or depressed. During the NNNS assessment and subsequent touch-based interventions, efforts are made to help anxious parents recognize when their infant is responding positively to their approaches, or when the infant’s behavior is communicating distress. When an infant’s presentation is typical, the opportunity to see the range of competencies their infant possesses can be reassuring. Strategies for utilizing the infant’s strengths to foster overall behavioral organization can be offered. This type of anticipatory guidance helps parents, especially first-time parents, to have more realistic expectations of their infants’ behavior, and to derive mutual pleasure through early interaction with their infant.

Alternatively the NNNS assessment may reveal subtle signs and symptoms that can contribute to discovery of previously unrecognized risk factors; even prenatal substance exposure. During NNNS assessment, mothers are able to observe vulnerabilities of their infants, such as excessive startling, tremors or inconsolability. Mothers may become aware, for the first time, of the effects on their infant of medications or substances used during pregnancy. Once cognizant of these effects, it has been our observation that these mothers are sometimes more receptive to guidance in interacting with their infant, including instruction in providing nurturing touch in a way that is mutually rewarding, and has the potential to strengthen early relationships.

When parents understand their infant’s unique style of responding to the world, they are more likely to provide care that is sensitive to the infant’s needs. Thus at WIH, the newborn developmental assessment, in and of itself, is being used as one of the earliest supportive interventions for infants at risk. Combined with early engagement in touch-based interaction, as a complementary, low cost treatment, these interventions have the potential to take at-risk dyads toward successful outcomes.

References