

Early identification of motor delay

Family-centred screening tool

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Abstract

Objective To describe the Harris Infant Neuromotor Test (HINT), an infant neuromotor test using Canadian norms published in 2010 that could be used to screen for motor delay during the first year of life.

Quality of evidence Extensive research has been published on the intrarater, interrater, and test-retest reliability and the content, concurrent, predictive, and known-groups validity of the HINT, as well as on the sensitivity, specificity, and positive and negative predictive values of parental concerns, as assessed by the HINT. Most evidence is level II.

Main message Diagnosing motor delays during the first year of life is important because these often indicate more generalized developmental delays or specific disabilities, such as cerebral palsy. Parental concerns about their children's motor development are strongly predictive of subsequent diagnoses involving motor delay.

EDITOR'S KEY POINTS

- The Canadian Task Force on Preventive Health Care recommends against screening for developmental delay in children aged 1 to 4 years with no apparent signs of developmental delay, whose parents and clinicians have no concerns about development.
- The Harris Infant Neuromotor Test (HINT) is a reliable and valid norm-referenced screening tool for identifying infants with motor delays during the first year of life. The HINT is the only infant motor screening test that enables input from parents as to their concerns about their infant's movement and play.
- Parental concerns about their children's motor development are strongly predictive of subsequent diagnoses involving motor delay, and research has shown that motor delay can be identified in the first year of life. Clinicians might find the HINT useful for early identification and intervention.



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This article has been peer reviewed.
Can Fam Physician 2016;62:629-32

La traduction en français de cet article se trouve à www.cfp.ca dans la table des matières du numéro d'août 2016 à la page e429.

Conclusion Only through early identification of developmental motor delays, initially with screening tools such as the HINT, is it possible to provide referrals for early intervention that could benefit both the infant and the family.

In 2013, the Neuromotor Screening Expert Panel of the American Academy of Pediatrics (AAP) published a clinical report on early identification and evaluation of young children with motor delays, including algorithms for surveillance and screening.¹ In letters to the editor following its publication, experts in the field of developmental screening raised concerns about limitations of the report.^{2,3} As the author of one letter noted, the clinical report failed to include developmental screening tools that had been published subsequent to the AAP's 2006 policy statement on developmental screening and surveillance, noting that "higher-quality references on which screening tools to select were missing in action."²

The Canadian Task Force on Preventive Health Care (CTFPHC) recently released recommendations against screening for developmental delay in early childhood (1 to 4 years of age) among children with no apparent signs of developmental delay, whose parents and clinicians have no concerns about development.^{4,5} The objective of this article is to describe a neuromotor screening tool (published after 2006) that would be appropriate to screen for developmental motor delay and key neurologic signs at well-child visits during the first year of life. This review describes the Harris Infant Neuromotor Test (HINT), which is the only such test to incorporate parental concerns, with reference to the recommendations highlighted in the AAP clinical report on early identification of motor delays¹ as well as to the CTFPHC protocol and guideline on screening for developmental delay in early childhood.^{4,5} Not only does the HINT include motor milestone items but also many of the items incorporated into the neurologic

examination recommended in the AAP clinical report¹: assessment of muscle tone and strength through observation of quality and quantity of antigravity movements; joint flexibility; asymmetry; eye movements; and the asymmetric tonic neck reflex.⁶

Quality of evidence

Research has been published on the reliability and validity of the HINT, as well as on the sensitivity, specificity, and positive and negative predictive values of parental concerns, as assessed by the HINT. Most evidence is level II.

Main message

Because Canadian family physicians have identified screening for developmental delay as a topic of interest⁴ and because the AAP has highlighted the importance of early identification of motor delays (in particular) during well-child visits,¹ the aim of this article is to provide readers with information about the HINT—a neuromotor screening test using Canadian norms that provides a critical first step in identifying developmental motor delays. Diagnosing motor delays during the first year of life is especially important because they are often indicative of more generalized developmental delays^{1,7} or specific disabilities, such as cerebral palsy (CP)⁷ and autism spectrum disorder.⁷⁻⁹

The HINT has the added advantage of including head circumference as one of its items—an important and noninvasive correlate of brain size¹⁰ and a measurement that has gained worldwide attention with the increased rate of microcephaly associated with the Zika virus.¹¹

Finally, the HINT is the only infant neuromotor screening test that incorporates questions about parent concerns within the assessment. In a level II epidemiologic study of parents of 273 young children referred to a rehabilitation clinic for evaluation of possible developmental delay, concerns about their children's motor development strongly predicted subsequent diagnoses involving motor delay, including CP and developmental coordination disorder: sensitivity of 83%; specificity of 86%; positive predictive value of 88%; and negative predictive value of 80%.¹²

Description of the HINT. Published in 2010, the HINT comprises 2 sections: a 5-item questionnaire asking parents about any concerns that they (or others) have about their infant's movement and play and 22 items administered by a health care provider.⁶ Because the AAP clinical report suggested that "it is essential to ask parents broad, open-ended questions" about their concerns about motor delay and movement,¹ the HINT provides an ideal opportunity to incorporate this component into the examination and, consequently, to support and value parents' impressions or concerns about their

infants. This practice also dovetails with the Rourke Baby Record, which recommends parents be asked if they have any concerns about their child's development (as part of developmental surveillance).¹³

The items administered by the health professional encompass many elements outlined in the AAP report that are essential for both screening and neurologic examination.¹ Other HINT items include measurement of head circumference, passive range of motion in prone and supine positions, visual following, resting posture of hands and feet, and presence of stereotypical behaviour.⁶

The cost of the HINT manual is \$36.00 (US); a packet of 50 score sheets is an additional \$60.00 (US).⁶

Age range, normative data, and scoring. Because it covers an age range of 2.5 to 12.5 months (and provides a mechanism for calculating corrected age for infants born at less than 37 weeks' gestation), the HINT is appropriate for screening and neurologic examination at well-child visits during the first year of life. For infants 7 months of age or older, administration and scoring of the HINT can be completed in 15 minutes; for younger infants, administration time is about 25 minutes.⁶ Whether a 15- to 25-minute assessment can feasibly be included within a typical well-child visit is open to debate,⁴ but early identification and intervention could benefit infants and their families.

The CTFPHC recommendation applies to children aged 1 to 4 because the working group believed, as the CTFPHC protocol on developmental delay states, that "infants younger than 1 year are unlikely to be assessed for developmental delay."⁴ Both the author's clinical experience and research evidence strongly support that developmental delay (especially motor delay) *can* be identified during the first year of life in low- as well as high-risk infants.¹⁴

Total HINT scores are based on normative data for 412 Canadian infants, enabling the examiner to determine if the infant's motor performance is within normal limits, immature or suspect (>1 SD and ≤2 SD above the mean), or significantly delayed or atypical (>2 SD above the mean).⁶ Higher total HINT scores equate to greater risk or less mature motor performance.

There is also an opportunity on the score sheet for the examiner to record an overall clinical impression about the infant's quality of movement (ie, normal, suspect, or abnormal). Based on the examiner's decisions about developmentally appropriate behaviour or developmental delay (from the SDs derived from the normative data) and the overall quality of movement from their clinical impressions, 4 possible actions can then be taken ranging from no further action needed to referral for early intervention services, including a comprehensive standardized assessment (**Figure 1**).⁶ This menu of possible actions supports the recommendation of

Figure 1. Overall clinical impressions based on total Harris Infant Neuromotor Test scores and possible actions to take based on infant performance

Overall clinical impressions (check one in each column)	
<input type="checkbox"/> Developmentally appropriate	<input type="checkbox"/> Qualitatively normal
<input type="checkbox"/> Immature or slightly delayed (> 1 SD and ≤ 2 SD above the mean)	<input type="checkbox"/> Qualitatively suspect (some concerning behaviour but infant might outgrow this)
<input type="checkbox"/> Significantly delayed (> 2 SD above the mean)	<input type="checkbox"/> Qualitatively abnormal
Action taken (check one)	
<input type="checkbox"/> None (infant's performance is developmentally appropriate and qualitatively normal)	
<input type="checkbox"/> Refer for follow-up screening in ____ weeks (for infants who are immature, slightly delayed, or qualitatively suspect)	
<input type="checkbox"/> Refer for comprehensive standardized assessment (eg, Bayley Scales of Infant Development III or Peabody Developmental Motor Scales-2)	
<input type="checkbox"/> Refer for early intervention services (to include comprehensive standardized assessment)	
Reproduced from Harris et al with permission. ⁶	

the AAP Neuromotor Screening Expert Panel to include a “time-definite follow-up plan” once screening has been completed.¹

Administration of the HINT. Any medical, nursing, or allied health professional with a background in infant development can administer the HINT. The test can take place in an office or in the infant's home. The only equipment required is a brightly coloured ring with an attached string, a picture book with black-and-white contrasting pictures, disposable paper tape measures, and head-circumference-for-age charts.⁶

Reliability and validity of the HINT. Considerable research has been published on the intrarater, interrater, and test-retest reliability¹⁵ and the content, concurrent, predictive, and known-groups validity of the HINT,¹⁶⁻¹⁸ as well as on the sensitivity, specificity, and positive and negative predictive values of parental concerns,¹⁹ all of which is summarized in the HINT manual.⁶ In a level II epidemiologic study that appeared subsequent to the manual's publication, involving longitudinal follow-up of both typical (n=58) and at-risk (n=86) infants, the predictive validity of the HINT at 10 to 12.5 months (the age closest to the AAP's recommended 9-month well-child assessment¹) relative to the Bayley Scales of Infant Development II Motor Scale²⁰ at 2 years of age (for children shown to have significant delay at age 2 years) was sensitivity of 100%; specificity of 95.8%; positive predictive value of 25%; and negative predictive value of

100%.²¹ The authors cautioned, however, that the high rates of sensitivity and specificity were owing in part to the low prevalence (1.4 per 100), ie, only 2 infants showed significant motor delays at age 2 years.²¹ This type of classification-accuracy study (ie, sensitivity, specificity, and positive and negative predictive values) was recommended by the CTFPHC protocol on screening for developmental delay as a key approach in evaluating screening tests.⁴

The correlation coefficients²¹ for the predictive validity of the 10- to 12.5-month total HINT score were $r=-0.55$ for the Bayley II Motor Scale score at 2 years of age and $r=-0.58$ for the Bayley III Gross Motor Scale score at 3 years of age.²²

Comparison of HINT norms to other samples. In a study comparing a sample of 64 American infants to age- and sex-matched infants from the HINT normative data, there were no significant differences in total HINT scores between the Canadian and US samples or between white and non-white US ethnic groups.²³ In another study of 335 Canadian infants of Asian or European origin, there were no significant differences in total HINT scores between the 2 groups.²⁴ These results support the use of the HINT in both the United States and Canada and among infants of different ethnic origins.^{23,24}

Validity of the HINT as a family-centred screening test. Although the AAP Neuromotor Screening Expert Panel failed to suggest the HINT (or any other tests published since 2006) as a possible screening test,¹ the panel did cite the earliest HINT study published (before the test's standardization)¹⁹ in support of parents' reliability in reporting on their infants' motor development and the fact that early diagnosis might reduce family stress and uncertainties. That acknowledgment supports the family-centredness of the HINT and dovetails nicely with the recommendation by Marks, author of one of the letters to the editor expressing concerns about the AAP report, that the algorithms presented in that report should be revised to be more parent- and patient-centred.²

Marks also suggested that the 2 developmental screening tools cited in the AAP clinical report (the Ages and Stages Questionnaire [ASQ]²⁵ and the Parents' Evaluation of Developmental Status²⁶) “work better in combination with a proper neuromotor examination.”² Because the HINT and the ASQ have been shown to have strong concurrent validity ($r=-0.83$),²³ it makes logical sense to have the parent or primary caregiver complete the ASQ in advance of the well-child visit and then have the health professional administer the HINT at the actual office visit if any parental concerns are noted on the ASQ.

Referral for early intervention services. As the authors of the AAP clinical report correctly noted, motor delays

can represent “the first or most obvious sign of a global developmental disorder.”¹ Recent retrospective and prospective cohort studies (level II evidence) have shown that motor delays during infancy are associated with later diagnoses of CP,⁷ autism spectrum disorder,⁷⁻⁹ developmental coordination disorder,⁷ and intellectual delays.⁷

The earlier such developmental disabilities are identified, the sooner these infants can be referred for early intervention services. One of the key questions included in the CTFPHC protocol on screening for developmental delay in early childhood was “What is the effectiveness of treatment for children diagnosed with developmental delay to improve outcomes?”⁴ The CTFPHC working group found some evidence suggesting that treatment of certain types of identified developmental delay is beneficial.²⁷ A recent systematic review also examined the effects of enriched environments on motor outcomes in infants with (or at risk of) CP.²⁸ Enriched environments were defined as interventions designed to enrich at least 1 aspect (motor, cognitive, sensory, or social) of the infant’s environment with the goal of enhancing learning. Based on a meta-analysis of the studies included, a “very small but favorable benefit” was found for improving the motor outcomes of infants with or at risk of CP.²⁸

Conclusion

The AAP clinical report on early identification and evaluation of motor delays¹ was extremely beneficial in raising awareness of the importance of screening for motor delays during infancy and early childhood.¹³ Only through early identification of such delays is referral for early intervention possible. Previous research on the HINT, as well as the items it shares with those components recommended in the AAP report to comprise part of the neuromotor examination (eg, muscle tone, joint flexibility, eye movements), suggest that it would be an appropriate screening test for infants at well-child visits during the first year of life. As the only infant neuromotor screening tool that includes parents’ impressions and concerns about their infants’ movement and play, the HINT highlights the importance of family-centred assessment.

Because the CTFPHC recommendation on screening for developmental delay in early childhood excludes children younger than 1 year of age,⁴ it is hoped that this article might prompt reconsideration of that decision. 🌿

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Competing interests

As lead author of the Harris Infant Neuromotor Test, **Dr Harris** receives royalties for the sale of the test manual.

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References

1. Noritz GH, Murphy NA; Neuromotor Screening Expert Panel. Motor delays: early identification and evaluation. *Pediatrics* 2013;131(6):e2016-27.

2. Marks KP. My concerns about the AAP clinical report on “Motor delays: early identification and evaluation.” *Pediatrics* 2013;132(5):e1449-50.
3. Glascoe FP, Squires JK. Quality developmental screenings are essential to quality surveillance. *Pediatrics* 2013;132(5):e1450.
4. Dunfield L, Mitra D, Tonelli M, Fitzpatrick-Lewis D, Rice M. *Protocol: screening and treatment for developmental delay in early childhood (v 2.0)*. Calgary, AB: Canadian Task Force on Preventive Health Care; 2014. Available from: <http://canadiantaskforce.ca/ctfphc-guidelines/2015-developmental-delay/protocol>. Accessed 2015 Dec 21.
5. Canadian Task Force on Preventive Health Care. *Screening for developmental delay in children aged 1 to 4 years*. Calgary, AB: Canadian Task Force on Preventive Health Care; 2016. Available from: <http://canadiantaskforce.ca/ctfphc-guidelines/2015-developmental-delay>. Accessed 2016 Jun 28.
6. Harris SR, Megens AM, Daniels LE. *Harris Infant Neuromotor Test (HINT). Test user’s manual version 1.0. Clinical edition*. Chicago, IL: Infant Motor Performance Scales; 2010. Available from: http://thetimp.com/store/large/382h6/TIMP_Products/HINT_Test_Manual.html. Accessed 2016 Jun 29.
7. Hatakenaka Y, Kotani H, Yasumitsu-Lovell K, Suzuki K, Fernell E, Gillberg C. Infant motor delay and early symptomatic syndromes eliciting neurodevelopmental clinical examinations in Japan. *Pediatr Neurol* 2016;54:55-63.
8. Arabameri E, Sotoodeh MS. Early developmental delay in children with autism: a study from a developing country. *Infant Behav Dev* 2015;39:118-23. Epub 2015 Mar 28.
9. Flanagan JE, Landa R, Bhat A, Bauman M. Head lag in infants at risk for autism: a preliminary study. *Am J Occup Ther* 2012;66(5):577-85.
10. Harris SR. Measuring infant head circumference. Update on infant microcephaly. *Can Fam Physician* 2015;61:680-4.
11. Petersen LR, Jamieson DJ, Powers AM, Honein MA. Zika virus. *N Engl J Med* 2016;374(16):1552-63. Epub 2016 Mar 30.
12. Chung CY, Liu WY, Chang CJ, Chen CL, Tang SF, Wong AM. The relationship between parental concerns and final diagnosis in children with developmental delay. *J Child Neurol* 2011;26(4):413-9. Epub 2010 Oct 15.
13. Riverin B, Li P, Rourke L, Leduc D, Rourke J. Rourke Baby Record. Evidence-based tool for the health of infants from birth to age 5. *Can Fam Physician* 2015;61:949-55 (Eng), e491-9 (Fr).
14. Harris SR. A plea for developmental motor screening in Canadian infants. *Paediatr Child Health (Oxford)* 2016;21(3):129-30.
15. Harris SR, Daniels LE. Reliability and validity of the Harris Infant Neuromotor Test. *J Pediatr* 2001;139(2):249-53.
16. Harris SR, Daniels LE. Content validity of the Harris Infant Neuromotor Test. *Phys Ther* 1996;76(7):727-37.
17. Megens AM, Harris SR, Backman CL, Hayes VA. Known groups validity of the Harris Infant Neuromotor Test. *Phys Ther* 2007;87(2):164-9. Epub 2007 Jan 9.
18. Tse L, Mayson TA, Leo S, Lee LL, Harris SR, Hayes VE, et al. Concurrent validity of the Harris Infant Neuromotor Test and the Alberta Infant Motor Scale. *J Pediatr Nurs* 2008;23(1):28-36.
19. Harris SR. Parents’ and caregivers’ perceptions of their children’s development. *Dev Med Child Neurol* 1994;36(10):918-23.
20. Bayley N. *Bayley Scales of Infant Development*. 2nd ed. San Antonio, TX: Psychological Corporation; 1993.
21. Harris SR, Backman CL, Mayson TA. Comparative predictive validity of the Alberta Infant Motor Scale and the Harris Infant Neuromotor Test. *Dev Med Child Neurol* 2010;52(5):462-7. Epub 2009 Oct 26.
22. Bayley N. *Bayley Scales of Infant Development*. 3rd ed. San Antonio, TX: Psychological Corporation; 2006.
23. Westcott McCoy S, Bowman A, Smith-Blockley J, Sanders K, Megens AM, Harris SR. The Harris Infant Neuromotor Test (HINT): comparison of US and Canadian normative data and examination of concurrent validity with the Ages and Stages Questionnaire. *Phys Ther* 2009;89(2):173-80. Epub 2009 Jan 8.
24. Mayson TA, Harris SR, Backman CL, Hayes VE. Motor development in Canadian infants of Asian and European ethnic origins. *J Early Interv* 2009;31:199-214.
25. Squires J, Potter L, Bricker D. *The ASQ user’s guide for the Ages & Stages Questionnaires®: a parent-completed, child monitoring system*. 2nd ed. Baltimore, MD: Paul H. Brookes Publishing Co; 1999.
26. Glascoe FP. *Parents’ Evaluation of Developmental Status (PEDS): collaborating with parents*. 2nd ed. Nolensville, TN: PEDSTest.com; 2013.
27. Canadian Task Force on Preventive Health Care. Recommendations on screening for developmental delay. *CMAJ* 2016;188(8):579-87.
28. Morgan C, Novak I, Badawi N. Enriched environments and motor outcomes in cerebral palsy: systematic review and meta-analysis. *Pediatrics* 2013;132(3):e735-46. Epub 2013 Aug 19.