LETTER TO THE EDITOR

The Hammersmith Infant Neurological Exam Scoring Aid supports early detection for infants with high probability of cerebral palsy

EDITOR—Earlier detection of cerebral palsy (CP) facilitates earlier intervention to optimize a child's development.[1] An international clinical practice guideline on early detection of CP[1] identified the Hammersmith Infant Neurological Exam (HINE) as a key tool for use in clinics that follow children after neonatal intensive care admissions or see children under 2 years of age in neurodevelopmental clinics. Evidence for the role of the HINE is growing, including two articles in this issue of *Developmental Medicine & Child Neurology*. Tian et al. demonstrate the HINE's ability to predict gross motor delays and follow the child's neurological status in the first year of life.[2] Romeo et al. have developed and validated a short version of the HINE called the Brief-HINE as a screening tool to identify which infants require a full HINE.[3] The HINE is generally used for infants between 3 to 24 months of age. It has 26 items, each scored from 0 to 3 with a maximum score of 78.[4] HINE scores vary based on chronological, gestational age, and neurological performance of the infant. This differential scoring creates a barrier to implementation of the HINE as clinicians must pull information from different articles or rely on memory to interpret scores. We have developed a HINE Scoring Aid (Figure 1) compiling published HINE scoring information including expected global and CP cut-off scores, to aid clinicians in efficient interpretation of HINE scores in clinics.

The HINE Scoring Aid consolidates information across numerous studies into a concise one-page tool, streamlining the interpretation of important data for clinicians. The aid provides expected global scores (median/ranges) for infants born at term[4] and infants born preterm[5] of various gestational ages with typical 2-year development. Tenth percentile scores (optimality scores), equal to or above which infants are considered to have typical neurological performance[4, 5] are provided where available. Typically developing infants born preterm have median global scores that are lower than typically developing infants born at term ranging from 9 points lower at 3 months to 3.5 points lower at 12 months.[5] CP cut-off scores are also provided and represent global scores below which infants born at term and infants born preterm with etiological factors for CP (e.g. preterm, neonatal encephalopathy) have a high probability of developing CP. We highlight the use of HINE asymmetry scores to identify infants with unilateral CP who may not have low global scores. A recommendation is made to refer for early intervention if global scores are below the CP cut-off scores or if greater than four asymmetries are present. A graph visually displays the 10th percentile and high probability CP cut-off scores from 3 to 18 months of age, which facilitates following the trajectory of HINE scores over time for an individual child.

To evaluate the usefulness of the HINE Scoring Aid, it was distributed to a Canadian Neonatal Follow-Up Early Detection of Cerebral Palsy Community of Practice (CoP). This CoP consisted of 24 neonatologists, developmental pediatricians, and occupational and physical therapists from 12 neonatal follow-up clinics, who aimed to integrate the HINE into their clinics. Clinicians provided iterative feedback on the scoring aid through surveys and guided discussions. Suggestions focused on the use of neutral language (e.g. high probability rather than high risk), highlighting differences in HINE scores between infants born preterm and infants born at term, and including neuroimaging and General Movement Assessment[1] results where available. All clinicians in the CoP reported the scoring aid was helpful in integrating the HINE into their clinical practice.

Clinicians in neonatal and neurodevelopmental follow-up clinics must consider numerous factors when performing the HINE; the HINE Scoring Aid aims to facilitate the interpretation of the HINE to support earlier detection and intervention referrals for children with CP in the clinic setting.

This letter to the editor is in response to the original articles by Romeo et al. and Tian et al. on pages 1173–1180 and 1181–1189 of this issue.

D Fehlings, A Makino, P. Church, R Banihani, K Thomas, M Luther, S Lam-Damji, B Vollmer, L Haataja, FM Cowan, DM Romeo, JM George, S Kumar, L Switzer (May 2024)

Name:_____
MRN:_____
Date of Birth:_____

Hammersmith Infant Neurological Examination (HINE): Score Interpretation Aid for Children Receiving Neonatal Follow-Up Care

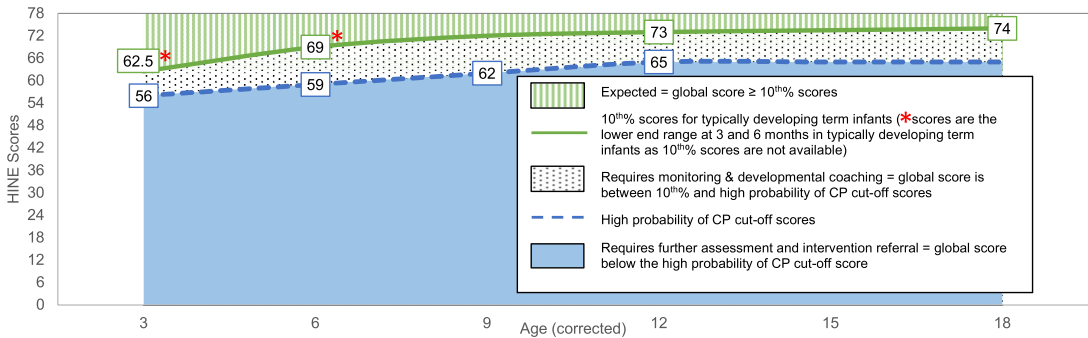Clinical history: _____

Brain imaging (if available): _____

Visit	Child's Age (corrected)	Child's Global HINE Score	HINE Asymmetry Score	Corrected Age for GMA (if available)	GMA Category (if available)	Interpretation/Action	Discussed with family
1							☐
2							☐
3							☐
4							☐
5							☐

HINE Scoring Aid Reference Information:

- Interpret HINE scores with clinical reasoning (e.g., term versus preterm, risk factors for CP, health co-morbidities, brain imaging, and General Movements Assessment (GMA)) when comparing to those from typically developing term infants. Follow the trajectory of HINE scores over time.
- The table provides expected global scores (median/ranges) for term[1,2] (column 2) and preterm infants[3,4] of various gestational ages (column 3,4) with typical 2-year development. 10th percentile scores (optimality scores) (equal to or above) which infants are considered to have typical neurological performance[1,4] is provided where available (column 2,4).
- Typically developing preterm infants have median global scores that range from 9 points at 3 months to 3.5 points at 12 months lower than typically developing term-born infants (column 3,4)[3,4]. There is also a wider range of scores around the median in preterms.
- CP cut-off scores (column 5) are global scores below which term and preterm infants with etiologic risk for CP (e.g., preterm, neonatal encephalopathy) have a high probability of developing CP[5]. Refer for early intervention.
- Infants with unilateral CP may not have low global scores but can have ≥4 asymmetries representing significant asymmetric neurologic performance[6]. Refer for early intervention if ≥4 asymmetries are present regardless of infant's age.

Column 1	Column 2 Global scores for typically developing term born infants[1,2]	Column 3 Global scores for low-risk LPT and VPT infants[3]	Column 4 Global scores for low-risk EPT infants[4]	Column 5 Cut-off scores for high probability of CP[5]
Child's Age (corrected)	37-42 weeks GA Median (range)	mean GA 32 weeks (range 27-36) Median (range)	mean GA 27 weeks (range 23-31) Median (range)	All birth gestational ages but definitive data not available for EPT infants
3 months	**67** (62.5*-69)[2]	**62** (51-69)[3]	**58** (47-69) (10th% 53)[4]	**≤56** (sen 96% sp 85%)[5]
6 months	**73** (69*-76.5)[2]	**66** (52-72)[3]	**67** (54-76) (10th% 62)[4]	**≤59** (sen 90% sp 89%)[5]
9 months	*N/A*	**70.5** (57-76)[3]	**71.5** (62-78) (10th% 67)[4]	**≤62** (sen 90% sp 91%)[5]
12 months	**76** (63-78) (10th% ≥73)[1]	**72.5** (60-77)[3]	**73.5** (67-78) (10th% 70)[4]	**≤65** (sen 91% sp 90%)[5]
18 months	**78** (71-78) (10th% ≥74)[1]	*N/A*	*N/A*	*N/A*
	10th percentile scores (10th%): 90% of infants score at or above this level. * See legend in graph below.	Data for LPT and VPT infants are combined – medians are similar, but the range span is narrower for LPT than VPT	Note median scores are considerably lower for EPT infants than FT, LPT and VPT infants at 3 months.	A global score <40 at any age is highly predictive of CP GMFCS III-V at 2 years of age[7].

N/A not available, Low-risk - no additional CP etiologic risk aside from being preterm[3,4],LPT Late preterm 33-36 weeks gestational age (GA), VPT very preterm 27-32 weeks GA, EPT extremely preterm (23 -31 weeks GA) as defined in this study[4], sen (sensitivity), sp (specificity)

Graph axis: HINE Scores (0–78) vs Age (corrected) 3–18. Data points: 56, 62.5*, 59, 62, 69*, 65, 73, 74.

Legend:
- Expected = global score ≥ 10th% scores
- 10th% scores for typically developing term infants (*scores are the lower end range at 3 and 6 months in typically developing term infants as 10th% scores are not available)
- Requires monitoring & developmental coaching = global score is between 10th% and high probability of CP cut-off scores
- High probability of CP cut-off scores
- Requires further assessment and intervention referral = global score below the high probability of CP cut-off score

[1] Haataja L, et al. Optimality score for the neurologic examination of the infant at 12 and 18 months of age. J Pediatr. 1999 doi: 10.1016/s0022-3476(99)70016-8. PMID: 10431108.
[2] Haataja L, et al. Application of a scorable neurologic examination in healthy term infants aged 3 to 8 months. J Pediatr. 2003 doi: 10.1067/S0022-3476(03)00393-7. PMID: 14603891.
[3] Romeo DM, et al. Early psychomotor development of low-risk preterm infants: Influence of gestational age and gender. Eur J Paediatr Neurol. 2016 doi: 10.1016/j.ejpn.2016.04.011. PMID: 27142353.
[4] Romeo DM, et al. 4Hammersmith Infant Neurological Examination in low-risk infants born very preterm: a longitudinal prospective study. Dev Med Child Neurol. 2022 doi: 10.1111/dmcn.15201. PMID: 35298030.
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[6] Pietruszewski L, et al. HINE Clinical Use to Recommend Therapist Assessment of Functional Hand Asymmetries. Pediatr Phys Ther 2021 doi: 10.1097/PEP.0000000000000822. PMID: 34417428
[7] Novak I, et al. Early, Accurate Diagnosis and Early Intervention in Cerebral Palsy: Advances in Diagnosis and Treatment. JAMA Pediatr. 2017 Sep 1;171(9):897-907. doi: 10.1001/jamapediatrics.2017.1689. PMID: 28715518;

FIGURE 1 Hammersmith Infant Neurological Examination (HINE): Score Interpretation Aid for Children Receiving Neonatal Follow-Up Care.

DATA AVAILABILITY STATEMENT
Data sharing not applicable - no new data generated, or the article describes entirely theoretical research.

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