EDITORIAL



"STEP", an early developmental screening tool that predicts oneyear outcomes

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Certain perinatal complications, such as moderate-to-severe hypoxic–ischemic encephalopathy (HIE) [1] and extreme prematurity (EP) [2], are associated with a more than 50-fold increase in the risk of cerebral palsy, as compared to the risk among infants born at term without complications. EP is associated also with a less severe form of motor impairment, developmental coordination disorder [3], and with an increased risk of cognitive [4, 5] and related [6–8] impairments.

While more research is needed in order to draw solid conclusions about the efficacy of therapies to prevent or ameliorate impairment [9, 10] a premise of close developmental surveillance among high-risk infants, such as those born extremely preterm, is that earlier initiation of developmental therapy improves the child's functional outcomes [10, 11]. One approach to assuring that intervention begins as early in life as possible is to refer for developmental intervention any infant with one or more risk factors for developmental impairment. However, since a majority of infants recovering from moderate HIE or EP do not develop major developmental impairments [12], a more cost-effective approach might involve targeting developmental interventions to those at greater risk. In the context of limited societal resources for developmental therapies, such as physical therapy, risk stratification and targeted referral for development intervention are important goals of neonatal intensive care unit follow-up clinics [13].

Tools for risk stratification of infants include neuroimaging [11, 14] and developmental assessment based on either parent-report [15–17] or direct observations [18–23]. A recent review cited a sensitivity of 86–89% for detection of cerebral palsy with neonatal magnetic resonance imaging

T. Michael O'Shea moshea52@email.unc.edu (MRI) [11] but lower sensitivity has been described for the more frequently used method of neonatal neuroimaging, i.e., ultrasonography [24].

Parent-report of motor milestones through 9 months of adjusted age has a sensitivity of 90% for detection of cerebral palsy among infants born preterm [15]. Among assessments that are based on direct observation, some, such as the General Movements Assessment, show great promise but currently require specialized training [25]. Other measures, such as the Test of Infant Motor Performance [26], and the Hammersmith Infant Neurological Examination [21], are relatively lengthy, which was the motivation for Gower et al. [27] to pursue a simpler assessment. Their goal was to develop an inexpensive, reliable, and sensitive tool for identifying infants with early indicators of developmental impairment and thereby enhance the benefit of early intervention.

To briefly summarize the findings of Gower et al., in a sample of infants born prematurely (24 to 34 weeks of gestation), scores on the Specific Test of Early Infant Motor Performance (STEP) at term age equivalent and at 3 months adjusted age (age adjusted for degree of prematurity) correlated highly with both motor and cognitive skills at 12 months adjusted age. The STEP took <10 min to administer and was found to have high inter-rater reliability. A STEP score ≤ 16 at term age equivalent predicted a low score on the motor scale of the Bayley Scales of Infant and Toddler Development-3rd edition (BSID-III) at 12 months of age with a sensitivity of 1.0 and a specificity of 0.9. A STEP score ≤ 22 at 3 months adjusted age predicted a low score on the motor scale of the BSID-III with a sensitivity of 0.75 and a specificity of 0.9.

The authors appropriately point out that replication of their findings is needed, since the results were based on a sample of only 13 infants assessed at term and 17 assessed at 3 months adjusted age. Another limitation is that STEP was studied only in preterm infants, so more study of this tool is necessary to determine whether the predictive accuracy is high among high-risk infants born at term, such

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as those with hypoxic-ischemic encephalopathy. In addition, the accuracy of the STEP for prediction of cerebral palsy also should be studied.

Nonetheless, if results similar to those reported by Gower et al. are reported from studies using the STEP for screening of larger and more heterogeneous samples of infants, the STEP could be an important tool for clinicians who provide developmental surveillance for high-risk infants. If the STEP proves to be highly sensitive, it could be incorporated into follow-up care after discharge of high-risk infants from neonatal intensive care to facilitate early identification of infants who will eventually develop cerebral palsy. Those infants scoring below the cut-offs identified by Gower et al. could be referred for physical therapy, while those with higher scores could be monitored without physical therapy intervention.

In the sample of preterm infants studied by Gower et al., the STEP assessment had a false positive rate of about 15%. Nonetheless, as pointed out by the authors, among individuals born extremely preterm, even children who do not show definite gross motor delay at 12 months exhibit an increased risk of motor impairments later in life [3], and this group of infants might benefit from referral for physical therapy. Perhaps more concerning is that 25% of infants who had delayed gross motor skills at 12 months were not detected using the STEP as a screen at 3 months adjusted age. This finding suggests that within replication samples other cut-offs should be considered as a strategy to possibly to increase the sensitivity of STEP.

While STEP was correlated with scores at 12 months on the BSID-III Cognitive Scale, only one study infant had a low BSID-III Cognitive score, so the sensitivity and specificity of a STEP score for prediction of cognitive delay could not be assessed. It is not surprising that STEP scores and BSID-III Cognitive Scale scores are correlated since some BSID-III items that assess cognitive function require motoric responses and normal gross motor function in infancy facilitates exploring the environment. On the other hand, it seems unlikely that assessment with STEP in the first three months, which evaluates only gross motor function, will replace other more specific assessments of early cognitive function, such as the Developmental Assessment of Young Children [28] and the Mullen Scales of Early Learning [29].

A central goal of developmental surveillance for infants with risk factors for cerebral palsy and other neuromotor impairments is to screen for indicators of delayed motor development so that physical therapy can begin as early as possible. Neuroimaging is expensive and does not detect all infants at high risk. Parent-report of motor milestones in the first three months is not likely to be as sensitive as methods based on direct observation. Barriers to implementation of highly sensitive assessments based on direct observation include cost of training, lack of reliability across a range of profession specialties, and duration of the assessment. The report by Gower et al. suggests that the STEP assessment might provide a highly sensitive tool that can be more easily implemented in neonatal intensive care follow-up clinics than currently available assessments. I applaud their foundational work on the STEP examination and look forward to further studies to more definitively characterize the usefulness of this assessment tool.

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Compliance with ethical standards

Conflict of interest The author declares that he has no conflict of interest.

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