

Screening for developmental delay: Reliable, easy-to-use tools

Win-win solutions for children at risk and busy practitioners

Practice recommendations

- Do not rely on clinical judgment only or developmental milestone review for the timely identification of developmental delays (B).
- Screen children for developmental delays regularly with cost- and time-effective screens such as the Ages and Stages Questionnaire and PEDS (Parents' Evaluation of Developmental Status) (C).
- Refer children with suspected delays promptly for comprehensive developmental assessment (C).
- Children with documented delays should receive prompt referral for appropriate early intervention (C).

One child out of 6 in your practice probably has a developmental disability.¹ However, identifying disability will be erratic if you rely solely on clinical judgment and informal milestone reviews.

There is reason for concern: the evidence for early intervention, though limited, shows that it confers long-term benefits for these children. Judicious use of practical, reliable standardized screens that I discuss in this article will increase your likelihood of identifying children who need help.

■ Needed: A screening net with tighter mesh

Disorders such as cerebral palsy and profound mental retardation are clearly recognizable and have well-known consequences. Disabilities such as language impairment, mild mental retardation, and learning disabilities (see **Range of disabilities**) are more subtle but also associated with poorer health status, higher rates of school failure, in-grade retention, and special education placement.^{1,2}

Developmental problems commonly escape detection in the first 5 years of life despite frequent well-child visits. Physicians generally acknowledge that screening for developmental disabilities is important,³ but few use standardized screening instruments.^{4,5} Most physicians rely instead on clinical judgment and milestone review.

Scope of the problem

A study that examined how doctors in the US screen for delays found that only 15% to 20% screened more than 10% of all of their patients with a formalized developmental instrument.⁵ Again, this points to reliance on clinical judgment to determine who should be screened. A National Survey of pediatricians and family physicians⁶ found that 53%

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Range of disabilities

Speech and language impairment are common among children (approximate prevalence 6%),⁷ as are learning disabilities (8%)⁸ and attention deficit disorder (7%).⁸ Less common conditions include mental retardation (1%–2%),⁹ cerebral palsy (0.2%),⁹ autism and autism spectrum disorders (0.5%).¹⁰ According to the US Department of Education, 13.2% of school-age children are in special education, most of them diagnosed with learning disabilities or mental retardation.¹¹

reported using no standardized instrument in their assessment of children for developmental delays. The most recent National Survey of Early Childhood Health (NSECH)¹² found that only 35% to 45% of parents recall their child's development ever being assessed by their doctor.

The fallout. Most children who would qualify for early intervention under federal law are not identified before school entry. Palfrey et al¹³ examined the records of 1726 children in special education classes at 5 sites and found that just 28.7% of developmental and behavioral problems were identified before entry into school (age 5). Just 15% to 25% of learning and speech disorders emotional disorders and attention deficit disorders were identified before school entry.¹³

A study in the UK¹⁴ found that despite of a system geared to detect subtle developmental disorders, their child health surveillance failed to detect 38% of children with moderate learning disabilities and 94% of children with mild or moderate learning disabilities. Another study¹⁵ on this matter shows a disappointing detection rate, failing to identify 55% to 65% of children with developmental problems before entry into school.

Studies have proven clinical judgment insensitive even in the detection of mental retardation. Two studies from the 1960s showed that US pediatricians accurately identified only 43% of children with an intelligence quotient (IQ) of <80.

Does early intervention work?

Much of the literature on early intervention in childhood focuses on children with risk factors such as prematurity and low birth weight or low socioeconomic status. In controlled studies, children at psychosocial disadvantage who received high-quality intervention exhibited long-term improvement in IQ, higher academic achievement, and decreased criminal behavior, and were, as adults, more likely to be employed and to earn higher incomes than those who did not participate in early intervention (SOR: A).^{16,17}

Other studies have similarly shown benefits from early intervention for children with such biological risk factors as low birth weight and prematurity (SOR: A).¹⁸ Early intervention for conditions such as learning disabilities or speech and language delays is generally thought to improve outcomes (SOR: C).²

Rationale for screening

Early identification mandated by law

The Individuals with Disabilities Education Act (IDEA) Amendments of 1997¹⁹ mandate the “early identification of, and intervention for developmental disabilities through the development of community-based systems.” This law requires physicians to refer children with suspected developmental delays to appropriate early intervention services in a timely manner. All states receive federal funding to provide appropriate intervention through infant and child-find programs for children with developmental delays.

In a study released in February 2006, the United States Preventive Services Task Force²⁰ concluded that the evidence is insufficient to recommend for or against routine use of brief, formal screening instruments in primary care to detect speech and language delay in children up to 5 years of age. The Canadian Guide to Clinical Preventive Health Care²¹ recommended against screening with the Denver

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Two tests easily filled out by parents are as valid as screens using professional observation

Developmental Screening Test and stated evidence was insufficient to support either the inclusion or exclusion of other screening tools. No studies have randomized children to screening versus no screening with contemporary screening tools.

Developmental screening is reliable

Screening tests can identify children with developmental delay with reasonable accuracy, and, as noted, such children may benefit from early intervention.

Developmental screening instruments fall into 1 of 2 categories: those that require the direct elicitation of developmental skills from children in conjunction with parental report, and those that rely solely on parental report.

Researchers in developmental screening regard a sensitivity of 70% to 80% as acceptable.²² Though this sensitivity is relatively low compared with other common screens used in medicine, it is in part unavoidable given the brevity of screens and the dynamic nature of child development. No screening tests have been shown to maintain sensitivity much greater than this without an unacceptable trade-off in specificity.

The specificity for a good developmental screen should also be in the range of 70% to 80%, ideally closer to 80%.²² Though this relatively low specificity will result in false-positive results, research has questioned whether this is problematic. Glascoe, in a study²³ involving a geographically representative sample of 512 children, found that though false positives on validated screening instruments did not reflect disabilities, these children nevertheless scored substantially lower than peers in intelligence, language, and academic achievement—the 3 best predictors for school success. Thus, many children who do not qualify for special educational services on subsequent testing may still have substantial risk factors for academic failure and may benefit from other services such as Head Start, Title 1 services, private speech-language therapy, and quality day care.

■ Suitable tests convenient for a busy office practice

The following 2 screening instruments rely on parental input. Research has shown that parental questioning is a valid means of screening for developmental delays, and that standardized instruments have a sensitivity and specificity similar to that of screens that require direct elicitation of a child's skills, such as the Brigance and the BDSI (discussed later).²⁴

PEDS

PEDS (Parents' Evaluation of Developmental Status) consists of 2 open-ended questions and 8 yes/no questions. It is written at a fifth-grade reading level and takes approximately 5 minutes to administer if an interview is needed—and even less time if parents can complete it independently. It need not be administered by a professional, and can be completed by a parent while waiting to see the doctor or even at home before a well-child visit.

PEDS was published in 1997 as a developmental screen entirely dependent on one kind of parental report—their concerns. The instrument was standardized and validated with 771 children representative of the 1996 US Census.²⁵ Twenty-five percent of the children used in standardization lived in poverty, 30% had unmarried parents. This questionnaire has a sensitivity of 74% to 79% and a specificity of 70% to 80% across ages 0 to 8 years in the detection of developmental delays and behavioral problems. It maintains its psychometric properties across various levels of parental education, socioeconomic status, and child-rearing experience.²⁶ The sensitivity and specificity for all ages combined was 75% and 74%, respectively.

Validity was determined through comparison with a battery of tests including the Woodcock-Johnson Psychoeducational Battery: Tests of Achievement, Stanford-Binet Intelligence Scale, and the Bayley Scales of Infant Development-II.

Scoring stratifies risk as low, medium, and high. Children at high risk require referral for more comprehensive assess-

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Parents can complete PEDS or Ages and Stages in the waiting room or at home before a visit

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Early intervention for learning disabilities and language delays is generally thought to improve outcomes

ment; validity studies found approximately 70% to possess disabilities or substantial delays on further evaluation. Children at intermediate risk require further screening, as approximately 30% were found to have disabilities or substantial delays on in validation studies.²⁵

The Ages and Stages Questionnaires

The Age and Stages Questionnaire (ASQ) system (formerly known as the Infant Monitoring Questionnaires) was developed by Bricker, Squires, and colleagues at the University of Oregon.²⁷ It is a low-cost and easily administered screening instrument relying on parental report.²⁸ Items are written at a fourth- to sixth-grade reading level; illustrations and examples are often provided. This self-administered assessment can be completed in 10 to 20 minutes and scored in 1 to 5 minutes.

The writers of the ASQ drew on several standardized developmental tests for item statements as well as literature that outlined early developmental milestones. They selected skills that could be observed or elicited easily by parents at home in the course of daily activities.

The system has 19 questionnaires designed to be administered at ages 4 months through 5 years, corresponding to common well-child visits. Five developmental areas are covered in each questionnaire—communication, gross motor, fine motor, problem solving, and personal-social. Five items query skills in each area. An overall section has 5 questions that cover general parental concerns.

Normative data were gathered from 2008 children drawn from an ethnically and socioeconomically heterogeneous population, with 81% of children judged “at-risk.”²⁸ The items were picked to represent the developmental quotient (DQ) of 75 to 100. Validity data were gathered from the analysis of 247 children, a subset of the population used in gathering normative data.

The ASQ has a specificity ranging from 81% (16 months) to 92% (36 months), and 86% overall. There was trend toward higher specificity when

screening older children. Sensitivity was lower, averaging 72%.²⁹ Age-appropriate tests of individual cognition were used as the gold standard, including the Bayley Scales of Infant Development, Stanford-Binet Intelligence Test (4th ed), and the McCarthy Scales of Children’s Abilities.

The instrument maintains its validity when screening high-risk children: when specifically used to evaluate infants born prematurely, the ASQ had 90% sensitivity, 77% specificity.³⁰ In this study formal assessment was performed with the Griffith Mental development Scales, Bayley Development Intelligence Scale.

Reliable tests requiring direct elicitation and observation of children

Brigance screens

The Brigance screens are not well known to physicians but are commonly used in Head Start and educational settings.³¹ They include 9 separate forms, each covering a 12-month age range. The Brigance requires about 15 minutes to administer and score. The screens address speech-language, motor skills, readiness, and general knowledge at younger ages, and also reading and math at older ages.

The Brigance screens were standardized using 1156 children; validity data were gathered through examining 408 children. Both groups were drawn from populations of diverse geographical and socioeconomic status, producing demographics similar to the US Census for the year 2000.

Validity data estimated the sensitivity and specificity for detecting children with delays at 82% and 75%, with a range of 72% to 100% across different years. Validity was determined through comparison with a battery of age-appropriate developmental assessment tools such as the Bayley Scales of Infant Development–II (BSID-II), Slossen Intelligence Test, and the Woodcock-Johnson Psycho-Educational Battery—Revised: Test of Achievement–II.³² A study examining the extension of the

Brigance screens to children ages 0 to 2 years found the screen to maintain its sensitivity (76% to 77%) and specificity (85% to 86%).³³ An additional feature of the Brigance is its ability to detect gifted and academically talented children with a sensitivity and specificity of 69% and 79%, respectively.³²

The Brigance II was published in early 2006; it has a sensitivity of 70% and specificity of 82% for the detection of developmental and academic problems.³⁴

Battelle Developmental Inventory Screening Test

The Battelle Developmental Inventory Screening Test (BDIST) can be used to screen children from age 12 to 96 months, using a combination of direct assessment, observation, and parental interview. Normative data were gathered from a geographically and socioeconomically diverse sample of 800 children.³⁵

Studies have shown the test to possess a sensitivity of 75% and specificity of 73%.³⁶ Validity data were gathered from 105 subjects, most of whose parents' incomes were below poverty guidelines. A battery of tests was used as a gold standard including the Bayley Scales of Infant Development–II, Kaufman Assessment Battery for Children or the Stanford-Binet Intelligence Scale. The BDIST requires 4 to 6 hours to learn and 10 to 30 minutes to administer, and may be impractical for routine screening in primary care. The receptive language subtest may be administered in lieu of the full screen and takes just a few minutes to administer; however, that diminishes specificity to 66% while maintaining sensitivity at 80%.³⁶

Bayley Infant Neurodevelopmental Screener

The Bayley Infant Neurodevelopmental Screener (BINS) is a recently developed test designed for screening high-risk infants aged 3 to 24 months. The test was standardized on a nonclinical sample of 600 children representative of the US Census data for 1988.³⁷ It uses 10 to 13

directly elicited items per 3- to 6-month range to assess neurodevelopmental skills and developmental accomplishments. Data published in the technical manual found the BINS to have a sensitivity and specificity of 75% and 86%, respectively, across all ages.³⁷

A subsequent study found the BINS to possess a sensitivity of 70% and a specificity of 71% when a population of infants born prematurely was screened at 12 and 24 months.³⁸

Both studies used the Bayley Scales of Infant Development–II as the gold standard. The BINS requires only about 10 minutes to administer, but requires experience in standardized assessment and familiarity with infant development.³⁹ A recent study found the BINS insensitive in the detection of developmental delays as compared with the Bayley Scales of Infant Development–II in environmentally at-risk children at ages of 6 months and 12 months.⁴⁰

Tests of questionable value Denver–II

The Denver Developmental Screening Test (DDST) was introduced in 1967. Research has consistently found it lacking in sensitivity. In response to this criticism, a revised version, the Denver II, was released in 1992.⁴¹

The Denver II is the most commonly used developmental screening tool.⁶ It combines direct observation and parental report. The tool consists of 125 items, organized into 4 developmental domains: gross motor, fine motor/adaptive, language, and personal/social. Items are displayed in bars that indicate the ages in which 25%, 75%, and 90% of children in the standardization study mastered a given task. A Denver test kit consists of scoring pads, materials used in eliciting skills, and a technical manual that details the appropriate administration and scoring of the test. Thirty-one percent of items can be addressed by parental report; the remainder requires observation of elicited

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Children with false-positive results on screening tests are often still at risk for academic failure

skills.⁴²

Though the Denver II used more than 2000 children to establish normative data, all of them were from Colorado, undermining our ability to generalize this data to a more heterogeneous population. Furthermore, both versions of the test were published without data on the test's validity, sensitivity, and specificity. The authors have instead relied on the significance of a child falling outside of the normal range as evidence of delay. This approach has been criticized.

Two studies have examined the validity of the Denver-II. In 1992, Glascoe et al⁴³ studied a demographically representative sample of 102 children and found that though the Denver II had a high sensitivity (83%), it had an unacceptably low specificity (43%). Attempts to improve specificity through categorizing questionable/untestable scores as normal raised specificity to 80%, but at the expense of sensitivity, dropping it to 56%.⁴³ Assuming a 16% prevalence of developmental disorders, the low specificity of the Denver-II would produce suspect scores in nearly 3 out of 5 children tested, but true problems could only be expected to be found in 1 of 4 children with suspect scores.

A follow-up study of 89 children by Glascoe and Byrne⁴⁴ found the Denver-II to possess excellent sensitivity (83%) but similarly disappointing specificity (26%), producing a positive predictive value of 28% in the study population (20% prevalence of disabilities).

In both studies, a battery of tests similar to those used to determine eligibility for special services were used as the gold standard. Properly performed, administration of the Denver-II requires approximately 20 minutes.⁴² Shortened versions or informal scoring of the Denver-II can only further degrade the questionable validity of this measure.

Child Development Inventories

The Child Development Inventory or CDI, formerly known as the Minnesota Child Development Inventory, was created to

provide a systematic, standardized method for parents to report on their children's strengths, problems, and present development. The original 300-item instrument has been broken down into instruments that apply to 3 age intervals.

The CDI measures a child's development in 8 areas: social, self-help, gross motor, fine motor, expressive language, language comprehension, letters, and numbers. It consists of a 300-item booklet and answer sheet for the parent to complete and a profile sheet for recording the results. It was standardized on a sample of 568 children from South St. Paul Minnesota, a predominantly Caucasian, working-class community near a large metropolitan area.⁴⁴

Parents complete the questionnaire by circling Yes/No responses to the statements. Children are considered "borderline" if their CDI scores are 25% below chronological age (1.5 standard deviations [SD] below the mean) and "delayed" if their scores are >30% below chronological age (2.0 SD). The CDI has been researched in presumed normal populations and in high-risk populations such as children born prematurely.

In a high-risk population of infants and children, it was found to have a sensitivity of 80% and specificity of 96% for detecting developmental delay (ie, CDI scores >2.0 SD below the mean) when compared with to the Bayley Scales of Infant Development-II, using 2 SD below the mean as the cutoff.⁴⁵ It seems to have particular utility for screening at-risk children even when applied to a population of low socioeconomic status and low education level.⁴⁶ In addition to validity, good predictive value has been established for future cognitive, reading, academic, intellectual, and adaptive functioning.

The CDI takes 35 to 50 minutes to complete, requires a seventh- to eighth-grade reading level, and may thus be impractical for screening large groups of low-risk children. Additionally, the CDI's generalizability to diverse populations is not established, as the normative data was gathered from a population that was 95%

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The Denver-II has low specificity; evidence for the CDI is insufficient to recommend it

Caucasian. The length and depth of the CDI has called some to question whether it is an instrument for developmental assessment rather than developmental screening.

The Child Development Inventories (plural) are shortened versions of the CDI (singular), tailored for ages 0 to 18 months and 18 months to 5 years.⁴⁷ The Infant Development Inventory (IDI) requires a parent to describe their child's development, using a chart of milestones, in social, gross motor, fine motor, and language skills areas.

The Child Development Review (CDR) is designed to screen for developmental problems in children ages 18 months to 5 years. The IDI and CDR are brief and easy to administer and score. Both rely on the formalized gathering of a parent's concerns and the parent's assessment of the child's progress in achieving milestones in several streams of development. Unfortunately, evidence in the technical manual or medical literature is insufficient to establish the validity of this instrument, and thus it is difficult to recommend the child development inventories when other parent-report instruments exist with well established validity.

■ Economics of developmental screening

It is useful to look at the economics of developmental screens from 2 perspectives—that of the physician and that of society. A 1998 review of the literature by the RAND group⁴⁸ concluded that 2 studies—the Elmira Prenatal/Early Infancy Project (EPEIP) and the Perry Preschool Project—followed children for sufficient time to allow for the assessment of the economic implications of intervention in children at risk for developmental delays.

Societal perspective

Both studies found that interventions led to considerable savings, with the biggest savings from decreased criminality in adulthood. The RAND group⁴⁸ estimated a government savings of \$18,611 per child who underwent early intervention in the

Elmira Prenatal/Early Infancy Project, and a savings of \$13,289 per child for individuals receiving intervention in the Perry Preschool Project (figures in 1996 dollars.)

It is difficult to know whether these same savings would be seen in developmental intervention applied on a larger scale. Additionally, it is difficult to know how generalizable research from intervention with high-risk children is to intervention stemming from screening in a doctor's office.

The physician perspective

Developmental screening is associated with additional costs. Dobrez et al⁴⁹ estimated the physician's expense in administering a number of developmental screens, accounting for the administration costs and costs associated with time required to discuss abnormal results. This analysis found screens based on parental report such as the ASQ, CDI, and PEDS considerably less expensive, with a per-visit expense of approximately \$12 for negative screen results and approximately \$16 for positive results. Tests requiring the direct elicitation of skills from children such as the Denver-II and BINS had an estimated cost of \$55.12 and \$22.22 for normal screens, respectively, and \$59.57 and \$26.67 for abnormal screens.⁴⁹ Medicaid reimbursement varies by state; information can be obtained through the Center for Medicaid/Medicare website. Private payers may or may not reimburse physicians for developmental screening.

CONFLICT OF INTEREST

The author has no conflicts of interest to declare.

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Administrative costs associated with PEDS and ASQ are lower than other screens

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Two long-term studies found that developmental screening led to significant saving for society—as much as \$18,000 for each child who had intervention

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