

Cornerstones



Practice-Based Research Syntheses of Child Find, Referral, Early Identification, and Eligibility Practices and Models
Volume Four, Number One

September 2009

Accuracy of Nurse Provider Child Screening Practices

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The accuracy of developmental screenings conducted by nurses for identifying children with developmental delays was the focus of this research synthesis. The practice constituting the focus of analysis was developmental screenings conducted by a nurse using either a standardized or non-standardized assessment procedure. The synthesis included 17 studies of more than 24,000 children mainly birth to six years of age. The results indicate that 40% to 67% of the screening results reported in the studies met generally accepted levels (80%) of accuracy, sensitivity, and specificity. Close examination of the findings from studies which produced high levels of accuracy, sensitivity, and specificity indicated that training nurses to use standardized instruments was more likely to produce acceptable levels of efficiency. Implications of the findings for early identification of young children with potential developmental disabilities or developmental delays are discussed.

Purpose

The purpose of this practice-based research synthesis is to assess the efficiency of developmental screenings by nurses for the early identification and referral to Part C early intervention or Part B(619) early childhood special education programs. Developmental screenings conducted by medical personnel include both formal and informal observations and assessments by physicians (e.g., Halfon et al., 2004), nurses (Cadman et al., 1987; Curry & Duby, 1994; Romeo, 2002), and other health care professionals (e.g., Romeo, 2002; Wright, Brown, & Davidson-Mundt, 1992). Nurse screening was the focus of this research synthesis because, as part of their work in pediatric and family practices, nurses could potentially conduct developmental screenings which provide important information for early identification of young children with developmental delays (American Academy of Pediatrics, 2001; Halfon et al., 2004; Holt, 1977; Okamoto, 2003). This synthesis focused on the accuracy of nurse screenings and the characteristics of the screening practices that influence accurate developmental screening results.

The synthesis was conducted using a characteristics and consequences framework (Dunst, Trivette, & Cutspec, 2007) where the focus of analysis was the

identification of the particular characteristics of nurse screenings that were associated with desired levels of identification of young children who might be eligible for Part C early intervention or Part B(619) preschool special education services. This was accomplished by coding different characteristics of developmental screenings performed by nurses and relating variations in the presence of the characteristics to indicators of accurate screenings.

Background

The Individuals with Disabilities Education Act (IDEA) (Individuals with Disabilities Education Improvement Act of 2004, 20 U.S.C. § 1400 et seq., 2004)

Cornerstones is a publication of the Tracking, Referral and Assessment Center for Excellence (TRACE) funded by the U.S. Department of Education, Office of Special Education Programs (H324G020002). Opinions expressed in this publication are those of TRACE and do not necessarily reflect the views of the U.S. Department of Education. TRACE is a major initiative of the Center for Improving Community Linkages, Orelena Hawks Puckett Institute (www.puckett.org). Copyright © 2009 by the Orelena Hawks Puckett Institute. All rights reserved.

encourages the early identification of children with developmental delays through the development of community-based systems that include early screening. Screening is often the first step in the identification of children who might be eligible for early intervention services. Medical professionals who provide routine pediatric services are in a unique position to influence the early identification of young children because of their close involvement with children and families during the children's early years of life.

Nurses currently are trained to conduct a variety of medical screening procedures (Oliveria et al., 2001; Rydz, Shevell, Majnemer, & Oskoui, 2005; Vision in Preschoolers Study Group, 2005). Consequently, they are a logical group to help in the early identification of children with developmental delays who might be referred to early intervention (Glascio, 2000). Nurse screening within pediatric practices is thought to hold promise as an early identification strategy for increasing referrals from primary referral sources (Dunst & Trivette, 2004). Having nurses conduct developmental screenings in private practices is one type of early identification activity (Dunst & Trivette, 2004) that constitutes the focus of research and practice at the *Tracking, Referral, and Assessment Center For Excellence* (www.tracecenter.info).

Description of the Practice

For this synthesis, screening is defined as a "brief assessment designed to identify children who should receive a more intense evaluation" (Center for Disease Control, 2008, para. 5). Developmental screening can involve the use of assessment scales, checklists, interview protocols, or standardized instruments to assess a child's development (e.g., Denver Developmental Screener). This practice differs from developmental surveillance which is defined as "a flexible, continuous process whereby knowledgeable professionals perform skilled observations of children during the provision of health care" (Dworkin, 1993, p. 533). Surveillance includes a number of components, one of which may be the use of a developmental screening instrument or tool (American Academy of Pediatrics, 2001). This synthesis focused only on developmental screening and did not assess the effectiveness of developmental surveillance. The specific characteristics of the screening procedures examined were: Screening setting, type of developmental area screened, use of a standardized screening tool, and use of trained nurses to administer and score the screening instrument.

Search Strategy

Search Terms

The following keywords were searched to identify relevant articles: *nurse* or *nurse screening* or *nurse as-*

essment or *nurse surveillance* or *health visitor surveillance* or *developmental screening* or *developmental surveillance* or *early identification*. Keywords derived from information database thesauri were used to limit the search and included *infant* and *child* as well as *developmental disability* or *delay* or *disorder*.

Search Sources

The Cumulative Index to Nursing and Allied Health (CINAHL), Medline, Health Source: Nursing/Academic Addition, Educational Resources Information Center (ERIC), Psychological Abstracts, and Social Sciences Citation Index (SSCI) were the primary information databases searched for relevant studies. Secondary information databases searched included Psychological Abstracts (PsychInfo), Academic Search Elite, Dissertation Abstracts, OCLC Papers First, World Cat, and the Cochrane databases.

An EndNote database maintained by the Puckett Institute was also searched. In order to identify additional studies, hand searches of relevant journal articles, book chapters, and books were used to supplement computer-assisted searches. The reference lists of all pertinent studies were examined with the aim of locating previously identified studies.

Search Criteria

Studies were included if: (1) some type of developmental screening was conducted, (2) most of the children were 5 years of age or younger, and (3) primarily nurses administered the screening instrument or procedure. Studies were excluded if accuracy, sensitivity, or specificity were not reported or could not be calculated from the information in the study report (e.g., Hewitt, Powell, & Tait, 1989; Morris, 1985; Stallard, 1993). Surveillance studies were included only if they reported accuracy, sensitivity, or specificity data for individual screenings. Screening studies that focused only on the identification of diseases or syndromes and did not include developmental measures were excluded.

Search Results

Seventeen (17) studies in 16 research reports met the inclusion criteria. Table 1 shows selected characteristics of the children who were screened and characteristics of the screeners who participated in the studies.

Participants

The 17 studies included 24,283 children. In the six studies that reported child gender, 53% (2,682) of participants were male. The age of the participants at the time of the initial screening ranged from birth to 72 months of age. The developmental screenings in the majority of the

studies (82%) were done on children in the general population. Child ethnicity was only reported in two studies (Eu, 1986; Lim et al., 1996).

Twelve studies reported that 198 people conducted the screenings. Most (97%, $N = 23,729$) of the screenings were completed by nurses. Three studies (Bryant, Davies, Richards, & Voorhees, 1973; Laing, Law, Levin, & Logan, 2002) used screeners who were primarily, but not solely, nurses.

Four studies were conducted in the United States, four were conducted in Australia, and two studies were conducted in each of the following countries: England, Sweden, and Israel. One study was conducted in Ireland (McGinty, 2000) and one in Singapore (Lim et al., 1996).

Research Designs

Table 2 shows the research designs used by the investigators. Sixteen studies were comparison studies. One study (Blackman & Hein, 1985) was longitudinal; however, only the information from the first assessment was used in this synthesis.

Screening Characteristics

The 17 studies differed on a number of practice characteristics (Table 2). Eleven of the 17 studies reported that nurses received training, though it is not clear what type of training they received or what level of interrater reliability was used, if any. Only three investigators (Eu, 1986; Eu & O'Neil, 1983; Jaffe, Harel, Goldberg, Rudolph-Schnitzer, & Winter, 1980) reported the level of interrater agreement to which the nurses were trained. In these three studies, nurses were required to reach a 90% interrater agreement level.

In seven studies, the screenings were conducted in health centers. Five studies were implemented in the children's homes. Two of the studies conducted screenings in hospitals. Two investigations did not report where the screenings were conducted.

About half of the studies (41%) reported how long it took to conduct the screenings. Three investigations reported the screenings took 12 minutes (Stewart, Hanna, & Bos, 1992; Tirosh, Lechtman, Diamond, & Jaffe, 1993; Westerlund, 2001), one study reported the screenings took 3 minutes (Curry & Duby, 1995), and two studies reported the screenings took only 1 minute (Bryant et al., 1973; McGinty, 2000). One study (Blackman & Hein, 1985) reported that the entire procedure took 60 minutes; however, the authors did not report the time required to administer the developmental screening instrument.

Eleven studies used at least one standardized instrument as part of the screening procedure. The most frequently used screening instrument (29%) was the Denver Developmental Screening Test. Six studies either did not

specify what tool was used or used an informal assessment procedure. Twelve studies focused on components of general development. Four of the studies assessed language/speech development.

Outcomes

The outcomes of interest in this synthesis were the levels of accuracy, sensitivity, and specificity that were achieved by the nurses who conducted the developmental screenings. For this synthesis, 80% accuracy, sensitivity, and specificity levels were considered acceptable.

Accuracy is defined as the proportion of individuals correctly classified either positively or negatively. It is an overall measure of "true" findings which is also termed "efficiency" or the predictive value of the screening process (Goldman, 1994; Meisels, 1989; Rydz et al., 2005).

Sensitivity is defined as the percentage of persons with an identified condition who have positive test results (Glascoe et al., 1992; Greenberg, Daniels, Flanders, Eley, & Boring, 1993; Rydz et al., 2005). The greater the sensitivity of a screening procedure, the more likely that the screening procedure will detect a child with a developmental delay (Wolery, 1989).

Specificity is defined as the percentage of individuals without an identified condition who receive a negative screening result (Glascoe et al., 1992; Greenberg et al., 1993; Rydz et al., 2005). The greater the level of specificity of the screening procedure, the more likely the child without a diagnosis will be excluded through the screening procedure (Wolery, 1989).

Search Findings

The findings from this synthesis were examined three ways. The first strategy was to determine the percentage of studies that had different levels of accuracy, sensitivity, and specificity. A second strategy was to determine which, if any, of the practice characteristics accounted for differences in the study results. Lastly, the five studies which reported acceptable (80%) levels of accuracy, sensitivity, and specificity were examined to identify common characteristics of the screening practices.

Omnibus Findings

Table 3 shows the accuracy, sensitivity, and specificity data for each of the individual studies. Figure 1 shows the percentage of studies in which nurse screenings reached different levels of accuracy, sensitivity, and specificity. These data are displayed as the percentage of studies where the screening percentages reached five levels of efficiency (<60, 60-69, 70-79, 80-89, and 90-100).

Findings from this synthesis show that 62% of the

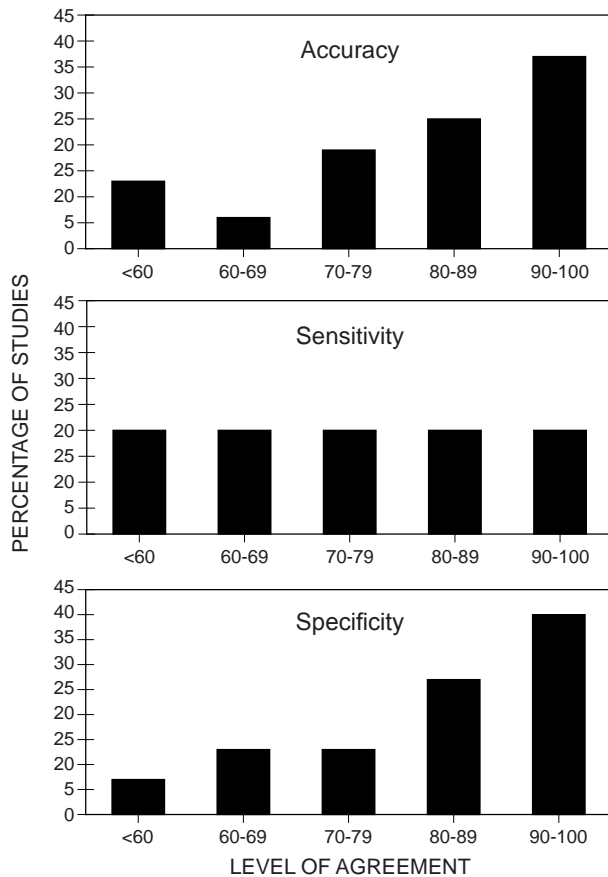


Figure 1. Percentage of accuracy, sensitivity, and specificity of the nurse screenings.

studies reported reaching an acceptable level of accuracy (80%), forty percent (40%) of the studies had sensitivity measures of 80% or higher, and specificity levels of 80% or higher were found in 67% of the studies. The mean level for the 15 studies that reported sensitivity was 70%. The 15 measures of specificity had a mean of 84%, and accuracy was measured 16 times with a mean of 81%.

Practice Characteristics

Accuracy, sensitivity, and specificity were examined to see if they varied as a function of different screening characteristics including the setting where the screening was conducted, the type of screening that was conducted, use of a standardized assessment instrument, and whether nurses were trained to use the screening instrument. Table 4 reports the results of these analyses.

For the studies conducted in home or community settings, the accuracy was 82% and specificity was 83%. For screenings conducted in a health clinic/hospital setting, only specificity had a mean of 80%.

The data were also examined to determine whether accuracy, sensitivity, or specificity differed as a function of the type of screening conducted. Accuracy and

specificity for the studies that used developmental assessments were 83% and 87%, respectively. Accuracy (74%), sensitivity (75%), and specificity (74%) were all less than 80% when language or speech were the focus of the screenings.

The three outcome measures were examined in relation to whether the screening instrument used was a standardized or non-standardized measure. The means were higher on all three outcomes measures when standardized measures were used: Accuracy (87%), specificity (87%), and sensitivity (74%). Only specificity reached 80% for the non-standardized measures.

Whether trained nurses achieved higher levels of accuracy, sensitivity, or specificity compared to untrained nurses was also assessed. The accuracy and specificity level for studies that reported nurses were trained and studies that did not indicate if they trained the nurses both reached a mean of more than 80%. The sensitivity level was 69% for the trained nurses. Caution is warranted when interpreting these findings. First, the comparison is between studies that indicate nurses were trained and studies that did not report whether nurses were trained. It is possible that nurses were trained in all the studies since no study indicated that the nurses had not been trained. Second, many of the studies that “trained” the nurses provided no detail about the training.

Exemplary Studies

An examination of the studies that reported acceptable results for all three outcomes revealed interesting findings. Five studies (Bryant et al., 1973; Eu, 1986; Jaffe et al., 1980; Pinto-Martin, Torre, & Zhao, 1997) reported that screenings reached 80% or better on all three efficiency measures. These studies reported levels in the high 80s or 90s. The two characteristics that emerged as likely to improve the accuracy, sensitivity, and specificity levels were using standardized instruments and training nurses to an interrater reliability level of 90%.

Conclusion

Findings from this practice-based research synthesis indicated that nurses can conduct developmental screenings with efficiency where the accuracy of nurse screenings was enhanced by training nurses to a high criterion level using a standardized test. This finding highlights the importance of ensuring that nurses have the skills to conduct the screening with accuracy. The results demonstrate that the conduct of developmental screening in pediatric and family practice settings by nurses has the potential to provide important information for the early identification and referral of young children to Part C early intervention or Part B(619) early childhood special education programs.

Implications for Practice

Family practice and pediatric physicians are in a unique position to identify young children with conditions or disabilities that might result in developmental delays and refer these children to intervention programs. Within busy medical practices, one strategy to help make early identification possible would be to use nurses to conduct developmental screenings. Findings from this practice-based research synthesis indicate that nurses can conduct developmental screenings with efficiency at least under certain conditions. To do this with accuracy, it is important that nurses be trained to use the screening tool and that training continues until they reach an acceptable level of reliability. It is also helpful to use a standardized tool since it is easier to train to a high level of reliability with a standardized tool than an informal assessment process. With these practices in place, nurses can gather information about children's physical, medical and developmental status which should facilitate early identification and referral for Part C early intervention or Part B(619) preschool special education services.

To assist practitioners in understanding the implications of these findings, an *Endpoints* (Vol. 4, No. 1) report that describes the major findings from this practice-based research synthesis in non-technical, user-friendly language has been developed. The *Endpoints* summarizes what we know about nurse screening of children's behavior and development 0-5 years of age. Both the *Cornerstones* and *Endpoints* reports are available at our website (<http://www.tracecenter.info/>).

References

- American Academy of Pediatrics, Committee on Children with Disabilities. (2001). Developmental surveillance and screening of infants and young children [Electronic version]. *Pediatrics*, 108, 192-196.
- Blackman, J. A., & Hein, H. A. (1985). Iowa's system for screening and tracking high-risk infants. *American Journal of Diseases of Children*, 139, 826-831.
- Bryant, G. M., Davies, K. J., Richards, F. M., & Voorhees, S. (1973). A preliminary study of the use of the Denver Development Screening Test in a health department. *Developmental Medicine and Child Neurology*, 15, 33-40.
- Cadman, D., Chambers, L. W., Walter, S. D., Ferguson, R., Johnston, N., & McNamee, J. (1987). Evaluation of public health preschool child developmental screening: The process and outcomes of a community program. *American Journal of Public Health*, 77, 45-51.
- Center for Disease Control. (2008). *Autism information center: Glossary*. Retrieved April 27, 2009, from <http://www.cdc.gov/ncbddd/autism/glossary.htm>.
- Curry, D. M., & Duby, J. C. (1994). Developmental surveillance by pediatric nurses. *Pediatric Nursing*, 20, 40-44.
- Curry, D. M., & Duby, J. C. (1995). Identification and referral by nurses of children at risk. *Issues in Comprehensive Pediatric Nursing*, 18, 67-74.
- Dunst, C. J., & Trivette, C. M. (2004). Toward a categorization scheme of child find, referral, early identification and eligibility determination practices. *Tracelines*, 1(2), 1-18. Available at http://www.tracecenter.info/tracelines/tracelines_vol1_no2.pdf.
- Dunst, C. J., Trivette, C. M., & Cutspec, P. A. (2007). *An evidence-based approach to documenting the characteristics and consequences of early intervention practices* (Winterberry Research Perspectives Vol. 1, No. 2). Asheville, NC: Winterberry Press.
- Dworkin, P. H. (1993). Detection of behavioral, developmental, and psychosocial problems in pediatric primary care practice. *Current Opinion in Pediatrics*, 5, 531-536.
- Eu, B. (1986). Evaluation of a developmental screening system for use by child health nurses. *Archives of Disease in Childhood*, 61, 34-41.
- Eu, B., & O'Neil, M. J. (1983). Development of the preschool child: The validation of psychomotor screen, and the influence of the home environment on psychomotor development. *Australian Paediatric Journal*, 19, 78-85.
- Glascoc, F. P. (2000). Detecting and addressing developmental and behavioral problems in primary care [Electronic version]. *Pediatric Nursing*, 26, 251-257.
- Glascoc, F. P., Byrne, K. E., Ashford, L. G., Johnson, K. L., Chang, B., & Strickland, B. (1992). Accuracy of the Denver-II in developmental screening. *Pediatrics*, 89, 1221-1225.
- Goldman, L. (1994). Quantitative aspects of clinical reasoning. In K. J. Isselbacher, E. Braunwald, J. D. Wilson, J. B. Martin, A. S. Fauci, & D. L. Kasper (Eds.), *Harrison's principles of internal medicine: Volume 1* (13th ed., pp. 43-48). New York: McGraw-Hill.
- Greenberg, R. S., Daniels, S. R., Flanders, W. D., Eley, J. W., & Boring, J. R. (1993). *Medical Epidemiology*. London: Lange-McGraw-Hill.
- Halfon, N., Regelado, M., Sareen, H., Inkelas, M., Reuland, C. H. P., Glascoe, F. P., & Olson, L. M. (2004). Assessing development in the pediatric office [Electronic version]. *Pediatrics*, 113, 1926-1933.
- Hewitt, K., Powell, I., & Tait, V. (1989). The behaviour of nine-month and two-year olds as assessed by health visitors and parents. *Health Visitor*, 62, 52-55.
- Holt, K. S. (1977, December). Normal and abnormal. *Nursing Mirror Supplement*, 145(23), i, iii, v.
- Individuals with Disabilities Education Improvement Act of 2004, 20 U.S.C. § 1400 et seq. (2004).

- Jaffe, M., Harel, J., Goldberg, A., Rudolph-Schnitzer, M., & Winter, S. T. (1980). The use of the Denver Developmental Screening Test in infant welfare clinics. *Developmental Medicine and Child Neurology*, 22, 55-60.
- Laing, G. J., Law, J., Levin, A., & Logan, S. (2002). Evaluation of a structured test and a parent led method for screening for speech and language problems: Prospective population based study. *British Medical Journal*, 325, 1152-1154.
- Larsson, J.-O., Aurelius, G., Nordberg, L., Rydelius, P.-A., & Zetterström, R. (1999). The role of cumulative observations in identifying children in need of health promotion. *Ambulatory Child Health*, 5, 209-217.
- Lim, H. C., Ho, L. Y., Goh, L. H., Ling, S. L., Heng, R., & Po, G. L. (1996). The field testing of Denver Developmental Screening Test, Singapore: A Singapore version of Denver II Developmental Screening Test. *Annals Academy of Medicine*, 25, 200-209.
- McGinty, C. (2000). An investigation into aspects of the Mayo Early Language Screening Test. *Child: Care, Health and Development*, 26, 111-128.
- Meisels, S. J. (1989). Can developmental screening tests identify children who are developmentally at risk? *Pediatrics*, 83, 578-585.
- Morris, J. M. (1985). A descriptive study of the practice of community health nurses with infants at risk for developmental disabilities. *Journal of Community Health Nursing*, 2, 53-60.
- Okamoto, J. K. (2003). Developmental screening of infants, toddlers and preschoolers. In J. K. Yamamoto, A. S. Inaba, J. K. Okamoto, M. F. Patrinos, & V. K. Yamashiroya (Eds.), *Case based pediatrics for medical students and residents*. Honolulu, HI: University of Hawaii, John A. Burns School of Medicine, Department of Pediatrics. Retrieved January 20, 2005, from <http://www.hawaii.edu/medicine/pediatrics/pedtext/s01c03.html>.
- Oliveria, S. A., Nehal, K. S., Christos, P. J., Sharma, N., Tromberg, J. S., & Halpern, A. C. (2001). Using nurse practitioners for skin cancer screening: a pilot study. *American Journal of Preventative Medicine*, 21(3), 214-217.
- Pinto-Martin, J. A., Torre, C., & Zhao, H. (1997). Nurse screening of low-birth-weight infants for cerebral palsy using goniometry. *Nursing Research*, 46, 284-287.
- Romeo, S. (2002). To know what is before you: Developmental screening in children. *Advance for Nurse Practitioners*, 10(2), 55-58.
- Rydz, D., Shevell, M. I., Majnemer, A., & Oskoui, M. (2005). Developmental screening. *Journal of Child Neurology*, 20, 4-21.
- Sahin, S. T. (1979). Nurses and the early identification of young-children at risk. *International Journal of Nursing Studies*, 16, 141-149.
- Stallard, P. (1993). Routine assessment of children at three years. *Health Visitor*, 66, 397-398.
- Stewart, S., Hanna, B., & Bos, D. (1992). Beyond three: MCH nurses' assessment leads to early interventions. *Australian Journal of Advanced Nursing*, 9(4), 4-9.
- Stokes, S. F. (1997). Secondary prevention of paediatric language disability: A comparison of parents and nurses as screening agents. *European Journal of Disorders of Communication*, 32, 139-158.
- Tirosh, E., Lechtman, M., Diamond, H., & Jaffe, M. (1993). An effective community-based approach to the identification of neurodevelopmental delay in childhood. *Developmental Medicine and Child Neurology*, 35, 238-242.
- Vision in Preschoolers Study Group. (2005). Preschool vision screening tests administered by nurse screeners compared with lay screeners in the Vision in Preschoolers study. *Investigative Ophthalmology and Visual Science*, 46, 2639-2648. Available at <http://www.iovs.org/cgi/content/abstract/46/8/2639>.
- Westerlund, M. (2001). Relationship between a global rating of speech ability at the age of 3 yrs and a phonological screening 1 yr later: A prospective field study. *Scandinavian Journal of Caring Sciences*, 15, 222-227.
- Wolery, M. (1989). Child find and screening issues. In D. B. Bailey, Jr. & M. Wolery (Eds.), *Assessing infants and preschoolers with handicaps* (pp. 119-143). Columbus, OH: Merrill.
- Wright, L., Brown, A., & Davidson-Mundt, A. (1992). Newborn screening: The miracle and the challenge. *Journal of Pediatric Nursing*, 7, 26-42.

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Table 1
Characteristics of the Study Participants

Study	Child Characteristics						Screener Characteristics		
	Sample Size	Age at Screening (months)	Percentages			Population Description	Sample Size	Position	Country
			Male	Ethnicity	SES ^a				
Blackman & Hein (1985)	1,440	4	57	NR	NR	High risk	NR	Pediatric Nurse Practitioner	US
Bryant et al. (1973)	96	12–13	NR	NR	NR	General population	4	Health Visitor	England
Curry & DUBY (1995)	90	0–72	NR	NR	NR	Hospital patients	29	Registered Nurse	US
Eu (1986)	124	2–48	51	12 Greek or Italian	31 high 42 med. 27 low	General population	1	Child Health Nurse	Australia
Eu & O'Neill (1983)	307	48	52	NR	33 high 35 med. 32 low	General population	1	Child Health Nurse	Australia
Jaffe et al. (1980)	823	6	NR	NR	NR	General population	NR	Public Health Nurse	Israel
Laing et al. (2002) Study I	282	30	NR	NR	NR	General population	18	Health Visitor	England
Laing et al. (2002) Study II	176	30	NR	NR	NR	General population	19	Health Visitor	England
Larsson et al. (1999) Method I	468	48	49	NR	NR	General population	NR	Child Welfare Center (CWC) Nurse	Sweden
Lim et al. (1996)	2,459	3–60	52.4	70 Chinese 24 Malayan 5 Indian 1 other	NR	General population	27	Nurse	Singapore
McGinty (2000)	120	18–60	74	NR	NR	Suspected language delay	NR	Public Health Nurse	Ireland
	80 ^b		53			General population			
Pinto-Martin et al. (1997)	717	24	NR	NR	NR	General population	NR	Pediatric Nurse or Pediatric Nurse Practitioner	US
Sahin (1979)	268	36–60	NR	NR	Mid-low	General population	10	Senior level nursing students	US
Stewart et al. (1992)	790	36–48	NR	NR	NR	General population	10	Nurse	Australia
Stokes (1997)	398	36	NR	NR	NR	General population	17	Child Health Nurse	Australia
Tirosh et al. (1993)	13,580	1–60	NR	NR	NR	General population	2	Clinic Nurse	Israel
Westerlund (2001)	2,065	36	NR	NR	NR	General population	60	Child Health Center Nurse	Sweden

^a Socio-economic status.

^b Control group.

NR = Not reported.

Table 2
Characteristics of Nurse Screening Practices

Study	Study Design	Screening Practice				
		Nurse Training ^a	Setting	Length of Screening ^b	Screening Instrument	Screening Type
Blackman & Hein (1985)	Comparison	NR	Hospital	NR	Denver Developmental Screening Test (DDST)	Development
Bryant et al. (1973)	Comparison; random assignment	Y	Home	1	DDST	Development
Curry & Duby (1995)	Comparison; random assignment	Y	Hospital	3	“Eligible Risk Criteria” risk factors	Development
Eu (1986)	Comparison	Y	NR	NR	Woodside system	Development
Eu & O’Neill (1983)	Comparison	Y	NR	NR	Adelaide Psychomotor Screen	Development
Jaffe et al. (1980)	Comparison	Y	Health Center	NR	DDST	Development
Laing et al. (2002) Study I	Comparison	NR	Home	NR	Structured screening test (Not specified)	Language
Laing et al. (2002) Study II	Comparison	NR	Home	NR	Parent led method with observation, clinical judgment, and health history	Language
Larsson et al. (1999) Method I	Comparison	NR	Home	NR	Four-years-old screening	Development
Lim et al. (1996)	Comparison; random assignment	Y	Health Center	NR	DDST (Singapore Version)	Development
McGinty (2000)	Comparison	NR	Home	1	Mayo Early Language Speech Test	Speech and language
Pinto-Martin et al. (1997)	Comparison	Y	Multiple sites	NR	Developmental assessment (Not specified)	Development
Sahin (1979)	Comparison	Y	Health Center	NR	DDST	Development
Stewart et al. (1992)	Comparison	Y	Health Center	12	Informal assessment	Development
Stokes (1997)	Comparison	NR	Health Center	NR	12-item checklist	Development
Tirosh et al. (1993)	Comparison	Y	Health Center	12	Routine developmental screening (Not specified)	Development
Westerlund (2001)	Comparison	Y	Health Center	12	Visual Analogue Scale (VAS) global rating scale	Language

^aTraining of nurses in the screening process varied from simply providing a general overview of the screening tool to training nurses and testing them until they reach a specified criterion.

^bNumber of minutes to complete the screening.

NR = Not reported.

Table 3
Efficiency of the Nurse Screening Practices

Study	Percentage		
	Sensitivity	Specificity	Accuracy
Blackman et al. (1985)	NR	NR	94
Bryant et al. (1973)	80	95	94
Curry & Duby (1995)	14	98	57
Eu (1986)	81	94	90
Eu & O'Neill (1983)	100	93	94
Jaffe et al. (1980)	94	88	89
Laing et al. (2002) Study I	55	89	84
Laing et al. (2002) Study II	76	68	70
Larsson et al. (1999)	67	77	77
Lim et al. (1996)	39	89	86
McGinty (2000)	84	70	NR
Pinto-Martin et al. (1997)	97	88	90
Sahin (1979)	40	97	84
Stewart et al. (1992)	NR	NR	78
Stokes (1997)	77	97	95
Tirosh et al. (1993)	69	43	50
Westerlund (2001)	74	68	69

NR = Not reported or could not be determined.

Table 4
Average Accuracy, Sensitivity, and Specificity of the Nurse Screenings

Study Characteristics	Accuracy			Sensitivity			Specificity		
	N	Mean	CI (90%)	N	Mean	CI (90%)	N	Mean	CI (90%)
<i>Setting</i>									
Multiple Settings/Unknown	3	91	81–95	3	93	75–109	3	92	86–97
Home/Community	5	82	73–90	6	69	56–82	6	83	72–93
Health Clinic/Hospital	8	77	66–89	6	61	37–85	6	81	63–98
<i>Type of Screening</i>									
Development	13	83	76–90	11	69	54–84	11	87	78–97
Speech/Language	3	74	60–89	9	75	66–84	4	74	62–86
<i>Standardized Tool</i>									
Yes	8	88	82–93	8	74	59–89	8	87	79–94
No	8	75	65–86	7	67	48–85	7	80	66–94
<i>Prescreening Training</i>									
Yes	11	80	72–88	10	69	52–86	10	85	75–95

N = Number of studies.
 CI = Confidence interval.