Identifying 4-Month-Old Infants at Risk in Community Screening

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Purpose: To validate a 2-step infant developmental screening protocol administered by nonphysician health professionals. **Methods:** The Parent Concerns Survey and the Meade Movement Checklist (MMCL) were administered during 5 community clinics. Infant scores at 4 months were compared with the Bayley Scales of Infant Development II and Movement Assessment of Infants at 6 months and to the Ages and Stages Questionnaires at 8 months. **Results:** Parents identified significantly more concerns on the Parent Concerns Survey ($x2 = 6.43$, $p = 0.011$) than parents not attending clinics. The correlation between infant MMCL scores at 4 months and Movement Assessment of Infants was $r = 0.58$ ($p = 0.01$) and $r = -0.48$ ($p = 0.01$) with Bayley Scales of Infant Development II scores at 6 months. The MMCL demonstrated 87.5% sensitivity, 91.4% specificity, and 70% positive predictive value. **Conclusion:** Combining parent concerns and observational screening effectively identified infants for further evaluation. This 2-step screening by nonphysician health professionals provides a valid, new perspective for screening young infants. (Pediatr Phys Ther 2009;21:150–157) Key words: child, developmental disabilities/diagnosis, health status indicators, infant, predictive value of tests, professional competence, reproducibility of results, risk assessment/procedures, risk assessment/standards, sensitivity and specificity

INTRODUCTION

The federal government of the US recognized the importance of early identification of children with developmental delay or disability by enacting the Individuals with Disabilities Education Act in 1997. The legislation, later revised as the Individuals with Disabilities Education Improvement Act in 2004, requires states to establish procedures to find children eligible for part C early intervention services (Child Find activities).[1]

Current efforts to identify eligible children have not been effective.[2] Only 1.8% of those children with delays or

disabilities, from birth through 2 years, are currently receiving part C early intervention services.[3] Screening strategies rely on either surveillance or tests for early detection; both strategies are expensive and may over-identify or under-identify children.[2]

Researchers estimated that 12.8% of the birth through 17-year-old population has a chronic healthcare need,[4] yet more than half of the children with a developmental delay or disorder reach kindergarten without identification of their problems.[2] Only 40% of those later classified as having autism are identified before school age.[5] Approximately one third of children with a developmental delay or disorder are identified by their healthcare provider.[6]

The purpose of screening is to identify infants who may be delayed or "at risk" in 1 or more areas of development.[7] Screening tests should be reliable and valid, referenced to normal, standardized in administration, scored objectively, and inexpensive.[8] Professionals determining the primary goal of a screening program decide acceptable levels of sensitivity and specificity based on the consequences of false negatives and false positives.[8]

Surveillance and detection are 2 primary procedures to screen children eligible for further services. Dworkin[2] advocated that surveillance, for the purpose of identifying

infants who may be experiencing developmental delays or disorders, should consist of a series of activities over time. Surveillance needs to be a flexible, continuous process and include parent information, relevant history, accurate infant observation, and continuous information sharing as the child develops.[2]

Barriers to Successful Screening

Current developmental screening recommendations of the American Academy of Pediatrics reaffirmed a 2001 policy statement that all children should be screened using standardized tests at each well child visit, following strong evidence that clinical judgment alone was not effective.[9] Researchers recently reported that only 23% of physicians use standardized tests during well child visits.[6] The most significant barrier to screening all children is time: 83% of pediatricians cited time and 49% cited lack of adequate reimbursement for their time.[6]

Efforts to address the time barrier have included the use of parent information screening tests. A study by Rydz et al[10] compared 2 standardized tests that provided parent information: the Ages and Stages Questionnaires (ASQ) and the Child Development Inventory. The researchers concluded that the resulting validity of these 2 tests (sensitivity 0.67 and 0.50; specificity 0.39 and 0.86) did not meet requisite standards of between 70% and 80% set as current screening recommendations. An effective screening protocol, therefore, continues to elude researchers and clinicians in pediatric medicine.[6,10]

Pediatric physical and occupational therapists have the knowledge and skills to become actively involved in preventive healthcare through early screening. In this study, nonphysician health professionals developed a screening clinic as an alternative strategy to screening in a pediatrician's office. Parents were invited to bring their questions and concerns to a developmental screening clinic staffed by nonphysician professionals, including physical therapists.
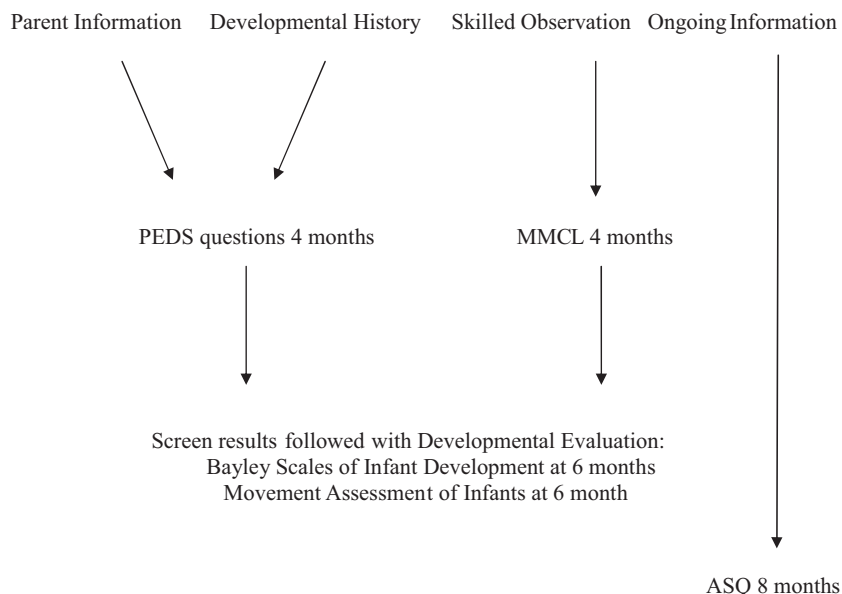
The purpose of this study was to create a screening protocol combining Dworkin's model of surveillance with detection and determine efficacy (Fig. 1). The model used 2 steps: parent concerns and an observational screening tool, to identify children at risk or with delay in any area of their development. A modification of the Parents' Evaluation of Developmental Status (PEDS) was selected to objectively determine parent concerns.[11] The infant's spontaneous movements were then scored with the Meade Movement Checklist (MMCL).[12] The infants screened using the 2 steps at 4 months of age were evaluated by an examiner blinded to screening results using the Bayley Scales of Infant Development II (BSID II)[13] and the Movement Assessment of Infants (MAI)[14] at 6 months of age. The 2 screening procedures addressed the primary barrier of physicians' professional time by using nonphysician health professionals to perform the screenings. This is 1 of only a few studies designed to determine if an alternative screening protocol, evaluated in a "real-world" clinical setting, can be more effective than physician office developmental screening routines reported in the literature.[2]

Four specific questions guided this research: (1) Will parent concerns accurately exclude infants who are developing typically? (2) Will infants be accurately referred for evaluation based on eligibility criteria for Individuals with Disabilities Education Act Part C early intervention services and scores on the MMCL?[12] (3) What is the relationship between the MMCL, the BSID-II[13] and the MAI?[14] (4) Will scores on the MMCL correlate with scores on the ASQ?[15]

METHODS

Participants

Parents of all infants (n = 213) who were 4 to 6 months old, adjusted for prematurity, residing in Houston

Parent Information   Developmental History   Skilled Observation   Ongoing Information

PEDS questions 4 months   MMCL 4 months

Screen results followed with Developmental Evaluation:
Bayley Scales of Infant Development at 6 months
Movement Assessment of Infants at 6 month

ASQ 8 months

Fig. 1. Theoretical framework adapted from Dworkin's model of developmental surveillance.
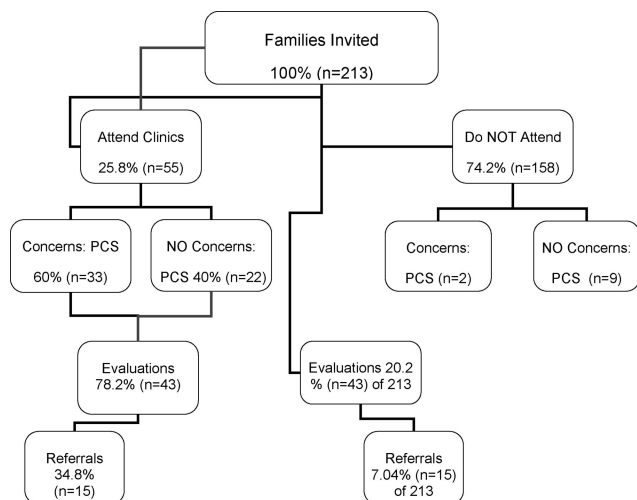
Fig. 2. Subject selection.

County, Minnesota, were eligible to participate in a program to screen their infants in all areas of development. Multiple, singleton, and preterm infants were included. The eligible infants were further divided into 2 groups, based on screening attendance. Group 1 included those parents who chose to attend, and group 2 included a random sample of parents who did not respond to the invitation to attend a screening clinic.

Group 1 included the infants (n = 55) attending the screening clinics. Of these infants, 43 were evaluated on a follow-up home visit when they were 6 months old, adjusted for prematurity. Parents were then sent the ASQ when their infants were 8 months old. Twenty-three ASQs were returned.

Group 2 consisted of a random sample of parents (n = 65) from the total group of parents (n = 158) who did not attend a screening clinic. The parents in group 2 received a follow-up letter, and the Parent Concerns Survey (PCS) was sent to their homes. Surveys were returned for 11 infants (Fig. 2).

The Institutional Review Board of Rocky Mountain University of Health Professions approved the use of human subjects for this study. Letters of agreement were obtained from the Director of Houston County Public Health, and parents also completed a consent form for the Public Health Department in Houston County, Minnesota.

Recruitment

All parents in Houston County, Minnesota, with infants who were 4 to 6 months old, adjusted for prematurity at the time of screening (n = 213), were invited to participate in the screening program. All eligible parents were sent an invitation to participate in 1 of 5 screening clinics in each town during a 1-year time period. A follow-up letter by Houston County Public Health staff was sent to each eligible child's parent to schedule a time to attend. Interested parents signed up for 1 of the scheduled sessions. Parents (n = 43) agreeing to a follow-up session for infant evaluation in their homes were then seen by the first author who remained blind to all subject information.

Instrumentation and Measurement

The following 5 tests were used to document information on the infants at different stages of the study.

Parent Concerns Survey. The author of the PEDS[11] gave permission to modify the test, which includes 4 PEDS questions (global/cognitive, expressive language, medical/other, and social emotional areas). Two additional questions were added: 1 question asking the parent to estimate their child's development[16] and 1 question about feeding performance.[17] Parents completed the PCS form. The first author scored the 4 PEDS questions and the 1 feeding question according to the specific criteria in the PEDS manual[11] to ensure reliability. The estimate questions had 3 multiple choice options. Additional reliability and validity studies were not completed on the PCS before this study.

Meade Movement Checklist.[12] The MMCL is a motor-based, observational screening test that is quick and easy to administer. The 27 items allow screeners to structure observations of infants, with adjusted ages (for prematurity) between 4 and 6 months, as parents actively interact and play with the child in 6 positions. The reliability of the screeners was measured twice: once after an initial day long training session and a second time midway through the data collection period using both a video film protocol and live infant models. Correlation ($ICC_{(3,1)}$) of 0.984 was obtained for the second session and when scores for the infants attending both sessions were combined.

Bayley Scales of Infant Development II.[13] The psychomotor development index (PDI) and mental development index (MDI) were used in this study. A cutoff of 1 SD below the mean was selected instead of 2 SD commonly used in Minnesota, because researchers have shown that children who scored as having only a mild delay may benefit from further evaluation and access to intervention services.[18] The first author was examined for reliability using video correlations with an experienced examiner during the data collection period. Every fifth child was chosen for videotaped reliability testing until 5 infants were videotaped to check accuracy of the measurement instruments. The following intraclass correlations were calculated: ICC = 0.84 for the MDI and ICC = 0.91 for the PDI.

Movement Assessment of Infants.[14] The MAI is specific in ruling out typical children at 4 months of age. It has excellent validity to 18 months[19] and has recently been shown to have predictive validity to 24-month cognitive scores on the BSID Mental Index in high-risk infants born at term.[20]

ASQ and Social-Emotional (ASQ-SE) Scales.[15] The parents or a primary caregiver completed a set of developmental questions. This screening tool is currently used for surveillance in Minnesota.

Data Collection

The public health staff members mailed 213 eligible parents a brochure and follow-up letter, scheduled attendance for screening clinics, and then sent follow-up letters and the PCS to a random sample of parents who did not

TABLE 1

Group 1 Demographic Characteristics by Parent Concern and Risk Status

Category	Parent Without Concerns (n = 22)	Parents with Concerns (n = 33)	Infants Followed on ASQ (n = 23)
Infant gender*			
Male	44%	56%	61%
Female	35%	65%	39%
Infant race			
White	20	32	20
Black	1	1	2
Other	1	0	1
Gestational age,†			
Mean (mo)	4.84	4.66	4.75
Age at test week,†			
Mean (mo)	4.75	4.89	7.88*
Multiple birth‡			
Median	0	2	0
Range	2	2	0
Birth order‡			
Median	2	2	2
Range	4	4	4
No. siblings‡			
Median	1	1	1
Range	4	2	4
No. risk positive status‡	8	26*	12
Family SES†			
Mean	3.0§	2.8	3.1
Range	4	4	4
Screen score†			
Mean	3.8	3.4	3.4
SD	±3.2	±3.1	±2.5
ASQ mean scores	274.1	266.8	

* Denotes statistically significant difference between groups.

† *t* test of difference between groups.

‡ Chi square test of difference between groups.

§ Measured by mother and fathers highest level of education scored 1–5.

ASQ indicates Ages and Stages Questionnaires.

TABLE 2

Sensitivity,* Specificity,† and Positive‡ and Negative§ Predictive Values as Measured by Parent Concerns and Parent Choice to Attend Clinics (Group 1 and Group 2)

	No. Parents Attending Clinic	No. Parents Not Attending Clinic	Total
No. parents concerned	33	2	35
No. parents not concerned	22	9	31
Total	55	11	66

* Sensitivity, 33/55 = 60.0%.

† Specificity, 9/11 = 81.0%.

‡ Positive predictive value, 33/35 = 94.2%.

§ Negative predictive value, 9/31 = 27.2%.

attend clinics and to MAI, BSID II mental, and motor index scores (dependent variables). The MMCL results were compared with scores on the MAI and BSID II mental and motor scores using the Pearson Product Moment Correlation coefficient.

RESULTS

Demographics

Two hundred and thirteen families of eligible infants were invited to attend a clinic, and 55 (25.8%) infants attended over the year. From these 55 infants, 43 (78.2%) detailed evaluations were completed by the first author, which represented 20.2% of the total number of infants. Of the 43 evaluations completed by the first author, 15 infants (34.8%) met referral criteria for evaluation, representing 7.04% of the total population invited (Fig. 2).

More male (n = 32; 58%) than female infants attended the clinics, and the majority of infants (n = 52; 92%) were white. Thirty four (68%) infants who attended the clinics were risk positive, which was defined for this study as any adverse factor in the pregnancy or birth history, subsequent illness, or established medical diagnosis. The sample included 2 sets of twins; both sets were born prematurely at 33 weeks of gestation (Table 1 for group 1 demographic variables by parent concern and risk category).

Step 1: Parent Concerns

Parent concerns were measured using 2 methods in this study, parent choice to attend clinics and parent documentation of their concerns on the PCS. Parents' choice to attend clinics effectively reduced the percentage of children who did not need to be screened (specificity 81%; Table 2). Of the 55 infants and their parents choosing to attend screening clinics, 22 (40%) listed no concerns on the PCS and 33 (60%) listed 3 or fewer (of 6 possible) concerns. The majority (61%) listed a concern about feeding. Parent concerns measured on the PCS and compared with the BSID II results were less specific (48%), resulting in a low positive predictive value (PPV) (32%) but a greater sensitivity (80%) in identifying infants who needed further evaluation.

respond. Parents attending a screening clinic completed consent forms, provided demographic information, and completed the PCS before 2 trained members of the Interagency Coordinating Committee guided parents and infants through the MMCL at 4 months of age. The first author evaluated infants of interested parents in their homes at the age of 6 months. The Director of Public Health sent all parents the ASQ to complete within a 1 month window when their infants were 8 months of age. A pilot study was completed 1 year before the start of this study to test all procedures. The pilot subjects included 51 eligible families invited to attend 1 of 5 clinics, and testing procedures were completed on 24 infants of families who chose to attend.

Data Analysis. Descriptive analyses were used for demographic information. Data were compared between parents with and without concerns using either the Student's *t* test or a Chi-square analysis (Table 1).

The PCS and MMCL data (independent variables) were evaluated for sensitivity, specificity, positive- and negative-predictive values compared with parent choice to

Sensitivity,* Specificity,† and Positive‡ and Negative§ Predictive Values
of MMCL and BSID PDI

MMCL	PDI of BSID >1.0 SD Below Mean	PDI of BSID Within 1SD of Mean	Total
MMCL >6 risk points	7	3	10
MMCL 6 or less risk points	1	32	33
Total	8	35	43

* Sensitivity, 7/8 = 87.5%.
† Specificity, 32/35 = 91.4%.
‡ Positive predictive value, 7/10 = 70.0%.
§ Negative predictive value, 32/33 = 96.9%.
MMCL indicates Meade Movement Checklist; BSID, Bayley Scales of Infant Development; PDI, psychomotor development index.

TABLE 4

Means and Correlation of MMCL and MAI, MDI and PDI

	N	Mean	Standard Deviation	r*
MMCL	43	3.88	3.268	
MAI	43	6.28	6.878	0.58
MDI of BSID II	43	91.56	10.89	−0.323
PDI of BSID II	43	98.63	17.959	−0.467

* Pearson correlation with MMCL.
MMCL indicates Meade Movement Checklist; MAI, Movement Assessment of Infants; PDI, psychomotor development index.

Of the 55 infants attending the clinics, only 1 difference was found between parents with and without concerns. Parents with concerns had more infants who were risk positive (n = 26; p = 0.002; Table 1). No statistically significant infant demographic differences (sex, race, birth order, sibling number, and socioeconomic level) were found between parents with concerns compared with parents without concerns identified on the PCS (Table 1).

Parents in group 2, the random sample of parents (n = 65) not attending the clinics were sent the PCS. Only 11 returned the completed forms and 2 parents (18%) listed a concern, suggesting that the parents who chose not to attend, had fewer questions or concerns and were therefore not interested in attending. Parents attending the screening clinics had significantly (χ^2 = 6.43, p = 0.011) more concerns listed on the PCS, compared with parents who did not attend.

Step 2: Skilled Observation

The MMCL, the second step of the screening process, was valid in identifying infants needing further evaluation. Fifty-five infants were screened with the MMCL at an average age of 4 months and 8.4 days (±7.9 days). The BSID II and MAI were completed as the comparison tests, with 43 infants at an average age of 5 months and 3.9 days (±7.4 days). The average age during administration of the screening tests was not significantly different between the infants of parents with concerns and the infants of parents without concerns (Table 1).

When the BSID II included scores on both the mental (MDI) and motor (PDI) development indices, the MMCL

was sensitive (77.8%) and specific (88.2%), with high PPV (63.6%) and negative predictive value (93.8%). Rescoring of the MMCL with the PDI as the comparison test, resulted in higher sensitivity (87.5%), specificity (91.4%), PPV (70%), and negative predictive value (96.9) (Table 3).

Concurrent validity was demonstrated between the MMCL and both comparison tests, the BSID II and the MAI. The MMCL was significantly correlated with all tests (Table 4). More than one fourth of clinic attendees (27.7%) were referred for further evaluation.

Follow-up Evaluations

No relationship was found between screening results at 4 months and the ASQ scores. A limited number of forms, n = 23 (42%), were returned, consistent with another clinical research study in which only 54% of ASQ forms were returned for infants aged 12 and 24 months.[21] Parents completed 8 month ASQs when the infants were an average age of 7.9 months. All questionnaires were completed in the recommended window of 1 month on either side of the age point. Parents and infants were not different on any demographic variables measured (see Table 1). Twenty of the 23 returned ASQ forms represented infants who scored in the normal range (6 or fewer points) on the MMCL between 4 and 6 months of age. As a result, only specificity (86%) could be calculated because 2 cells were n = 0.

DISCUSSION

This 2-step screening process was effective and yielded the highest PPV (70%) currently reported for developmental screening of infants at 4 months of age. Three important points determined the success of this protocol over other screening strategies. First, parent concerns were measured both by choice to attend clinics and by a questionnaire, the PCS. Parents with concerns chose to attend the screening clinics, resulting in a group of infants who received a second screen, which increased the efficacy of the process as measured by the PPV. Second, an observational movement screen, the MMCL was used instead of a general developmental screen as step 2. Finally, as recommended by Portney and Watkins,[8] combining 2 tests (the PCS and MMCL) was more accurate than using 1 test alone. This study successfully identified infants and used 2 tests, creating an effective community screening protocol. Nonphysician health professionals screened only 25.8% of an infant cohort and referred 27.7% of these clinic attendees for further evaluation. These procedures saved valuable physician time, the primary barrier to screening.

Step 1: Parent Concerns

Parents with concerns actively decided to attend a community clinic focused on their infants' development. Only 1 other study by Castro and Yolton[22] indicated that parents with concerns will attend a clinic. Many of the parents' concerns regarded subtle behaviors such as feeding, and parents may have attended to seek reassurance. Forty-four percent of infants whose parents had concerns

met the referral criteria. In contrast, most infants whose parents did not have concerns scored within normal limits.

Inviting parents to attend was an efficient strategy to identify infants needing to be screened and saved valuable time. Of the families invited, 25.8% attended, effectively excluding almost 75% of the population. Of the 2 strategies used to measure concerns, parent choice to attend the clinics (specificity 81%) more successfully excluded infants developing typically than measuring parent concerns using the PCS (specificity 48%). In this study, only 55 infants needed to be screened to refer 7.04% of the total cohort of 213 for further evaluation (Fig. 2). In contrast, researchers using a standardized screening test of parent information in a physician practice needed to screen the complete cohort of 1428 children to refer a similar 7.5% for evaluation.[21]

Parents' listing of concerns on the PCS identified (sensitivity 80%) the infants needing further evaluation. Sensitivity of the PCS was higher than the findings of Glascoe,[11] while specificity was similar. Glascoe[11] determined that using the 10 questions of the PEDS with infants (n = 86 infants; birth to 18 months old) resulted in a sensitivity of 75%. The PPV for the modified PEDS was much higher (32% for the modified PEDS, PCS, compared with a PPV of 16% using the PEDS[11]), and the PCS was shorter (6 vs 10 questions). The higher PPV of the PCS may be due to the choice of questions, a variable for future analysis.

Investigators Majnemer and Barr[23] and Monson et al[24] have raised questions about the validity of screening typical populations of 6-month-old infants since the initiation of supine sleep position guidelines.[23] In this study, parents with concerns had significantly more (n = 26; p = 0.002) risk positive infants with lower developmental scores compared with infant scores of parents without concerns. This finding is consistent with Castro and Yolton[22] who found that infants born preterm (n = 1483) attending follow-up clinics had lower Bayley MDI scores than infants not attending clinics. The research by Glascoe[18] also indicated that parents with concerns had children with lower developmental scores. Only 15% of the parents with concerns in this study listed a concern about general development, consistent with a study by Bailey et al,[3] which indicated the average age that parents became concerned about their infant's development was 7 months. In contrast to these studies of typical infants, the infants in this study were identified for earlier screening by their parents' concerns.

The current sample included risk positive infants and differed from previous research because the sample was self-selected by parents rather than professionals. Of the 34 infants with a risk-positive status, 15 (44%) were referred for further evaluation. This finding supports the value of screening those infants with parent concerns and questions the recommendations by the American Academy of Pediatrics[9] and Glascoe et al[25] that all infants may need to be screened. Interestingly, 13 of the 15 infants identified as risk positive and referred for further evaluation in this study had not been previously identified as at risk by the local public health system. The majority of these infants were being followed by pediatricians, but had not been referred for evaluation. Only 1 of the 2 sets of twins, already known to the system, met criteria for referral.

Step 2 Screening Phase: Skilled Observation

Combining the PCS and MMCL in 2 steps resulted in higher validity. The MMCL was compared with 2 in-depth comparison evaluations, the BSID II and the MAI, which take time and extensive training, but ensure that the infants who were referred would meet the strict eligibility criteria for Early Childhood Special Education in Minnesota at the time this study took place. The MMCL compared well with the PDI (sensitivity 87.5% and specificity 91.4%), distinctly above the recommended range of 70% to 80% for a screening test.[25] The correlations between the MMCL and both comparison tests indicated that these infants would go on to meet the referral criteria for services when examined by the team at a later date. Trained screeners can be confident that using the MMCL in primary care settings will accurately designate those infants needing further evaluation.

Although it is often recommended to screen all areas of development, the 27 test items of the MMCL highlight the contribution of movement at 4 months of age. The infant must be posturally stable in each position to successfully interact with parents and toys. Even with a motor focus, higher risk scores on this screening test do not predict that a baby will have a motor impairment. Another well known infant screening test, the Alberta Infant Motor Scale was not selected as the second screen because the PPV at age 4 months (39%) did not meet the requisite screening standard of 70%.[26]

The 15 infants who met referral criteria were not a homogenous group. No single characteristic set this group apart, except that each infant had a variable in the pregnancy, social, or biological history that placed them into a risk positive category. Only 2 participants had a motor impairment (torticollis). The other infants continued to need extra help in a variety of developmental areas. At 18 months, the infants in Early Childhood Special Education continued to meet referral criteria, particularly for speech development.

Other researchers support that early movement scores may predict performance in other areas of development. Rose-Jacobs et al[20] found that the movement "risk" scores on the MAI for a group of 4-month-old infants at high social risk correlated with BSID mental index scores when the children were 2 years old. Current research by Taanila et al[27] supports the association of motor development rate in the first year, with 30-year outcomes in academic and educational achievements. The authors suggested that, although children may test as "normal," those with more rapid motor development may have a "biologic advantage" illustrated by their higher performances in life skills over time.[27]

Validity and PPV of 2 Steps

Although parent attendance at the clinics excluded typical children (specificity 81%), adding the second

screen increased the specificity to 88.2%. Although other authors have advocated screening in 2 steps, only Glascoe[11] compared 1 screen (the PEDS) with a second step developmental screen, the Brigance. Glascoe[11] recorded similar results for both steps and recommended referral after step 1, the PEDS test. This recommendation would require evaluating approximately 3 children who tested positive to select 1 with the target condition, which would result in a resource-expensive protocol. Addition of the MMCL in this study brought the specificity value closer to an optimal of 90%, which also increased the PPV.

Portney and Watkins[8] advocated that the PPV is the most important value to determine the feasibility of implementing a screening program because it indicates effectiveness in identifying the target condition with the least missed cases and consequently, the use of expensive resources. Identifying a population and increasing the specificity of a test are 2 recommendations offered to increase PPVs when the prevalence rate (number of cases in a population) of a condition is low.[7] Both strategies were successfully used in this study to increase the PPV to the optimum 70% recommended by Glascoe et al.[25] This study demonstrated that identifying parents with concerns and excluding typical infants allowed testing of fewer infants and referral of a larger proportion, resulting in better use of limited professional resources.

Limitations

Several limitations may have influenced the results of this study. First, we found a smaller than expected number of parents attended each screening clinic. The initial estimate that 50% of parents would attend the screening clinics was based on pilot study results. Second, interrater reliability continued to be a challenge throughout this project and had to be consistently and successfully addressed by training each interested staff member (using the MMCL training film). Third, parents often chose to attend at the end of their workdays when the infants were tired. Although the MMCL takes 5 minutes to perform and did not likely affect the outcome, the full evaluation takes approximately 1 hour, and infant fatigue may have contributed to lower correlations between the screen (MMCL) and the comparison tests (BSID II and MAI).

Future Directions

Screening young infants is an important goal, but expensive to perform successfully. Future research could determine if using 2 step screening as part of community surveillance will balance costs and benefits for all stakeholders. Calculation of interrater reliability with the PCS would be useful in large screening programs. Even when the process is shown to be effective, overhead expenses should be determined. Evaluation and intervention expenditures need to be compared with intensity of manpower, delay in starting services, and satisfaction of families.

Because this study took place in a region populated primarily by white people, replication should occur with ethnically diverse participants. Long-term follow-up would document the evolving development in infants screened at 4 to 6 months of age. Further study is also recommended to evaluate the outcome of infants who do not attend screening clinics.

Clinical Relevance

Physical and occupational therapists developed and validated this screening protocol for 4- to 6-month-old infants as an alternative to screening in busy physician practices. Inviting parents to bring their questions and concerns to a clinic focused only on their infant's development resulted in fewer infants needing to be screened (25.8%). The effectiveness of the second level screen, the MMCL, allowed more of these infants to be correctly identified for evaluation, saving valuable physician time. In contrast to the majority of children with disabilities who are not referred until older ages, the children in this study (4–6 months of age) will have the advantage of very early intervention to promote optimal developmental outcomes.

Pediatric physical and occupational therapists have the knowledge and skills to be actively involved in first level, community screening. The APTA's Vision 2020[28] states the physical therapist will be the practitioner of choice for consumers. Screening clinics afford an opportunity for pediatric therapists to interact with consumers at a potential entry point to services.

CONCLUSION

This 2-step developmental screening process illustrates the most effective community screening protocol reported for 4- to 6-month-old infants. Implementation of a valid, efficient community-based protocol for young infants addresses the primary barrier of time and provides a new perspective for infant developmental screening outside the typical time limitations of the physician's regular office visit.

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