The Cost-Effectiveness of Home Visiting Versus Group Services In Early Intervention

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This paper examines the cost-effectiveness of providing early intervention services to individual children and families in their own homes versus providing services to small groups of children and families at an early intervention program site. The analysis estimates the amount of change in adaptive behavior, mother-child interaction, and parenting stress associated with each service for subgroups of children that vary by age at entry into early intervention and by severity of disability. The results suggest that the service identified as more cost-effective varied by subgroup and outcome measure. The findings are reviewed in light of the strengths and weaknesses of the methodology used. Critical issues for future research are discussed.

The provision of early intervention (EI) services according to the mandates of P.L. 99–457 presents providers, family members, and policy-makers with many challenges around service delivery and resource distribution. First, the children entitled to receive services vary considerably in terms of the type and severity of their disabilities (Meisels & Wasik, 1990). Meeting the needs of this heterogeneous population requires that EI programs provide "a broad range of service options, extending from ongoing monitoring and the provision of educational materials to intensive, multidisciplinary team efforts" (Shonkoff & Meisels, 1991, p. 22). Second, the law requires that an individualized family service plan (IFSP) be developed for each eligible child and family (Education of the Handicapped Act Amendments of 1986, 100 Stat 1149–1150, Sec. 677). Under this provision, parents and EI professionals must work together to set goals and decide on the types and amounts of services necessary to reach those goals. Third, although the legislation earmarked some federal money to the states, each state must assume primary responsibility for using its limited resources to finance EI services for all eligible children and families.

Under P.L. 99–457, therefore, the challenge is to match services and recipients so that individual children and families can get their needs met and individual states can cover their financial obligations. Currently, however, data regarding the most efficient way to match services and recipients are incomplete.

A cost-effectiveness analysis is one technique that can be used to provide insights into these types of EI service delivery decisions. A cost-effectiveness analysis compares two or more models of intervention designed to achieve the same goal, by estimating both the monetary value of the resources used to deliver the services within each model and the effect of providing those services (Barnett, 1986). To conduct a cost-effectiveness analysis, specific components of an intervention must be identified (Levin, 1993). EI services
differ within and across a wide range of dimensions including location, curriculum focus, rationale, timing, duration, intensity, and the primary recipient of the intervention (Guralnick & Bennett, 1987). Location of service delivery is typically as either home-based services to individual children and families or center-based services to small groups of children and families (Hanson & Lynch, 1989; Peterson, 1987).

The contrast between home-based and center-based group services is important to examine from research, service delivery, and public-policy perspectives for two reasons. First, decisions about the type of service to provide are often influenced by the child's age and severity of disability (Hanson & Lynch, 1989; Peterson, 1987). Home-based services are more likely to be provided to younger infants, whereas center-based group services are more common for older toddlers (D.B. Bailey & Simeonsson, 1988; E.J. Bailey & Bricker, 1985; Erickson, 1992). For example, some programs serve infants at home on a weekly basis until they are 12 to 18 months old and then provide group services for a few hours once a week (Hanson & Lynch, 1989). Further, regardless of age, children with severe disabilities have been found to receive more hours of home visits than those with milder impairments (Erickson, 1992; Shonkoff, Hauser-Cram, Krauss, & Upshur, 1992). The efficiency of these common service patterns should be examined.

Second, the data available on the cost and effectiveness of home-based individual versus center-based group services also suggest that this is an important dimension of service delivery to study. Barnett and Escobar (1990) conducted a comprehensive review of the costs of 13 center-based and 8 home-based EI and compensatory educational programs. Whereas the center-based programs were more expensive than the home-based programs in terms of the total cost per child, the home-based programs provided fewer hours of service at a higher cost per hour. In addition, two cost-effectiveness analyses comparing the efficiency of home-based individual and center-based group services for preschool children with speech disorders found that the home-based model produced significantly larger gains in speech and language functioning and was either less expensive or the same cost as the center-based model (Barnett, Escobar, & Ravsten, 1988; Eiserman, McCoun, & Escobar, 1990).

In order to expand upon these initial cost-effectiveness analyses, samples of children with a wider range of disabilities must be studied, and a broader set of outcomes must be measured. Previous efficacy studies have focused on increased intelligence as the primary outcome even though the goals of EI are more multifaceted (Cicchetti & Wagner, 1990). The concept of social competence is now viewed as a more appropriate child outcome to measure (Shonkoff et al., 1992). This concept includes two aspects of behavior: adaptive behavior measures each child's ability to meet societal expectations, and child-mother interaction refers to how well a child develops interpersonal relationships. Previous studies have found that subgroups within the population of children with disabilities display differential skills in these domains (Shonkoff et al., 1992).

Further, previous efficacy studies have often been limited by failing to assess family outcomes (Shonkoff & Hauser-Cram, 1987). The provision of EI services to mothers and fathers is designed to enhance the way in which they adapt to the demands of parenting a child with a disability. Adaptations involve developing skills to build a positive relationship with their child and minimize the stresses associated with parenting (Meisels, 1988). These skills are critical because they enable parents to build the type of caregiving environment necessary to promote the cog-
nitive and social development of their children (Guralnick, 1989).

Thus, the available literature provides some evidence that home-based individual and center-based group services differ both in terms of cost and, on a limited number of child-focused outcomes, efficiency. Further, the provision of these services varies according to certain child characteristics. No studies, however, have examined the cost-effectiveness of these two service types for different groups of children across multiple child and family outcomes. The purpose of this paper, therefore, is to conduct a cost-effectiveness analysis to compare the efficiency of home-based individual versus center-based group services. Comparisons are made between subgroups of children varying by age at entry into EI and severity of disability, across a variety of child and maternal outcomes.

The following four research questions will be addressed:

1. Based on the total amount of EI service hours received, what is the average change per hour in child competence and maternal adaptation for subgroups of children varying by age at entry and severity of disability?

2. Is there a difference between the younger and older subgroups in the mean level of change in child competence and maternal adaptation associated with 1 hour of home visiting versus 1 hour of group services?

3. Is there a difference between the subgroups of children with mild versus severe disabilities in the mean level of change in child competence and maternal adaptation associated with 1 hour of home visiting versus 1 hour of group services?

4. How does the mean level of change per hour in each outcome compare to the cost per hour of each service type?

METHODS

Subjects

The children and families in the sample are part of the Early Intervention Collaborative Study (EICS) conducted at the Department of Pediatrics of the University of Massachusetts Medical School with the assistance of 29 publicly supported EI programs in Massachusetts and New Hampshire. The purpose of this longitudinal research is to assess the impact of EI services on a variety of child and family outcomes (see Shonkoff et al., 1992, for an expanded discussion of the EICS methodology). Since cost data were available only for the EI services provided by the 25 Massachusetts programs, the present analysis is conducted on the Massachusetts subsample (n = 157) of the total project sample (N = 190).

By design, the EICS sample included children with Down syndrome, motor impairment, and developmental delays of uncertain etiology. For the Massachusetts sample, the number of children in each diagnostic category was 42, 64, and 51, respectively. The mean age of these children at study enrollment was 10.5 months (SD = 6.5, range = 1.3–26.9). Because the sample was fairly evenly split between children entering EI before and after their first birthday, two age groups were examined. There were significant differences between the diagnostic groups by age at entry ($\chi^2 = 45.97, p = .000$). All (100%, n = 42) of the children with Down syndrome, 39 (61%) of those with motor impairments, and 16 (31%) of those with developmental delays, entered before they were 12 months old.

The children’s mean mental developmental index (MDI) at study entry was 63.53 on the Bayley Scales of Infant Development (Bayley, 1969). Because the lowest standard MDI score on the Bayley is 50, two groups based on level of cognitive impairment were created: mild (MDI > 50) and severe (MDI <
Almost all (93%, n = 39) of the children in the Down syndrome group were defined as having mild cognitive impairment, whereas almost two-fifths (39%, n = 25) of those with motor impairment were identified as more severely disabled. Over two thirds (71%, n = 36) of the children with developmental delays were defined as mildly impaired.

Most of the mothers were married (80%), white (91%), and listed their primary occupation as homemaker (62%). Two thirds (67%) of the families had a yearly income of $20,000 or more.

Procedure
Detailed data on the type, amount, and estimated value of all services received by each family as well as outcome data to assess effectiveness were gathered from various sources. Families were recruited between December 1985 and January 1988, during their initial intake interview into an EI program. All of the children and families in the sample were visited in their homes by the EI's staff within 1 month of their entrance into an EI program (T1) and then again one year later (T2). During each visit, the EI's staff gathered data through interviews and observations and left a packet of questionnaires for parents to complete and mail back to the research office.

Outcome Data
Three instruments were used to assess different aspects of child social competence and maternal adaptation. Adaptive behavior was measured by the Vineland Adaptive Behavior Scales (Sparrow, Balla, & Cicchetti, 1984). The Vineland is commonly used to measure social competence in children ages birth to 18 years (American Association on Mental Retardation, 1992). The interview version was used and four domains were assessed: communication, daily living skills, socialization, and motor skills. These scores were combined into an adaptive-behavior composite age equivalence score. The Cronbach’s alpha reliability coefficient for adaptive behavior in this analysis was .95.

Children’s ability to interact with their mothers was measured during the T1 and T2 home visits using the Nursing Child Assessment Teaching Scales (NCATS) (Barnard, 1978). The NCATS is a 73-item scale completed by an observer who evaluates the interaction between a mother and child. The observation occurs while the mother teaches her child a task that is above the child’s ability level so that an assessment of adaptive patterns in the child-mother dyad can be made. Trained EICS data collectors who were blind to the study’s hypotheses conducted all assessments. The behaviors scored reflect the child’s ability to produce clear cues for the mother and to respond to the mother. The Cronbach’s alpha reliability coefficient for this outcome was .73.

Mothers’ interactions with their children were also assessed using the NCATS. The adaptive behaviors scored for the mother are sensitivity to her child’s cues and success in alleviating her child’s distress as well as fostering emotional and cognitive growth in her child. The Cronbach’s alpha reliability coefficient for this outcome was .71.

The Parenting Stress Index (PSI, Abidin, 1983) was used because it is considered appropriate for measuring stress in families that have children with a variety of disabilities. The PSI is a self-report measure consisting of 101 Likert-type items. Mothers completed the PSI after each home visit. The summary score for the parenting stress domain was used. This domain assesses various aspects of parenting, including depression, attachment, restriction of role, sense of competence, social isolation, relationship with spouse, and parent health. The Cronbach’s alpha reliability coefficient for this outcome was .84. Analyses using the PSI were based on a sample of 124, due to missing data.
Service Data
In December 1983, Chapter 699, which mandated that Medicaid reimbursement be secured for EI services, was enacted in the state of Massachusetts. Because Medicaid requires that uniform units of service and set rates for those services be established, the Department of Public Health (DPH) commissioned a study to identify and define uniform types of EI services and to set rates by which programs would be reimbursed for providing each type of service (Harrison, 1984).

The analysis determined that EI programs provided six core types of services: (a) home visits, (b) services provided to small groups of children and families at the EI program site (i.e., group services), (c) services provided to individual children and families at the EI program site (i.e., center-based individual services), (d) parent support group services, (e) screenings, and (f) assessments. Professionals from a variety of disciplines (e.g., education, social work, nursing, and physical, occupational, and speech therapy) work either individually or in teams to provide these services.

To be defined as a home visit, services had to be provided in the family's home or other approved setting outside of the program site for the purpose of furthering the child's developmental progress (Harrison, 1984). Typically, a home visit would occur once per week or once every other week for approximately 1 hour and could involve counseling the parent, teaching the parent a specific therapeutic technique, or working with the child on a specific activity.

To be defined as a group session, services had to be provided at an EI program site to either a group of children or a group of both children and parents for the purpose of furthering the child's developmental progress. As defined by state law, the size of these groups varied depending on the size of the classroom, the number of EI staff present, and the ages of the children involved. Fairly intense staff:child ratios were required. For example, one staff member had to be available for every two infants or every three toddlers. Thus, on average, groups did not include more than six to eight children.

EI programs would often combine group services with parent support meetings. During a typical 1½- to 2-hour group session, children and parents would be involved together for the first 15 to 30 minutes, depending on the age of the child, while the remainder of the session would involve only the children and EI staff. Group sessions often involved the provision of therapeutic services and socialization services and would be provided once per week or twice per week at most.

Voluntary parent support group services were offered to all families enrolled in EI programs (Krauss, Upshur, Shonkoff, & Hauser-Cram, 1993). Groups of four to eight parents (usually mothers) would meet once a week to share information, provide emotional support, discuss specific parenting techniques, or receive advocacy training. A social worker, nurse, or educator facilitated group sessions, but parents were involved in setting the agenda for each group or leading the groups themselves.

Center-based individual sessions were mostly used to provide therapeutic services to either the child alone, the parent alone, or the parent and child together. Screenings were conducted upon entry into EI to determine eligibility, and assessments were conducted about twice a year to gather information necessary to review service delivery plans.

DPH reimburses EI programs for the provision of these six types of services to Medicaid-eligible children and their families as well as to Medicaid-eligible children for services Medicaid will not cover. For example, Medicaid does not pay for services provided by an educator, but does reimburse programs.
for EI services provided to eligible children and families by members of other disciplines.

For the EICS study, EI providers completed 12 monthly service forms for each child and family by recording the number of hours of service received through each of the six service types. A family's participation in the EICS study did not influence the amount or type of services they received. Services were individualized in accordance with the needs identified jointly by family members and EI staff. As a result, the total amount of services received varied tremendously. The number of hours of service received by a family during their first year in EI ranged from 10.8 to 267.4 (M = 94.9, SD = 55.6).

Of the six types of services provided, on average children and families received more hours of home visits (M = 39.5, SD = 22.5, range = 0.0–11.5) and group services (M = 32.1, SD = 32.4, range = 0.0–137.1) than parent support services (M = 12.8, SD = 18.0, range = 0.0–76.0), center-based individual services (M = 6.1, SD = 10.6, range = 0.0–57.6), screenings (M = 1.4, SD = 0.8, range = 0.0–4.0), or assessments (M = 3.1, SD = 1.9, range = 0.0–11.0).

**Expenditure Data**

Once the six core types of EI services were identified and defined, a unit cost analysis was conducted. All EI programs participated in a 2-week time study to develop a basis for applying costs to services (Harrison, 1984). Data on both actual costs and donations were documented in the following categories: personnel, occupancy, and operating expenses.

Personnel costs included salaries, payroll taxes, fringe benefits, contracted services, and staff mileage allowances. Occupancy costs included taxes, insurance, utilities, repairs and maintenance, and rent. Operating expenses included staff training, office supplies, transportation costs, food, medical and educational supplies, equipment, depreciation, and indirect costs.

For fiscal year 1988 (i.e., when the majority of services received by the EICS sample were provided), home visits were reimbursed at a rate of $53.68 per hour, and group sessions were reimbursed at $21.52 per hour.

**Data Analysis**

The end product of a cost-effectiveness analysis is a set of ratios comparing the amount of change in an outcome measure associated with a particular intervention to the cost of delivering that intervention. In general, the cost-effectiveness of any type of intervention is assessed most easily when an experimental or strong quasi-experimental research design is used, in which individuals with similar characteristics are assigned to one of two or more groups (Barnett, 1988; Levin, 1983). Although each group receives a different set of predetermined services, individuals in any one group receive the same type and amount of services.

In contrast, the EICS project was designed as a prospective, pretest-posttest study with no control or comparison group. Sample selection was based on the child's type of disability and age (Shonkoff, et al., 1992). Rather than assigning individuals to receive a set amount of home visits or a set amount of group services, sample members received different amounts of services and, in most cases, received both home visiting and group services during their first year in EI. Further, previous analyses have indicated that different child and family characteristics are significantly correlated with the receipt of different types of services (Erickson, 1992).

Thus, the design of the EICS study does not fit the criteria for a conventional cost-effectiveness analysis. Therefore, a complex, three-step procedure was used: multiple regression equations run on the full sample (in combination with cost-per-hour values) esti-
mated a set of cost-effectiveness ratios for specific subgroups.

The first step involved estimating the hours of service received by subgroups of children varying by age at entry and severity of disability. Correlation analyses between variables measuring hours of service provision and a variety of child and family demographic features were conducted. The characteristics significantly associated with at least two of the six types of services provided were entered into the multiple regression and tobit equations in Table 1.

Regression analysis was used to investigate the predictors of hours of home visits, screenings, and assessments. In addition, because portions of the sample did not receive any hours of group (22.3%), center-based individual (38.9%), or parent support (40.8%) services, tobit analyses were conducted to identify the predictors of those service hours. The tobit technique is a modified version of regression that is used when the distribution of the dependent variable has a large number of values clustered at one point, usually zero (McDonald & Moffitt, 1980; Tobin, 1958). The coefficients generated from a tobit analysis can be interpreted in the same way as regression coefficients (Amemiya, 1984).

Estimates of the average hours of service received by a particular subgroup of children and families can be calculated from the data in Table 1 by multiplying a value for each independent variable by the coefficient associated with that variable and adding in the constant term (Agresti & Finlay, 1986). Because each independent variable was entered as a dummy variable, each coefficient can be multiplied by a value of one if the characteristic is present or by a value of zero if the characteristic is not present. Thus, by defining values of the four dummy variables in each equation, estimates of the mean hours of service received by specific subgroups within the overall sample were calculated.

Since the purpose of this analysis is to ex-

| TABLE 1 |
|------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
|                  | Home Visits | Group Services | Center-Based Individual | Parent Support Group | Screening | Assessment |
| Independent Variables | b | t | b | t | b | t | b | t |
| Severe Disabilites | 17.0 | 4.2*** | 9.2 | 1.3 | -0.5 | -0.2 | 13.2 | 2.7* |
| Less than 12 Months of Age at Entry | 4.9 | 1.2 | -28.0 | -4.0*** | -5.0 | -1.7 | -13.0 | 2.5* |
| Down syndrome | -1.1 | -0.2 | 3.4 | 0.4 | 1.1 | 0.3 | 12.7 | 2.2* |
| Yearly Income > $20,000 | 0.0 | 0.0 | 2.8 | 0.4 | 6.1 | 2.3* | 9.2 | 2.0* |
| Constant | 32.1 | 39.3 | 0.6 | -0.2 | 2.0 | 9.4 |

Notes: Regression analyses were conducted for hours of home visits, screenings, and assessments. Tobit analyses were conducted for hours of group, center-based individual, and parent support group services.  
$b = b$-regression and tobit coefficients  
t = t-test statistic  
* $p < .05$; *** $p < .001$
amine the influence of age and severity of disability on the cost-effectiveness of home visiting and group services, subgroups representing the following four combinations of characteristics were analyzed:

1. children with mild disabilities who entered EI at less than 12 months of age, who were diagnosed as having either motor impairments or developmental delays, and whose families earned more than $20,000 per year
2. children with severe disabilities who entered EI at less than 12 months of age, who were diagnosed as having either motor impairments or developmental delays, and whose families earned more than $20,000 per year
3. children with mild disabilities who entered EI at greater than 12 months of age, who were diagnosed as having either motor impairments or developmental delays, and whose families earned more than $20,000 per year
4. children with severe disabilities who entered EI at greater than 12 months of age, who were diagnosed as having either motor impairments or developmental delays, and whose families earned more than $20,000 per year.

Using the values in Table 1, the estimated mean hours of home visits received by the first subgroup of children described above were calculated as follows:

Estimated Hours of Home Visits = k + b₁Sev + b₂LT12 + b₃DS + b₄HIGH + E,

where k = constant term, b₁ = coefficient associated with each variable, Sev = dummy variable identifying those with severe disabilities, LT12 = dummy variable identifying those who entered EI at less than 12 months of age, DS = dummy variable identifying those with Down syndrome, HIGH = dummy variable identifying those whose families earned more than $20,000 per year, and E = error term.

Estimated Hours of Home Visits = 32.1 + (0) (17.0) + (1) (4.9) + (0) (-1.1) + (1) (0.0) = 37.0 hours

The estimated hours for each service type and subgroup are presented in Table 2. Total hours for each subgroup were estimated by adding together the hours for each of the six service types.

It would have been possible, mathematically, to use the equations in Table 1 to estimate the mean hours of service received by subgroups of children with Down syndrome. Given the way in which the sample was recruited, however, all children with Down syn-

### TABLE 2

Estimated Hours by Service Type and Subgroup

<table>
<thead>
<tr>
<th>Subgroup</th>
<th>Home Visits</th>
<th>Group Services</th>
<th>Center-Based Individual</th>
<th>Parent Support</th>
<th>Screening</th>
<th>Assessment</th>
<th>Total Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild, LT12</td>
<td>37.0</td>
<td>14.1</td>
<td>1.7</td>
<td>0.0</td>
<td>1.5</td>
<td>8.5</td>
<td>62.8</td>
</tr>
<tr>
<td>(n = 22)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sev, LT12</td>
<td>54.0</td>
<td>23.3</td>
<td>1.2</td>
<td>9.2</td>
<td>1.6</td>
<td>8.4</td>
<td>97.7</td>
</tr>
<tr>
<td>(n = 11)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild, GT12</td>
<td>32.1</td>
<td>42.1</td>
<td>6.7</td>
<td>9.0</td>
<td>1.6</td>
<td>9.5</td>
<td>101.0</td>
</tr>
<tr>
<td>(n = 22)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sev, GT12</td>
<td>49.1</td>
<td>51.3</td>
<td>6.2</td>
<td>22.2</td>
<td>1.7</td>
<td>9.4</td>
<td>139.9</td>
</tr>
<tr>
<td>(n = 17)</td>
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<td></td>
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</tr>
</tbody>
</table>

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drome entered EI at less than 12 months of age and the vast majority (92.9%) had mild disabilities. Thus, subgroups of children with Down syndrome varying by age at entry and severity of disability are not representative of common groups in the overall sample, so hours estimates were not calculated for them. Similarly, subgroups of children from families who earned less than $20,000 per year are not representative of typical children in the sample since two thirds of all families had a yearly income of $20,000 or more.

The second step in estimating cost-effectiveness ratios involved constructing and testing three types of ordinary least-square regression models to investigate the relation between hours of service and change in the outcome measures (see Erickson, 1991, for a more detailed discussion of how different regression equations were developed and tested). The best fitting model is represented by the regression equations in Table 3. The dependent variables were measures of the gain per hour (i.e., calculated by subtracting the T1 score from the T2 score and dividing by total hours) in adaptive behavior, child-mother interaction, and mother-child interaction, and the reduction per hour (i.e., calculated by subtracting the T2 score from the

### Table 3

**Multiple Regression Coefficients for Change-Per-Hour Measures (N = 157*)**

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Adaptive Behavior</th>
<th>Child-Mother Interaction</th>
<th>Mother-Child Interaction</th>
<th>Parenting Stress</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>b</td>
<td>t</td>
<td>b</td>
<td>t</td>
</tr>
<tr>
<td>Log of Pre-Intervention Score</td>
<td>-0.041</td>
<td>-2.015*</td>
<td>-0.184</td>
<td>-7.005***</td>
</tr>
<tr>
<td>Log of Hours of Service Received</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Home Visiting</td>
<td>-0.086</td>
<td>-2.029***</td>
<td>-0.022</td>
<td>-1.539</td>
</tr>
<tr>
<td>Group Services</td>
<td>-0.020</td>
<td>-2.580**</td>
<td>-0.001</td>
<td>-0.114</td>
</tr>
<tr>
<td>Center-Based Individual Parent Support</td>
<td>-0.028</td>
<td>-3.243**</td>
<td>-0.023</td>
<td>-2.447*</td>
</tr>
<tr>
<td>Group Screening</td>
<td>-0.019</td>
<td>-2.225*</td>
<td>-0.008</td>
<td>-0.918</td>
</tr>
<tr>
<td>Assessment</td>
<td>-0.025</td>
<td>-1.895</td>
<td>-0.024</td>
<td>-1.658</td>
</tr>
<tr>
<td>Severe Disabilities Less Than 12 Months of Age at Entry</td>
<td>-0.046</td>
<td>-1.982*</td>
<td>-0.005</td>
<td>-0.225</td>
</tr>
<tr>
<td>Down syndrome Yearly Income &gt; $20,000</td>
<td>0.014</td>
<td>0.508</td>
<td>0.056</td>
<td>2.385*</td>
</tr>
<tr>
<td>Constant</td>
<td>0.718</td>
<td>0.688</td>
<td>1.570</td>
<td>-3.731</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.498</td>
<td>0.331</td>
<td>0.183</td>
<td>0.095</td>
</tr>
</tbody>
</table>

*The sample size for the parenting stress equation was 124 due to missing data.

**p < .05; ***p < .01; ****p < .001**

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*IEL, 1995, 19:2*
T1 score and dividing by total hours) in parenting stress.

Although there has been much debate about the use of difference scores to measure change (Hauser-Cram & Krauss, 1991), they were chosen for this analysis for two reasons. First, the Cronbach’s alpha reliability coefficients for these measures were acceptable. The coefficients were .76 for adaptive behavior, .72 for child-mother interaction, .63 for mother-child interaction, and .69 for parenting stress. Second, although difference scores have been criticized because they do not control for initial status, in this analysis, change scores per hour were estimated using regression techniques that did control for the T1 score.

Change per hour estimates were calculated for each of the four subgroups and outcome measures by multiplying a value for each independent variable by the coefficient associated with that variable and adding in the constant term. As in the hours equations, the value for each independent dummy variable is 1 if the characteristic is present and 0 if it is not present. For the interval level variables, mean values were substituted. The calculation below illustrates how the coefficients in the equation for adaptive behavior in Table 3 were used to estimate the mean change per hour for the subgroup of children with mild disabilities who entered EI at least 12 months of age.

\[
\text{Change/Hour} = k + b_1 \ln[T1 + 1] + b_2 \ln[HV + 1] + b_3 \ln[GP + 1] + b_4 \ln[C1 + 1] + b_5 \ln[P + 1] + b_6 \ln[SC + 1] + b_7 \ln[AS + 1] + b_8 \text{Sev} + b_9 \text{LT12} + b_{10} \text{OS} + b_{11} \text{HIGH} + E,
\]

where \( \ln = \) natural log, +1 = 1 was added to the variable to eliminate zeros in the distribution since the natural log of zero is undefined, \( T1 = T1 \) score of the dependent variable, \( HV = \) hours of home visits, \( GP = \) hours of group services, \( C1 = \) hours of center-based individual services, \( PG = \) hours of parent support group services, \( SC = \) hours of screening services, \( AS = \) hours of assessment services, and \( E = \) error.

\[
\text{Change/Hour} = .718 + [-.041] \\
(\ln(6.807 + 1)) + [-.086] \ln(37.0 + 1) + [-.020] \ln(14.1 + 1) + [-.028] \ln(1.7 + 1) + [-.019] \ln(0.0 + 1) + [-.046] \ln(0) + [.014] \ln(1) + [-.019] \ln(1.5 + 1) + [-.025] \ln(8.5 + 1) + [.046] \ln(0) + [.014] \ln(1) + [.014] \ln(0) + [.014] \ln(1) + [.014] \ln(0) + [.014] \ln(1)
\]

\[
\text{Change/Hour} = .718 + [-.084] + [-.313] \\
\]

The estimated mean change per hour values for each subgroup and outcome were used to address the first research question.

The final set of calculations rely on the regression equations in Table 3, the mean change-per-hour estimates, and the hours estimates. By taking the first derivative of the equations in Table 3 with respect to each type of service hour, the change associated with 1 hour of each service type was estimated. The calculation below illustrates how the change in adaptive behavior associated with 1 hour of home visiting services can be estimated for the subgroup of children with mild disabilities who entered EI before they were twelve months old.

\[
\text{dC} \times \text{Ti} = \text{Service Type Effect}, \text{ where } i = \text{type of service}.
\]

\[
\text{Service Type Effect} = \text{Change/Hour} + [b] \times [\text{Total Hrs/Type Hrs}]
\]

where \( \text{Change/Hour} = \) estimates of change per total hours of service, \( b = \) coefficient in
Table 3 associated with the service type and subgroup analyzed, Total Hrs is the estimated total hours value in Table 2 for the subgroup analyzed, and Type Hrs is the estimated hours value in Table 2 for the service type and subgroup analyzed.

Home Visiting Effect = .169 + (−.086)
[62.8/37.0]

Home Visiting Effect = .169 − .146 = .023

Since the calculated change-per-hour values associated with 1 hour of each service by outcome measure and subgroup are estimates of mean values, the properties of the distribution of values around these means are difficult to ascertain. Thus, tests of significance cannot be performed to compare these values. These estimates can, however, be evaluated to address the second and third research questions by describing which service type is associated with the larger change per-hour value. Further, the fourth research question requires that the magnitude of the mean change-per-hour values be compared to the cost of providing 1 hour of each service to identify the more cost-effective strategy.

RESULTS

The first research question was: Based on the total amount of EI service hours received, what is the average change per hour in child competence and maternal adaptation for subgroups of children varying by age at entry and severity of disability? Table 4 presents the means and standard deviations of the outcome scores at T1 and T2 as well as the means and standard deviations of the variables measuring change in adaptive behavior, child-

| TABLE 4 |
| Means, Standard Deviations, and Range of Values for T1, T2, and Change Scores Between T1 and T2*. |
|-----------------|------------|------------|-------------|
| Variable        | M          | SD         | Range       |
| Adaptive Behavior (N = 157) | | | |
| T1               | 7.417      | 5.100      | 0.00–21.00  |
| T2               | 14.229     | 5.931      | 0.50–36.00  |
| Change Score     | 6.812      | 3.576      | −3.00–17.75 |
| Child-Mother Interaction (N = 157) | | | |
| T1               | 14.191     | 4.495      | 0.00–23.00  |
| T2               | 17.548     | 3.585      | 6.00–23.00  |
| Change Score     | 3.357      | 5.532      | −10.00–18.00|
| Mother-Child Interaction (N = 157) | | | |
| T1               | 36.675     | 6.308      | 17.00–48.00 |
| T2               | 37.160     | 5.650      | 18.00–48.00 |
| Change Score     | 0.485      | 7.088      | −18.00–28.00|
| Parenting Stress (N = 124)b | | | |
| T1               | 116.772    | 23.083     | 59.00–179.00|
| T2               | 118.527    | 24.834     | 62.00–204.00|
| Change Score     | −1.754     | 17.069     | −62.00–36.00|

*a Change scores = T2−T1 for all variables except parenting stress where change = T1−T2.

b The sample size for all analyses involving the Parenting Stress Index (PSI) is 124 due to missing data.
mother interaction, mother-child interaction, and parenting stress.

On average, for the sample as a whole, positive increases in adaptive behavior, child-mother interaction, and mother-child interaction were found. The range of values for each of the change scores indicates, however, that not all sample members experienced improvements on these measures after 1 year of EI services. Overall, the sample experienced an increase in parenting stress, although the range of change score values indicates that parenting stress was reduced for some individuals. The regression equations in Table 3 were used to estimate change-per-hour values.

Table 5 presents the mean change-per-hour estimates by subgroup and outcome measure based on the total hours of service received. For adaptive behavior, three of the four subgroups experienced positive gains per hour, although the magnitude of this gain was largest for the subgroup of younger children with mild disabilities. Only the two subgroups of children who entered EI before their first birthday had positive gains per hour in child-mother interaction. In contrast, only the two subgroups of children with severe disabilities had positive gains per hour in mother-child interaction. Finally, the largest reductions in parenting stress per hour were associated with the two subgroups of older children.

These results highlight three important findings. First, the change-per-hour estimates did vary by subgroup and outcome measure. Subgroups of younger children gained more per hour on the measures of child competence while the subgroups of children with severe disabilities and the subgroups of older children changed more in terms of gains in mother-child interaction and reductions in parenting stress, respectively. Although it is difficult to evaluate the magnitude of these gains without a control or comparison group, the differentiation of results within the sample were produced when the T1 score for each outcome was controlled for. This suggests that the influence of EI was variable across the subgroups. More research is needed to assess the level of change that can be expected for different subgroups on different outcomes.

Second, for some subgroups, the overall change per hour was negative. In addition to promoting growth in various areas of development, EI services are also designed to prevent declines in certain skills (Farran, 1990). For some children, EI may be able to reduce or slow the regression in skills that would occur if services were not provided. Without a control or comparison group, it is not pos-

<table>
<thead>
<tr>
<th>Subgroup</th>
<th>Adaptive Behavior</th>
<th>Child-Mother Interaction</th>
<th>Mother-Child Interaction</th>
<th>Parenting Stress</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild, LT12 (n = 22)</td>
<td>.169</td>
<td>.081</td>
<td>−.002</td>
<td>−.036</td>
</tr>
<tr>
<td>Sev, LT12 (n = 11)</td>
<td>.056</td>
<td>.096</td>
<td>.007</td>
<td>.014</td>
</tr>
<tr>
<td>Mild, GT12 (n = 22)</td>
<td>.042</td>
<td>−.042</td>
<td>−.005</td>
<td>.130</td>
</tr>
<tr>
<td>Sev, GT12 (n = 17)</td>
<td>−.046</td>
<td>−.047</td>
<td>.013</td>
<td>.152</td>
</tr>
</tbody>
</table>

* For parenting stress, of the 124 sample members analyzed, the number in each subgroup was Mild, LT12 (n = 18); Sev, LT12 (n = 17); Mild, GT12 (n = 22); Sev, GT12 (n = 31).

* Positive change-per-hour estimates indicate a reduction in parenting stress.
sible to assess whether EI services were successful in this regard. Another explanation for the negative change-per-hour values is related to the sensitivity of the instruments used and the number of domains assessed. A ceiling effect may occur for some groups, on the NCAT for example, so that once a high score was achieved on the initial assessment the instrument was not able to measure an increase at T2. In addition, it is possible that important gains were made in domains not evaluated in the current study.

The negative results support the finding from a previous analysis that the relation between hours of service and change is not strictly linear (Warfield, 1994). For some outcomes, hours of service may be associated with marginal gains up to a maximum point, beyond which additional service hours may be associated with either no change or negative change. It is important to remember that the analysis focused on 1-year period and assessed change between two data points. The line between these points represents only one section of a curve that could be drawn linking measurements of any one outcome over several points in time. Thus, the change-per-hour values represent a mean estimate of change in a limited range of the curve.

Third, the average change-per-hour values in Table 5 cannot be used to estimate which services contribute to or fail to contribute to progress in any one outcome. These estimates incorporate all of the EI services received, each of which has a different cost per hour attached to it. Thus, there is no single measure of expenditure that can be compared with these change-per-hour estimates.

Table 6 presents the mean change-per-hour estimates associated with 1 hour of home visiting and 1 hour of group services, by outcome measure and subgroup. These estimates, along with the unit rates were used to address the three remaining research questions.

The second research question was, Is there a difference between the younger and older subgroups in the mean level of change in child competence and maternal adaptation associated with 1 hour of home visiting versus 1 hour of group services? The results for the younger versus the older subgroups dif-

| TABLE 6 |
|---|---|---|---|---|---|
| Adaptive Behavior | Child-Mother Interaction | Mother-Child Interaction | Parenting Stress |
| Subgroup | Home | Group | Home | Group | Home | Group | Home | Group |
| Mild, LT12 (n = 22) | .044 | .077 | .025 | .038 | .023 | .080 | .044 | .077 |
| Sev, LT12 (n = 11) | -.100 | -.028 | .056 | .092 | .036 | .045 | .486 | .081 |
| Mild, GT12 (n = 22) | -.229 | -.006 | -.111 | -.044 | .045 | .017 | .951 | .168 |
| Sev, GT12 (n = 17) | -.291 | -.100 | -.110 | -.050 | .059 | .037 | .896 | .196 |

*For parenting stress, of the 124 sample members analyzed, the number in each subgroup was Mild, LT12 (n = 18); Sev, LT12 (n = 7); Mild, GT12 (n = 17); Sev, GT12 (n = 15).

b Positive change-per-hour estimates indicate a reduction in parenting stress.
ffered in three ways. First, among the younger subgroups, positive gains in child-mother interaction were associated with both service types. The increase associated with an hour of group services, however, was larger than that associated with an hour of home visiting. In contrast, decreases in child-mother interaction scores were found for both service types among the older subgroups. Second, positive gains in mother-child interaction were associated with an hour of home visiting and group services for both the younger and older subgroups. Among the younger subgroups, the larger gain was associated with an hour of group services while for the older subgroups, the larger gain was associated with an hour of home visiting. Third, reductions in parenting stress were associated with both service types across all subgroups. Although the larger change-per-hour estimate was associated with an hour of home visiting for all subgroups, the magnitude of the reduction was roughly twice as large for the older compared to the younger subgroups.

The third research question was: Is there a difference between the subgroups of children with mild versus severe disabilities in the mean level of change in child competence and maternal adaptation associated with 1 hour of home visiting versus 1 hour of group services? Differences between the mild and severe subgroups occurred only on the measure of adaptive behavior for the younger age group. Improvement in adaptive behavior associated with both service types was found for the younger subgroup with mild disabilities, whereas decreases in adaptive behavior were associated with both services for the younger subgroup with severe disabilities. Similar to the findings for child-mother interaction, the gain associated with an hour of group services was larger than that associated with an hour of home visiting.

Thus, the findings associated with Research Questions 2 and 3 indicate that the change-per-hour values differed more by age at entry than severity of disability. Most of the negative change-per-hour values were associated with the older subgroups rather than those composed of children with severe disabilities. Although these findings may indicate that neither 1 hour of home visiting nor 1 hour of group services is effective in promoting certain kinds of improvements, it may also indicate that gains in some outcomes take longer to occur and rely on change made in other domains. For example, gains in mother-child interaction may need to be made before the mother along with EI staff can help facilitate improvements in the child's adaptive behavior skills.

The final research question was, How does the mean level of change per hour in each outcome compare to the cost per hour of each service type? As described previously, the unit rate at which EI programs were reimbursed by DPH and Medicaid for fiscal year 1988 was $53.68 per hour for home visits compared to $21.52 per hour for group services.

Comparisons between these cost-per-hour figures and the change-per-hour values presented in Table 6 must be made carefully in order to identify which service type is more cost-effective for a particular subgroup and outcome measure. Since 1 hour of home visiting costs approximately 2.5 times more than 1 hour of group services, it would be possible to provide 2.5 hours of group services for the same cost as 1 hour of home visiting. Thus, one method of comparison would be to multiply the change-per-hour values associated with group services by 2.5 hours. These new change values could then be compared directly with the change associated with 1 hour of home visiting.

An incorrect assumption is embedded in this method of comparison, however (Barnett, 1993). This method assumes that each increase of 1 hour of service produces the same level of change. For example, if 1 hour
of group services produces a .08 increase in adaptive behavior skills for children with mild disabilities who entered EI at less than 12 months of age, then two hours of group services would produce a .16 increase in adaptive behavior skills for these children. The nonlinear relation between hours of service and change, however, suggests that this assumption is incorrect (Warfield, 1994). Since the analysis focuses on the nature of the relation between services and change over a limited range, predictions regarding the level of change that may result from doubling the number of hours are speculative.

Therefore, in order to compare the change-per-hour and the cost-per-hour values correctly, it is critical to place 1 hour of service provision in context. Despite the tremendous variability in overall service provision, the total number of service hours received over 12 months was fairly modest (Shonkoff et al., 1992). Children and families would rarely receive more than one 1-hour home visit or one 2-hour group session a week. By using these common weekly patterns of service as a context within which to assess cost-effectiveness, the change-per-hour and cost-per-hour values can be compared more accurately.

An examination of the positive change-per-hour values associated with adaptive behavior for the subgroup of younger children with mild disabilities suggests that group services are more efficient. Even if it is assumed that the second hour of a weekly group session produces no gain in addition to the .08 gain associated with 1 hour, the change-per-hour value is still 3.5 times larger (i.e., .080/.023 = 3.5) than the change associated with a 1-hour home visit. In addition, 2 hours of group services cost less ($43.04) than a 1-hour home visit ($53.68).

Similar results were found for both subgroups of younger children in terms of child-mother and mother-child interaction. The larger change-per-hour values associated with 1 hour of group services and the lower cost of that service indicate that serving younger children in small groups is more efficient.

Among the older subgroups, the change-per-hour values in mother-child interaction associated with an hour of home visiting were larger than those associated with an hour of group services. In this type of situation, where the most costly option is also the more effective one, assessment of the more cost-effective option is difficult (Barnett, 1993). The question to be considered is whether additional money should be spent to achieve greater gains in mother-child interaction. Specifically, based on a comparison of the common weekly pattern of service provision, 1 hour of home visiting at $53.68 per hour costs $10.64 more than providing 2 hours of group services at $43.04. Given this relatively small monetary difference, an hour of home visiting may be more cost-effective.

The reduction in parenting stress associated with 1 hour of home visiting was larger than that associated with 1 hour of group services for all four subgroups. In comparison to the results for the older subgroups on mother-child interaction, the reduction-per-hour values associated with 1 hour of home visiting were much larger than those associated with 1 hour of group services for all subgroups. Thus, given the relatively small monetary difference between 1 hour of home visiting and 2 hours of group services, home visiting appears to be more cost-effective in reducing parenting stress.

**DISCUSSION**

This paper presents a three-step procedure for using multiple regression equations and cost-per-hour values to compare the cost-effectiveness of providing home visiting versus group services to subgroups of children who vary by age at entry into EI and by se-
verity of disability. Although the findings must be considered preliminary given the limitations of the methods used, they identify critical issues that should be investigated in future research.

Specific patterns of results were found by reviewing the positive and negative change-per-hour values. First, when we examine the total hours of services received, the younger subgroups were more likely to make positive gains per hour on both child outcomes, whereas negative change-per-hour values were calculated for the older subgroups. In contrast, whereas the younger subgroups experienced little change per hour on the measure of parenting stress, the older subgroups experienced reductions in stress.

Second, comparisons between the magnitude of the change-per-hour values associated with each service type also revealed differences between the younger and older subgroups across outcomes. For the younger subgroups, the largest change-per-hour values were associated with group services for both interaction measures, whereas the largest change-per-hour values for parenting stress were associated with home visiting. For the older subgroups, the greater change-per-hour values for both maternal outcomes were associated with home visiting. These findings are somewhat at odds with the common service delivery strategy of providing more home-based individual services to infants and more group services to toddlers.

Third, the consistent relation found between home visiting and reductions in parenting stress across all subgroups supports the findings derived from analyses of parental ratings of EI services, which were conducted using the full EICS data set (Upshur, 1991). Mothers rated home visits as the most helpful service component and a significant correlation was found between the overall rating of program helpfulness and decreases in parenting stress.

In addition to exploring these patterns further, the analysis highlights seven areas where more research is needed. First, in most cost-effectiveness analyses comparing two or more distinct experimental program models, the first step in assessing cost-effectiveness ratios involves judging whether either service is worth implementing (Barnett, 1986). In other words, do any of the models analyzed generate enough of an effect to justify their associated costs? This question is particularly salient when negative change-per-hour values are calculated. Given that EI programs under PL 99-457 are mandated to serve all eligible children, the option of not providing services is not really viable. Therefore, other methods of EI intervention should be assessed in cost-effectiveness analyses. For example, the efficiency of placing a child on monitoring status to track their development versus providing either home visits or group services should be examined. By assessing various methods of intervention relative to their costs and effects, a greater number of options for efficient service delivery can be identified for diverse groups of children and families.

Second, comparisons between the cost per hour of each service and the magnitude of the change-per-hour values highlight the complexities involved in identifying the more cost-effective service strategy for a particular subgroup. For any one outcome, when the more effective of two or more service options is also the least costly, identifying the most cost-effective strategy is relatively straightforward. Interpreting the results of a cost-effectiveness analysis is more difficult, however, when the most effective option is also the most costly option and when multiple outcomes are assessed (Barnett, 1993).

Cost-effectiveness analyses do not provide criteria by which to judge the priority of reaching one goal over another or the equity of distributing resources one way versus another (Barnett & Escobar, 1990). Decision
makers (e.g., EI service providers and administrators) need to judge the relative importance of each effect and to consider whether additional money should be spent to achieve greater gains (Barnett, 1986). For example, among the younger subgroups, 1 hour of home visiting appears to be more cost-effective if reducing parenting stress is a greater priority than making improvements in mother-child interaction. Although an hour of home visiting is also associated with gains on both interaction measures, the gains are lower and more costly than those associated with group services. More basic research on child development is needed to understand the importance of making progress in some domains over others and in learning how development across domains is linked.

Third, more research is needed to examine what occurred when services were delivered in both the home-based and group context. Specific aspects of each service strategy may be particularly effective. For example, if providing information and referral services to parents during home visits was key to stress reduction, it may be possible to test how that information could be provided in a less expensive manner with the same level of effectiveness.

Fourth, cost-effectiveness analyses that focus on the ways in which individual EI programs distribute resources to their eligible population should be conducted. Comparisons between weekly and yearly allocation of resources may identify specific longer term patterns of service provision worthy of further evaluation. In addition, this type of analysis could be used to investigate whether variables other than child characteristics influence how services can be provided most efficiently. Variables to examine include the estimated total number of children in the area to be served, staffing patterns, the geographical characteristics of the service area, and the cultural and ethnic values of communities in the service area (Peterson, 1987).

Fifth, the opportunity costs to parents of participating in EI programs should be assessed. The time required for parents to participate is time they could otherwise use to become employed, accomplish tasks at home, or use for leisure activities (Barnett, 1993). These costs would be especially important to measure for EI services placing extensive demands on family time and resources (Brotherson & Goldstein, 1992). Explicit documentation of the time parents spend involved in EI activities is needed to incorporate these opportunity costs into the analyses.

Sixth, the analysis relied on mean change-per-hour estimates to identify which service strategy was more cost-effective. This method has limitations, because it is difficult to measure the variability around these means and therefore identify statistically significant differences. Future analyses should develop more precise estimation procedures.

Finally, the cost-effectiveness of home visits and group services should be evaluated for samples that include a greater diversity of children and families. Since the change-per-hour estimates were not computed for subgroups of children with Down syndrome or subgroups of children from lower income families, the results cannot be generalized to populations with these characteristics.

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