ABSTRACT. In an evaluation of 31 selected studies, statistical procedures for synthesizing data (meta-analysis) were used to assess the effects of early intervention services on disabled children younger than 3 years of age and on their families. Results indicate that early intervention is effective in promoting developmental progress in infants and toddlers with biologically based disabilities. Programs that served a heterogeneous group of children, provided a structured curriculum, and targeted their efforts on parents and children together appeared to be the most effective. Definitive evaluation of the efficacy of early intervention programs is tempered by the restricted range of outcomes measured and by a paucity of information about the children and families enrolled in such programs, as well as about the specific nature of the services received. Despite their limitations, available data provide the basis for a rational pediatric approach to early intervention programs, while highlighting specific directions for further investigation. Pediatrics 1987; 80:650–658; disabled infant, handicap, developmental disability.

The concept of developmental risk in young children and interest in the efficacy of early intervention services are matters of growing concern. Although resource allocation for both research and service delivery during the past two decades has focused largely on the consequences of socioeconomic disadvantage, increasing attention is being directed to the needs of biologically vulnerable infants. With the recent passage of the Education of the Handicapped Act Amendments of 1986 (Public Law 99-457), new federal incentives are now available for states to develop family-centered, community-based services for handicapped infants beginning at birth.

As the professional best situated to identify infants with developmental delays or disabilities, the primary care pediatrician is urged by increasing numbers of early childhood advocacy groups to refer such children to early intervention programs. Yet, conclusive data on program effectiveness and criteria for determining whether a specific service model will meet the individual needs of a given child and family are unavailable. Whereas some treatment programs (eg, “patterning”) have been criticized for their exaggerated promises and excessive demands on families, the generalization of such criticism to all early intervention efforts is unwarranted. Much of the literature on more conventional services for handicapped infants, however, is published in journals that few pediatricians read. In many communities, physicians learn about the philosophy and logistics of early intervention through their contacts with local service providers; in others, programs are unavailable.

Although there have been numerous reviews of studies on early intervention services, few have concentrated on research that relates only to infants with disabilities. Indeed, most of the reviews focus on programs for socioeconomically disadvantaged preschoolers and acknowledge the limited number of rigorous studies conducted on the handicapped population. Even the most extensive reviews of early intervention programs for children with disabilities focus on methodologic issues, not on outcomes. For example, in reviewing 27 studies, Simeonsson et al found that statistical procedures were used to analyze data in only 59% of the reports; yet, 93% reported program success.

By using the techniques of meta-analysis, a method of data aggregation that uses summary
statistics from primary studies, we have developed a more comprehensive assessment of the range of programs and outcomes than has been available previously. Meta-analysis is based on the statistical examination of "effects" reported in individual studies. An effect is defined as the mean of the experimental (treatment) group minus the mean of the control group divided by the standard deviation of the control group \((\bar{X}_t - \bar{X}_c/SDc)\) for each outcome variable. The calculation of effects produces a common measure across studies that provides a means of synthesizing diverse findings in a systematic fashion.

A meta-analytic approach to reviewing a set of research studies has both advantages and limitations. It allows reviewers to develop, with specified degrees of confidence, a comprehensive picture of results for a large range of subjects, programs, times, and measures. Furthermore, the aggregation of effects from multiple sources can demonstrate patterns of findings across studies with small samples. This issue of statistical power is particularly important for low-incidence disorders for which modest, but reliable, treatment effects may not be appreciated because the small sample sizes make it difficult to achieve statistical significance in any single investigation.

The most fundamental limitation of a quantitative review, however, is that it can be no better than the original studies it examines. If important data are missing from the primary sources, a common problem in studies of early intervention effectiveness, no statistical technique can suggest their content. Furthermore, meta-analysis can be applied inappropriately to a mix of disparate studies, thereby raising criticism that it is "comparing apples and oranges." Thus, for a field as heterogeneous as early intervention, the need for specific definitions is critical. Because the aura of credibility typically associated with quantitative analyses may be substantial, it is important that the questions that are asked be as conceptually rigorous as possible, while the potential value of more qualitative data not be disregarded. In our view, meta-analysis is most useful as a hypothesis-generating venture in which an examination of patterns across studies suggests variables that deserve further investigation.

The analyses presented in this paper were guided by the following questions: (1) What are the effects of early intervention programs? (2) Do effects differ significantly by the type of outcome measure used? (3) Do impacts vary for different types of children and families? (4) Do certain characteristics of programs, such as the locus of service (e.g., home-based or center based), intensity of intervention, type of curriculum, or degree of parent involvement produce differential effects?

MATERIALS AND METHODS

Development of Data Set

This review is based on a subset of a large data base of 230 early intervention efficacy studies compiled by the staff at the Early Intervention Research Institute at Utah State University through computer searches of data bases, letters sent to individuals involved in early intervention research, and reviews of bibliographies. In the development of the large data set, early intervention was defined as any service designed to improve the cognitive, social/emotional, or life skills of handicapped, at-risk, or disadvantaged children that began before the child was 66 months of age and that was designed and reported so that an estimate of impact could be calculated. Each study was coded for 87 variables reflecting description of subjects, type of intervention, type and quality of research design, type of outcome, and conclusions.

To examine the impact of early intervention services on disabled or biologically vulnerable infants and their families, we identified a subset of the data base for separate analyses. A total of 53 studies emerged when the following criteria were used: (1) children were enrolled in an early intervention program before the age of 36 months; (2) the principal handicapping condition of the majority of children in the sample was not the family's socioeconomic status; and (3) children were raised at home or in a foster home, not at a residential facility.

We then added two additional constraints. First, we eliminated studies in which two forms of intervention were compared with each other (intervention A v B). Next, we omitted studies that had such major design flaws as to call into question their results. This determination was based on coding seven threats to validity (history, maturation, testing, instrumentation, statistical regression, selection bias, and mortality) for each study, using conventional definitions. Our final data set consisted of 31 studies. We reviewed each of these studies carefully to check the coding. Although no single investigation is without flaws, none of the 31 selected studies has major threats to validity, and as a group, they represent the best available data on the impact of early intervention services for biologically vulnerable children younger than 3 years of age.

Statistical Analyses on Distribution of Effects

Examination of data from the selected set of 31 studies yielded 91 effects that could be manipulated for further analysis. Standard formulas were used in calculating each effect. Because this data base was composed of many studies with relatively small
samples, a correction factor was used that, in essence, weights effects by sample size and yields an unbiased estimator of effect.\(^{*}\)

Although effects based on outcomes, rather than on studies, are conventionally used in meta-analyses, it is beneficial to investigate the distribution of average effects per study as well as the total distribution of effects.\(^{*}\) If the distributions are dissimilar, one or two studies may be lending a disproportionate number of effects. In this case, both distributions are similar; both are bell shaped and, based on statistical analyses, do not depart significantly from normal. Furthermore, as no statistical relation was found to exist between the number of effects contributed by a study and the magnitude of effects, no single study appeared to be contributing a disproportionate amount to the calculated effect estimates when outcomes were used as the unit of analysis. To take advantage of the diversity within studies (such as different outcome measures and varied samples), the remaining analyses were conducted on the full range of 91 effects.

RESULTS

Mean Effects and Their Distribution

For the group of 91 effects, derived from a total of 31 studies, we found the mean effect of early intervention services to be 0.62 (median 0.51; range 0.94 to 2.08). This means that, on average, the best available studies of early intervention for disabled children younger than 3 years of age demonstrate a 0.62 SD superiority in performance for children receiving services compared with a contrast or control study. Because 0.5 SD generally is considered clinically significant,\(^{*}\) and according to the conventions of Cohen a 0.62 effect size represents a medium effect, the results\(^{*}\) of our meta-analysis point to moderate positive effects.

Characteristics of Studies

Two types of studies are represented in this analysis: experimental studies (either random assignment or matched pair designs) and pre-/post-adjusted comparisons. Although, in general, effects from pre-post comparisons tend to be larger than those from experimental designs,\(^{*}\) for this group of studies, no significant differences in effects were found between these two types of investigation. Therefore, results were aggregated for the remaining analyses.

Although studies with major validity threats were eliminated, certain research flaws existed in the final set of studies, especially in pre-post designs, even though adjusted for pretest scores. The most prevalent threat to validity was the “testing effect,” because the majority of investigations used the same instrument or parallel versions of the same measure at two data collection points. We do not consider this to be a major problem in interpreting study results, given the young age of the children and the average length of time between testing sessions of greater than 1 year.

Outcome Variables Assessed

Of the 91 effects, 51% involved a measure of child IQ or a developmental quotient. Only seven studies included any parent-related outcomes other than measures of program satisfaction.\(^{20,25,27,29,40,43,46}\) Four of these were measures of parental attitudes toward child rearing.\(^{25,40,43,46}\) Three involved assessments of parent-child interaction\(^{20,20,20}\) and two studies included a measure of stimulation provided in the home.\(^{30,40}\) No study used measures of family functioning.

Because of the small number of dependent measures involving parents, only child outcomes were considered in the analyses. More than three quarters of the 91 effects could be classified into one of three groups: IQ or developmental quotient, motor skill, and language development. Significant differences in program impact were found for these three types of measures, with language ability the least frequently assessed but associated with the highest mean effect, and motor tests associated with the lowest mean effect (\(F(2, 68) = 4.2; P = .02; \text{Table 1}\)).

Characteristics of Children and Families

Information on service recipients is limited because the independent variables in most studies were generally not well defined. The majority of the programs served children with a range of disabili-

TABLE 1. Differential Effects of Early Intervention Services by Outcome Measure and Population Served

<table>
<thead>
<tr>
<th>Type of Measure</th>
<th>Mean Effect</th>
<th>No. of Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>IQ/developmental quotient</td>
<td>0.62</td>
<td>46</td>
</tr>
<tr>
<td>Motor</td>
<td>0.43</td>
<td>14</td>
</tr>
<tr>
<td>Language</td>
<td>1.17</td>
<td>11</td>
</tr>
<tr>
<td>Population served</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orthopedic impairment</td>
<td>0.11</td>
<td>6</td>
</tr>
<tr>
<td>Mental retardation</td>
<td>0.42</td>
<td>29</td>
</tr>
<tr>
<td>Developmental delay</td>
<td>0.70</td>
<td>20</td>
</tr>
<tr>
<td>Heterogeneous</td>
<td>0.94</td>
<td>24</td>
</tr>
</tbody>
</table>

\* \(F(2, 68) = 4.2; P = .02\).
\† \(F(3, 75) = 4.12; P = .008\).
ties, whereas only a few focused exclusively on children with a specific type of handicap. Those serving diverse groups of youngsters represented the majority of programs and demonstrated the highest mean effect (0.94), differing significantly from programs exclusively for mentally retarded children (0.42) and those serving only youngsters with orthopedic impairments (0.11) \((F(3, 75) = 4.12; P = .008; \text{Table 1})\). Heterogeneous programs also enrolled children at a significantly younger age (mean 11.5 months) than programs targeted at any one disability group \((F(3, 63) = 2.71; P = .05)\).

Data base limitations preclude any meaningful conclusions regarding the influence of severity of disability on child outcomes. Most programs served groups of children whose developmental problems reflected a wide range of severity, and no significant differences emerged for those few programs that focused on children with a specific degree of disability (mild, moderate, or severe). Similarly, there were no significant interactions for level of disability by specific type of handicap.

Relations between age at program entry and effects were also analyzed. Although children are enrolled in early intervention programs at different ages, and most programs serve a wide age range, a few of the programs studied limited their enrollment to certain age groups. For those programs, no significant differences in outcome were found to correlate with age of enrollment, with one important exception. Programs that focused on “mildly” impaired children demonstrated significantly higher outcomes when the children were enrolled before the age of 6 months \((t = 8.15; P = .008)\). Because of an insufficient distribution of ages of entry reported for the other severity groups, similar analyses could not be performed for programs aimed at moderately or severely impaired youngsters.

Perhaps the most striking finding in this set of studies is the lack of information provided about families. Critical variables such as race, marital status, number of children in the home, and parents’ education levels were specified in less than 30% of cases. The only demographic characteristic reported in a majority of the investigations was socioeconomic status. No significant differences in outcome were found among programs that served a single socioeconomic group exclusively, although the majority of programs served children and families from a range of socioeconomic circumstances.

Program Features

The majority of programs offered both home- and center-oriented components, although a few were exclusively home or center based. Services differed in their average age of enrollment, with the mean entry age for home programs about 6 months younger than that for center-based services. No differences in outcomes were related to the locus of service delivery.

Those programs that used a structured curriculum were associated with significantly better child outcomes (mean 0.92) than those that did not (mean 0.59) \((t = 2.23; P = .03; \text{Table 2})\). In structured approaches, at least half of the intervention involved implementation of defined activities based on a sequence of learning and a plan of instruction, usually involving specific criteria for progressing to new material.

Analyses of service intensity were performed most typically on amounts of planned service rather than on that which is actually implemented. In this data base, few studies reported sufficient information regarding the frequency of service delivery as either planned or implemented. The only intensity variable reported in a majority of cases was the planned number of weeks of intervention, with the typical program providing 12 to 18 months of service. There was a nonsignificant relation between the number of weeks of intervention and child outcome.

Analysis of the role of parents revealed that programs that planned extensive parent involvement showed significantly greater effects (mean 0.70) than those with little or no planned parent participation (mean 0.30) \((t = 3.31; P = .002; \text{Table 2})\). Criteria for extensive involvement in center-based programs were met when parents volunteered in the classroom, participated in planning and evaluating activities, and implemented carryover activities at home. In home-based programs, extensive involvement occurred when parents were required to assist in planning, developing, and implementing activities on a frequent (such as daily) basis. Although it is impossible in most cases to assess whether the intended participation was implemented fully, it is reasonable to hypothesize that

<table>
<thead>
<tr>
<th>Service Variable</th>
<th>Mean Effect</th>
<th>No. of Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extent of curriculum structure*</td>
<td>High</td>
<td>0.92</td>
</tr>
<tr>
<td>Low</td>
<td>0.59</td>
<td>40</td>
</tr>
<tr>
<td>Planned level of parent involvement†</td>
<td>Extensive</td>
<td>0.70</td>
</tr>
<tr>
<td>Limited/none</td>
<td>0.30</td>
<td>17</td>
</tr>
<tr>
<td>Type of parent involvement‡</td>
<td>Parents and/or child separately</td>
<td>0.44</td>
</tr>
<tr>
<td>Parents and child together</td>
<td>0.74</td>
<td>56</td>
</tr>
</tbody>
</table>

* \(t = 2.23; P = .03\).
† \(t = 3.31; P = .002\).
‡ \(F(1,89) = 4.71; P = .03\).
programs that plan greater parent involvement differ from other services in additional important and systematic ways. Even within those programs that promote extensive roles for parents, however, interesting differences emerge among subgroups. Some, for example, focused primarily on parents, providing training in child development related to specific disabilities. Others concentrated on giving direct service to children, with a separate support group for parents. Finally, some programs targeted their efforts on parents and infants together, linking the parents’ role to the services given the child. This later type of program model appears to be significantly more successful than those that work with either parent or child in isolation ($F(1, 89) = 4.71; P = .03$; Table 2).

**DISCUSSION**

**Effectiveness of Early Intervention for Disabled Infants and Their Families**

Several commentaries on early intervention services for handicapped infants and toddlers have questioned their effectiveness or asserted that methodologic deficiencies in the available studies are so striking as to invalidate any conclusions regarding program impact. In contrast, we found that available data clearly suggest that early intervention services are effective in promoting developmental progress for many disabled children younger than 3 years of age.

Nevertheless, the data analyzed for this review confirm a widespread clinical impression that all disabled children and their families do not benefit equally from early intervention services. Programs oriented toward youngsters described as “developmentally delayed” appeared to report greater cognitive gains than those serving children with “mental retardation,” whereas the smallest impact was associated with programs for children with orthopedic handicaps (although sample size was quite small). The reasons for such discrepancies are not readily apparent. The distinction between developmental delay and mental retardation may simply reflect severity of disability. Clearly, not all programs offer the same array of services, nor do they necessarily enroll children with comparable needs or cognitive potential. It is possible that services in programs exclusively for children with motor impairments may not be as comprehensive as those provided for children with other types of deficit or delay. Alternatively, measuring outcome by conventional cognitive tests, which are heavily reliant on motor performance in young children, presents a major validity problem for infants with functional motor deficits. Further understanding of these findings will require studies that focus on children with specific disabilities rather than on programs that serve particular target groups.

Another feature that appears to be related to intervention effectiveness, in addition to type of disability, is the relation between severity of disability and age at program entry. For infants categorized as mildly impaired, enrollment before the age of 6 months is associated with a significantly better outcome than beginning services at a later age. More severely handicapped children, on the other hand, appear to have a constant rate of improvement (0.5 SD) regardless of their age at program entry. Because data collection in the studies reviewed was restricted to the time that a child was enrolled in (or just leaving) a program, we do not know whether long-term child effects differ by severity level for those who begin services during early infancy as compared with those enrolled at later ages.

In view of the broad range of families that seek services for their disabled child, it would be surprising to find a program model that is equally effective for all types of service recipients. Rather, differences in family resources and varied access to social supports would be expected to affect outcomes across many domains of concern. Some evaluations of Head Start programs, for example, found greater effectiveness with certain types of families. Although we expected to reach similar conclusions for programs designed to help biologically disabled infants, our analyses were thwarted because so few studies reported family characteristics.

**Program Characteristics Related to Effectiveness**

One of the most robust findings in our analysis is that programs with a well-defined curriculum demonstrated significantly greater child effects than those that used a less structured approach. Types of curricula, however, vary widely, and presently, it is impossible to determine which methods promote greater progress for certain subgroups of children. Studies in which specific types of children and their families are randomly assigned to alternative service models would yield such critical comparative information. Furthermore, the measurement of a broader range of outcome variables, beyond traditional IQ scores, would strengthen substantially the potential contribution of such investigations.

Locus of service delivery is another dimension demanding further analysis. The majority of programs in our database had both home-visit and center-based components. The manner and degree to which these two formats were combined to provide services for children and families varied among
programs. The differential cost implications of such service alternatives underline the need for more specific investigation.

Perhaps the most important findings of this review involve the relative importance of the roles of parents in programs for disabled children younger than 3 years of age. Our analyses indicate that programs that aim for high levels of parent involvement appear to be more effective than those that minimize or disregard the parental role. Furthermore, the most prevalent and most effective model appears to be that which focused intervention on the child and parent together. Although such programs occasionally offered supplemental services, their core program elements provided parents with guidance and support through specific skill development activities with their child.18,19,23,24,36

Although these findings are consistent with the claims of many early intervention service providers and advocacy groups, they have not been adequately tested empirically.68 Furthermore, they contrast sharply with reports from the Utah State University Early Intervention Research Institute that found no association between parent involvement and child outcomes in separate meta-analyses of two related data sets of 162 and 74 early intervention studies.57 The larger Utah State data set consisted of a heterogeneous range of investigations that included early education programs for socio-economically disadvantaged youngsters, as well as a smaller number of interventions for biologically disabled and “at-risk” children, from birth through 5 years of age.7 The smaller data set focused exclusively on programs serving handicapped children up through age 5 years.57 These divergent findings point to the importance of studying well-defined and delimited data sets. Our analyses suggest that parent participation in service programs might have a greater impact on child outcomes for disabled youngsters younger than 3 years of age than for children up through 5 years whose developmental vulnerability is defined by either environment or biology. It may be that criteria for distinguishing extensive from limited parent involvement differ for infant services compared with preschool programs. Also, it is possible that the competencies measured by infant developmental tests are more sensitive to parental influence than many of the skills assessed by preschool instruments. Further investigation of parent-child interaction as an intervening variable in the development of infants with disabilities is clearly needed.

**Directions for Future Research**

The findings of the meta-analysis presented in this paper highlight major gaps in our current knowledge of the effectiveness of early intervention services. Basic descriptive data on infants enrolled in such programs, including the types and severity of their disabilities and the presence of associated medical problems, are rarely available (C. Upshur, B. DiVitto, J. Shonkoff, et al, unpublished data). Even less information has been gathered systematically about families or about the broader ecologic context in which they live.

Perhaps the most serious limitation of existing studies on the impacts of early intervention is their disproportionate focus on cognitive development as the primary dependent variable. Despite their widespread use in early childhood program evaluations, including more than half of the Head Start effectiveness studies,55 conventional cognitive measures have limited utility for children younger than 2 years of age, especially for those with atypical developmental patterns.38-41 Moreover, the popularity of IQ tests often overshadows other important measurable domains of function, including social competence, behavior, and motivation.62

Because the conceptual model underlying early intervention programming assumes a central role for the parent-child relationship,63,64 it is surprising that so few efficacy studies have included measures of parent-child interaction. Previous research has suggested that a mother’s responsiveness may be related to her infant’s development.65-67 Brooks-Gunn and Lewis68 reported mothers of disabled or delayed infants to be more sensitive to their child’s general behavioral repertoire (inferred from his or her mental age) than to either the child’s chronicologic age or handicapping condition. Brinker and Lewis69 speculated that the behavior of infants with motor difficulties might lead parents to adopt specific patterns of interaction that ultimately could impede the child’s learning. A great deal more research is needed to explore how specific interventions can influence the parent-child relationship to facilitate adaptive development.

Finally, despite the growing acceptance of a family-oriented approach to early intervention services,70,71 measures of family functioning have been neglected in virtually all outcome studies. The birth and rearing of a disabled child is acknowledged as having a major impact on a family system, often resulting in physical and emotional strain, financial burden, social isolation, and ongoing stress.72-74 Recent studies indicate that social support networks appear to serve as a stress reducer in families,72,73,76 yet some investigators have reported that parents experience a decrease in social support when they find that their child is disabled.77 The extent to which early intervention programs enhance personal support networks and facilitate family coping...
and adaptation requires documentation and careful investigation.

In summary, the critical research problem currently facing the field of early intervention is to understand the differential impacts specific kinds of services have on infants and families depending upon the nature of the child's adaptive capacities and disabilities as well as upon the characteristics of the family. In a field that emphasizes the importance of individual differences, and recognizes the limitations of a "one-size-fits-all" service model, there is a critical need for greater understanding of interactions among child, family, and service variables. Available data suggest that early intervention for disabled children younger than 3 years of age seems to provide some benefits. What we do not know is what specific program features work best, to what end, and for whom. As the traditional boundaries among health, education, and social needs are becoming less sharply defined, early intervention programs provide an ideal laboratory in which collaborative research can address scholarly questions regarding child and family development in conjunction with the policy concerns of human services delivery.

Implications for Pediatric Practice

At a time of growing emphasis on early identification and comprehensive service provision for disabled infants and their families, the primary care physician must make a number of important clinical management decisions on the basis of limited empirical data. The findings of our systematic analysis provide a framework within which a rational pediatric approach to early intervention programs can be delineated.

First, although the pool of studies that meet minimal criteria for acceptable research is small, available data clearly suggest that early intervention services have a moderate and positive effect on the developmental progress of many disabled children younger than 3 years of age. Thus, the answer to the general question of whether such programs have a measurable impact on children is a qualified "yes."

Second, results of analyses suggest that the most effective programs are those that work with parents and children together and are equipped to serve youngsters with a variety of disabilities using a structured approach to intervention. Such findings provide criteria that physicians can use to help families select appropriate services from among alternative program options.

Third, although available data can be translated into preliminary guidelines for pediatric management and service referral, the need for more refined research is substantial. The paucity of data on differential program impacts depending on diverse child and family characteristics, the disproportionate reliance on child IQ as a measure of program efficacy, and the virtual absence of family-oriented dependent variables highlight important directions for further investigation. The strong support of the pediatric community for such broad-based yet precisely-targeted research could have significant impact.

In summary, pediatricians can help disabled infants and their families by acknowledging the potential benefits of early intervention programs and by using the best available data to direct families toward service models that appear to be the most effective. Furthermore, physicians can play a critical role in supporting further research on program efficacy not only to determine whether early intervention works but to extend our understanding of the differential impacts of alternative program models depending upon the individual characteristics of the children and families who receive such services. Finally, pediatricians can play a crucial role in the ongoing evolution of early intervention services by helping to define appropriate goals for children with disabilities while endorsing the central importance of families, as critical influences on the development of their children and as worthy recipients of supportive services themselves.

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