Implementing Behavioral Intervention Components in a Cost-Effective Manner: Analysis of the Incredible Years Program

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Abstract

Multi-component interventions for conduct disorder target several contexts of a child's life (e.g., both home and school environments) and are generally more effective than single-component behavioral interventions. Whether the multi-component approach is cost-effective remains an unanswered question. This article analyzes two decades of data from the Incredible Years (IY) Series to examine the cost-effectiveness of delivering multiple, stacked intervention components versus a single-component delivery approach. Cost-effectiveness analysis (CEA) provides decision makers with important economic information that can be used to aid in the selection of a program delivery format from one of several competing approaches. CEA concepts, including explicit budget constraints and strict dominance, are demonstrated using IY data; guidelines for interpreting CEA results are provided. Our analyses suggest that combining intervention components is a cost-effective approach to treating behavioral problems in a clinic-based youth population.
Keywords: cost-effectiveness, multi-component interventions, Incredible Years Series, conduct disorder.

Conduct disorder (CD) is among the most common emotional and behavioral disorders affecting youth (Institute of Medicine, 1989), occurring in an estimated 10 percent of preschool and early-school-age children (Institute of Medicine, 1989; Webster-Stratton & Reid, 2003). Children with CD often engage in a variety of behaviors that are detrimental to themselves, their families, and society (Institute of Medicine, 1989; Webster-Stratton & Reid, 2003). Youth diagnosed with CD exhibit persistent behaviors consistent with three or more of the following four behavioral categories: aggression toward people or animals; property destruction; deceitfulness or theft; and serious rule violations (DSM-IV, 1994). These children frequently lack critical social and self-regulation skills necessary for making friends, and, as a result, often endure peer rejection and isolation from an early age (Kaiser & Hester, 1997; Miller-Johnson, Coie, Maumary-Gremaud, Bierman, & CPPRG, 2002).

CD puts youth at risk for other costly outcomes such as weapon use, alcohol use, and other drug use and increases the likelihood of teenage pregnancy, dropping out of school, and police contact (Robins and Price, 1991; Achenbach, Howell, McConaughy, & Stanger, 1998; Bardone, Moffitt, Caspi, Dickson, Stanton, & Silva, 1998; Scott, 1998). Scott, Knapp, Henderson, and Maughan (2001) found evidence of a linear relationship between severity of conduct problems and societal costs; children with conduct problems (but who did not meet diagnostic criteria for CD) and children diagnosed with CD generated societal costs three and ten times greater than children with no conduct problems, respectively. Children with CD often become involved with public, child-serving systems, such as juvenile justice. This involvement creates juvenile court costs, incarceration costs, costs of lost productivity due to incarceration, and victim costs (both tangible and intangible) all borne by society (Cohen, 1998). Cohen (1998) estimates that one life of crime results in societal costs ranging from \$1.3 to \$1.5 million.

Research suggests that early intervention is most effective, especially for those at greatest risk. Although the incidence of CD is higher among adolescents (Searight, Rottnek, & Abby, 2001), a small minority of young children begin to display conduct disorder symptoms as early as preschool age (Moffitt, 1993). Without intervention, childhood-onset CD generally results in bleaker trajectories than adolescent-onset CD (Searight et al., 2001). Compared with their peers, children identified in kindergarten as high-risk for behavioral problems are more likely to be placed on medication, to repeat a grade, to receive mental health services, and to come in contact with police (Jones, Dodge, Foster, Nix, & CPPRG, 2002). Early and effective CD interventions are essential for improving both individual and societal outcomes. Behavioral prevention and intervention programs designed for children with CD may also benefit children with or at risk for the development of other mental health conditions. For example, Lahey, Loeber, Burke, Rathouz, and McBurnett (2002) found that CD is both co-morbid with and predictive of ADHD, oppositional defiant disorder (ODD), depression, and anxiety. Therefore, efforts to prevent and treat CD may also prevent or improve related psychopathology.

Past research has identified numerous etiologic factors that contribute to the development of CD; these factors include (but are not limited to) child, parent, and environmental characteristics. As a result, research suggests that a comprehensive intervention approach is the most effective means for treating CD (e.g., Craig & Digout, 2003). Multi-component treatment approaches target multiple risk factors across several contexts of a child's life (Kaiser & Hester, 1997; Craig & Digout, 2003). Typically, multi-component behavioral interventions focus on the home and school settings, and target parent, teacher, and peer communication skills. Because of the various components involved in multi-component interventions, health decision makers are able to choose from several different implementation approaches. For example, an agency might elect to implement one, several, or all components of a multi-component behavioral intervention. Agencies should select the most cost-effective treatment combination for implementation; however, the guidelines for selecting the most cost-effective treatment approach are often overlooked.

Although a combination of treatment components may reduce negative behaviors most reliably, agencies typically implement just one component. Often, the selected component is either logistically the most feasible to implement or has the lowest per-child treatment cost. Schools may opt for behavioral interventions that involve both teachers and children; they may be less likely to engage parents due to cost or logistical difficulties. Similarly, mental health agencies are more likely to involve parents in the treatment process; however, they are less likely to engage teachers due to similar involvement difficulties. In such situations, agencies may miss opportunities to implement more cost-effective interventions. If agencies fail to consider the cost-effectiveness of implementation strategies, limited resources may not be allocated optimally. A higher effect size for a multi-component treatment may justify its increased cost. On the other hand, if the effect size for a more expensive multi-component treatment is only slightly higher than that of single-component interventions, agencies may be better off treating comparatively more children using the single component that produces the greatest behavioral improvements. Therefore, the implementation decision should consider not only treatment costs, but outcomes and the specific population to be treated, as well. Simply selecting the implementation strategy that is the most feasible or that has the lowest per-person costs creates situations in which agencies may miss out on maximizing health gains for marginal increases in cost (Bala & Zarkin, 2002).

While the effectiveness of multi-component CD interventions has been demonstrated, their cost-effectiveness is largely unknown. This article considers the differential cost-effectiveness of delivering treatment components in combination. Our perspective is that of the public health official with a fixed budget for prevention programs. We also provide an introduction to cost-effectiveness methodology and consider common financial issues that arise when health decision makers must choose from a series of competing treatment combinations of varying cost, intensity, and complexity. This framework is used to evaluate the cost-effectiveness of The Incredible Years Parents, Teachers, and Children Training Series – an evidence-based multi-component intervention created to treat young children with early-onset conduct problems (CD/ODD).

Prior Research

Treating Conduct Disorder

Effective and early behavioral intervention must be provided before patterns of negative behaviors become habitual (e.g., Kaiser & Hester, 1997; Webster-Stratton & Reid, 2003). Therefore, interventions designed for very young children may be more successful in treating CD than those designed for school-age children (Keenan & Wakschlag, 2000). A large body of research currently indicates that multi-component interventions are most effective for treating CD in youth-based populations (e.g., Craig & Digout, 2003).

One example is the Incredible Years Series; it has been identified as an effective CD/ODD treatment and prevention program for young children by the Office of Juvenile Justice and Delinquency Prevention (Webster-Stratton, 2000). Additionally, when an independent APA review committee reviewed findings from over 82 studies of CD interventions, the Incredible Years Series and programs based on the manual *Living With Children* (Patterson & Gullion, 1968) were reported as the only two behavioral intervention strategies that met the criteria for well-established efficacious CD treatments (Brestan & Eyberg, 1998).

Cost-Effectiveness Evaluation of Social Interventions

Economic evaluation can take any of several forms. Perhaps better known, benefit-cost analysis involves measuring both the costs and the benefits of a program in dollar terms (Thompson, 1980). Cost-effectiveness analysis (CEA), on the other hand, does not assign monetary costs to all benefits; program costs are assigned monetary values while program benefits are valued in non-monetary units (e.g., health indicators) (Johannesson, 1995). CEA requires fewer research dollars but does not provide a "bottom line" for each program; rather, it is useful for comparing competing programs and well-suited to the question addressed here.

Recent interest in the scope and efficiency of health prevention programs, as well as limited funding for health interventions, has stimulated cost-effectiveness research within many public health sectors. Studies incorporating CEA commonly focus on health prevention programs such as those designed to decrease transmittal rates of HIV/AIDS, increase smoking cessation initiatives, and avert costly side effects associated with diabetes and depression (e.g., Pinkerton, Holtgrave, Johnson-Masotti, Turk, Hackl, DiFranceisco, et al., 2002; Song, Raftery, Aveyard, Hyde, Barton, & Woolacott, 2002; Hoerger, Bethke, Richter, Sorensen, Engelgau, Thompson, et al., 2002; Raikou, Gray, Briggs, Stevens, Cull, McGuire, et al., 1998; Scott, Palmer, Paykel, Teasdale, & Hayhurst, 2003; Miller, Chilvers, Dewey, Fielding, Gretton, Palmer, et al. 2003).

The current study applies CEA methodology to data generated from repeated implementations of the Incredible Years Series. Given the multiple implementation formats available for this program, CEA data will be combined with additional information to help inform health decision makers as to which Incredible Years treatment format would be most cost-effective given their agency's unique budget constraints and intervention goals.

The Incredible Years Parent, Teacher and Children's Series: Program Design and Goals

Program History and Goals. The Incredible Years Parents, Teachers, and Children Training Series – developed by Carolyn Webster-Stratton, Ph.D., and evaluated by colleagues at the University of Washington's Parenting Clinic – is a multi-component program designed to treat young children (ages 3 to 8) with early-onset conduct problems. Based on implementation methods, the Incredible Years (IY) Series also has been adapted to serve as a cost-effective, community-based prevention program for children at risk for the development of CD. Over the past 20 years, this intervention has been repeatedly implemented in both clinic and natural environment contexts such as mental health settings and schools.

Ultimately, the IY Series strives to prevent delinquency, drug abuse, and violent acts among high-risk children. However, immediate goals of the program include the reduction of conduct problems in children; the enhancement of social, emotional, and academic capabilities of children; the promotion of parental competence and positive discipline strategies; the strengthening of families as well as the school-home connection; and the enhancement of teacher classroom management skills (Webster-Stratton, 2000).

The IY Series is comprised of three main single treatment components each focusing on different contexts and types of social interaction a child encounters in his or her daily life. The three treatment components include (1) a child-based program (referred to as Child Training or CT); (2) a parent-based program (referred to as Parent Training or PT); and (3) a teacher-based program (referred to as Teacher Training or TT). CT and PT leaders initially learn program curricula from certified IY trainers; following training, CT and PT leaders deliver program curricula to child and parent participants, respectively, over a series of weekly small group sessions. Teachers taking part in TT initially learn the program content during a 4-day long training workshop led by certified IY trainers; trained teachers then incorporate program content into their daily classroom activities over the course of the school year. The IY Series, therefore, contains both selective and non-selective treatment components; CT and PT focus specifically on high-risk or diagnosed children while TT also offers treatment benefits to the classmates of high-risk or diagnosed children. For a detailed description of treatment component goals, curriculum, and implementation methods, please see Webster-Stratton (2000).

Webster-Stratton and colleagues have implemented the IY Series using the three single treatment components either alone (e.g., CT program alone) or stacked in various combinations (e.g., CT plus TT and/or PT). Different combinations of the IY components are recommended depending on the targeted child population.

Program Success. The IY Series has been effective in reducing the frequency of children's conduct problems regardless of treatment locale. Service agencies (mental health agencies, child welfare systems, and schools) continue to implement the IY Series; large-scale diffusion of the program has occurred across the United States, Canada, UK, and Norway. Agencies adopting the IY Series are responsible for budgeting for initial training from certified IY trainers, program materials (videotapes, group leader manuals, parent and child materials, and handouts), program implementation, and ongoing consultation with IY trained staff. Following the initial materials and training fees, the IY Series may be offered to participants from successive cohorts at minimal cost to the service agency.

Past literature has assessed the impact of participant characteristics, individual component intensity, and multi-component delivery methods on the effectiveness of the IY Series. Numerous randomized control group studies by the developer (e.g., Webster-Stratton, 1990; Webster-Stratton & Hammond, 1997; Webster-Stratton & Reid, 1999a; Webster-Stratton & Reid, 1999b; Webster-Sratton, Reid & Hammond, 2001) and by independent investigators (e.g., Taylor, Schmidt, Pepler, & Hodgins, 1998; Miller & Rojas-Flores, 1999; Scott, Spender, Doolan, Jacobs, & Aspland, 2001; Barrera, Biglan, Taylor, Gunn, Smolkowski, Black, et al., 2002) strongly support the assertion that the IY Series consistently improves child behavior across a range of outcome indicators. However, no investigation into the cost-effectiveness of stacking IY intervention components has been completed to date.

This paper utilizes cost and outcome data from the IY Series to examine the cost-effectiveness of stacking multiple intervention components versus delivering single intervention components. Traditional CEA theory is employed, along with conventional CEA decision criteria, to produce financial data that offer insight into the economic appropriateness of various IY implementation strategies. This paper serves as the first study to date of the cost-effectiveness of stacked components within the context of the IY Series.

Method

Participant Characteristics

Data were combined from 21 separate cohorts enrolled in six randomized clinical trials of the IY Series (Webster-Stratton, 1982; 1984; 1994; Webster-Stratton & Hammond, 1997; Webster-Stratton, Hollinsworth, & Kolpacoff, 1989; Webster-Stratton & Reid, 1999a). The final sample included 459 children, ages 3-8, who had participated in IY Series research over the past 20 years. Data from these studies could be pooled because of common data collection procedures; all six studies measured program efficacy using an identical set of child behavior measures. Random assignment and longitudinal follow-up occurred with each clinical trial.

The following criteria were required for entry into the IY clinical-based treatment-outcome trials: (1) the child was between 3 and 8 years of age; (2) the child had no debilitating physical impairment, intellectual impairment, or history of psychosis and was not already receiving psychological treatment; (3) the primary clinic referral reason was for conduct problems such as noncompliance, aggression, and oppositional behavior that continued for more than six months; (4) parent-report symptoms on the Eyberg Child Behavior Inventory (ECBI) were clinically significant (more than two standard deviations above the mean); and (5) the child met criteria for ODD and/or CD according to either the Diagnostic and Statistical Manual of Mental Disorders, Third Edition, Revised (DSM-III-R, 1986) or the DSM-IV (1994) depending on the child's study entry date (Webster-Stratton & Reid, 2003).

Following baseline assessments, families were assigned to one of seven conditions: (1) Child Training only (CT); (2) Parent Training only (PT); (3) Child Training and Parent Training (CT+PT); (4) Parent Training and Teacher Training (PT+TT); (5) Child Training and Teacher Training (CT+TT); (6) Child Training, Parent Training, and Teacher Training (CT+PT+TT); and (7) a control condition. A more detailed summary of participant characteristics may be found below in Table 1.

Table 1: Participant Summary Statistics by Incredible Years Treatment Category

Treatment Category	N	Child Ethnicity	Average Child's Age (Months) at Intake	Average Mother's Age (Years) at Child Intake
CT	**54** Boy: 43 Girl: 11	Caucasian: 48 Hispanic: 0 Black: 4 Other: 2	72.3	36.1
PT	**292** Boy: 215 Girl: 77	Caucasian: 265 Hispanic: 3 Black: 4 Other: 20	59.6	34

CT+PT	**38** Boy: 27 Girl: 11	Caucasian: 31 Hispanic: 1 Black: 2 Other: 4	72.4	35.4
PT+TT	**24** Boy: 22 Girl: 2	Caucasian: 21 Hispanic: 0 Black: 1 Other: 2	67.4	38.3
CT+TT	**11** Boy: 9 Girl: 2	Caucasian: 7 Hispanic: 1 Black: 0 Other: 3	74.3	35.6
CT+PT+TT	**19** Boy: 17 Girl: 2	Caucasian: 16 Hispanic: 1 Black: 0 Other: 2	71	39.9
Control	**21** Boy: 19 Girl: 2	Caucasian: 18 Hispanic: 0 Black: 0 Other: 3	68.9	36.1
Total	**459** Boy: 352 Girl: 107	Caucasian: 406 Hispanic: 6 Black: 11 Other: 36	69.4	36.5

Estimating Treatment Costs

To estimate per-child costs of the IY treatment combinations (excluding the control condition), total per-child costs were first estimated for each of the three IY single components (CT, PT, and TT). Costs were derived using a series of detailed financial estimates provided by the developer of the IY Series. The payer perspective was used to determine costs; that is, these financial estimates included all fees for which the agency implementing the IY Series is responsible. Estimates included fees associated with training and ongoing supervision of CT and PT group leaders and trained teachers participating in TT; group leader salary including time for peer review, self-study, and preparation; costs of providing materials for participants; and additional fees – both on- and off-site – necessary for actual program implementation (i.e., on-site childcare, participant meals, cab vouchers, and off-site childcare compensation). These costs comprise those described by Weinstein (1990) as direct treatment costs and direct personal costs stemming from program implementation. CEA ratios generated in this paper reflect financial estimates based on 2003 dollars.

After total per-child costs were estimated for each of the three single components (CT, PT, and TT), estimates were summed to generate total per-child costs for each of the four stacked treatment combinations (CT+PT, PT+TT, CT+TT, and CT+PT+TT) (i.e., total per-child cost of CT+PT = total per-child cost of CT + total per-child cost of PT). Table A1, located in Appendix A, summarizes how per-child costs were estimated for each treatment category.

Cost Estimate Assumptions. Total per-child cost estimates did not include costs associated with the space required for initial leader and teacher training and weekly small group sessions. It is assumed that agencies and schools implementing IY will provide on-site space in which group leader and teacher training, as well as group sessions, may be conducted. (If an agency does not have space available for training and small group sessions, the cost of space rental should be included when calculating total per-child cost estimates). It should also be noted that the CT+PT condition required the purchase of only one set of parent manuals at the cost of $179.40 per 12 parents; therefore, this fee was not duplicated when summing total per-child costs for CT and PT to derive the total per-child cost for CT+PT.

Various cost categories included in the total per-child cost estimates represented one-time program initiation costs. For example, estimates presented in Table A1 assumed that each new CT group leader, PT group leader, and TT trained teacher complete just one sequence of the IY Series following certification. However, in real-world implementation, newly trained group and classroom facilitators who have completed training in CT, PT, and TT will likely lead more than one sequence of the IY Series. Because group leaders and teachers complete training only prior to the first IY sequence, training costs depreciate as the number of children participating in IY increases. Similarly, after the first sequence of IY, costs associated with one-time purchases of materials are not included in additional sequences of IY. Therefore, with each additional cohort of children treated, total per-child costs decrease for each treatment category. For these reasons, total per-child treatment costs presented in Table A1 can be considered conservative.

Table A1: Mean Per-Child Costs by Incredible Years Treatment Category

Treatment Combination				**PT+TT**	
	CT	**PT**	**CT+PT**	**PT**	**TT**
Training Fees					
CT Leader Training by Cert. IY Trainer (3 8-hour days)	$3,600		$3,600		
PT Leader Training by Cert. IY Trainer (3 8-hour days)		$3,600	$3,600	$3,600	
TT Teacher Training by Cert. IY Trainer (4 8-hour days)					$4,800
CT Leader-in-Training's Time (3 8-hour days)	$480		$480		
PT Leader-in-Training's Time (3 8-hour days)		$480	$480	$480	
TT Teacher-in-Training's Time (4 8-hour days)					$400
Material Fees – (Training and Small Group Session)					
CT Small Group Session Materials	$975		$975		
CT Puppet	$269		$269		
CT Leader Lesson Plans	$150		$150		
CT Small Group Session Handouts (for 6 children)	$14		$14		
PT Training Materials		$15	$15	$15	
PT Small Group Session Materials		$1,300	$1,300	$1,300	
PT Leader Manual		$90	$90	$90	
CT and PT Parent Manuals (for 12 parents)	$179	$179	$179	$179	
TT Teacher Handbook					$25
TT Classroom Handouts					$10
Additional Fees - Staff Time					
CT Leader's Time in Sessions	$880		$880		
CT Weekly Supervision	$440		$440		

PT Leader's Time in Sessions		$720	$720	$720	
PT Leader Additional Time		$480	$480	$480	
TT Consultation Costs					$390
Additional Fees - IY Implementation					
PT Small Group Session Meals		$1,000	$1,000	$1,000	
PT Small Group Session Babysitting Fees		$1,080	$1,080	$1,080	
PT Small Group Session Cab Vouchers		$240	$240	$240	
PT Small Group Session Day Care Costs		$288	$288	$288	
TT Training Session Snacks					$160
Total	$6,987	$9,472	$16,280	$9,472	$5,785
Divided by Number of Children Served	6	6	6	6	20
Adjusted Total (Per-Child Cost)	$1,164	$1,579	$2,713	$1,579	$289
Total Per-Child Cost for Treatment Category	**$1,164**	**$1,579**	**$2,713**	**$1,868**	

Treatment Combination	CT +TT		CT+PT+TT	
	CT	TT	CT+PT	TT
Training Fees				
CT Leader Training by Cert. IY Trainer (3 8-hour days)	$3,600		$3,600	
PT Leader Training by Cert. IY Trainer (3 8-hour days)			$3,600	
TT Teacher Training by Cert. IY Trainer (4 8-hour days)		$4,800		$4,800
CT Leader-in-Training's Time (3 8-hour days)	$480		$480	
PT Leader-in-Training's Time (3 8-hour days)			$480	
TT Teacher-in-Training's Time (4 8-hour days)		$400		$400
Material Fees – (Training and Small Group Session)				
CT Small Group Session Materials	$975		$975	
CT Puppet	$269		$269	
CT Leader Lesson Plans	$150		$150	
CT Small Group Session Handouts (for 6 children)	$14		$14	
PT Training Materials			$15	
PT Small Group Session Materials			$1,300	
PT Leader Manual			$90	
CT and PT Parent Manuals (for 12 parents)	$179		$179	
TT Teacher Handbook		$25		$25
TT Classroom Handouts		$10		$10
Additional Fees - Staff Time				
CT Leader's Time in Sessions	$880		$880	
CT Weekly Supervision	$440		$440	
PT Leader's Time in Sessions			$720	
PT Leader Additional Time			$480	
TT Consultation Costs		$390		$390
Additional Fees - IY Implementation				
PT Small Group Session Meals			$1,000	
PT Small Group Session Babysitting Fees			$1,080	
PT Small Group Session Cab Vouchers			$240	
PT Small Group Session Day Care Costs			$288	
TT Training Session Snacks		$160		$160

Total	$6,987	$5,785	$16,280	$5,785
Divided by Number of Children Served	6	20	6	20
Adjusted Total (Per-Child Cost)	$1,164	$289	$2,713	$289
Total Per-Child Cost for Treatment Category	**$1,454**		**$3,003**	

Calculating Treatment Outcomes

Analyses involved pre-test and immediate post-test assessments for two key outcomes: (1) a teacher-reported Total Problem Behavior Score measured by the Behar Preschool Behavior Questionnaire (PBQ) and (2) a combined 5-item Negative Child Behavior Score measured by independent home observations according to the Dyadic Parent-Child Interactive Coding System – Revised (DPICS-R). The PBQ (Behar, 1977) identifies children as young as age 3 who display symptoms of emotional problems. The Total Problem Behavior Score was formed by combining data from 36 teacher-reported items measuring three negative behavioral constructs: (1) hostile-aggressive; (2) anxious-fearful; and (3) hyperactive-distractible. The DPICS-R records behaviors of children and their parents in a home setting (Reid, Webster-Stratton, and Baydar, 2004). Thirty-nine parental and eight child behavioral categories are assessed during 30-minute in-home observations by third-party observers (Reid et al., 2004). The Negative Child Behavior Score was formed by combining data from five separate negative behavior measures: (1) negative physical actions, (2) destructive behaviors, (3) yell/cry/whine, (4) "smart talk", and (5) overall behavior valence (Beauchaine, Webster-Stratton, and Reid, 2005). (Not all children participating in IY were enrolled in school at the time of treatment; therefore, the sample size for the Behar analysis was reduced somewhat.).

The PBQ and DPICS-R outcome measures assess children's behaviors across settings, capturing treatment impact on problem behaviors in the school and home environments. These two outcome measures also incorporate evaluations of child behavior by adults other than the parents of target children; therefore, these observational measures may represent more impartial views of children's behaviors.

Mean difference scores were created for both outcome variables by subtracting each child's post-test score from their pre-test score and averaging within treatment category. Because both outcome measures code negative child behavior highly, post-test scores were expected to be lower than pre-test scores; lower post-test scores indicate that the IY treatment categories reduced the frequency of negative child behavior. Pre-post difference scores for each treatment category were then standardized by subtracting the mean pre-post difference score for the control condition and dividing by the standard deviation of the pre-test control group score. One-sided t-tests were performed to determine whether treatment categories' difference scores were significantly different from zero.

The Role of Agency Budget Constraints

Agencies typically must operate within some form of financial constraints. The nature of an agency's budget constraints plays an important role in determining which implementation strategy among alternatives is considered most cost-effective. Our analyses considered the scenario of public health officials with fixed, or explicit, budget constraints.

Explicit budget constraints are defined as the specific per-person dollar amount (D) available for treating a condition in a target population (e.g., a health system has $50,000 to treat ADHD in a clinic-based population of 100 young children; D=$500) (Bala & Zarkin, 2002). This scenario is likely to be relevant to many health decision makers due to availability of funding. For example, small agencies, such as individual schools or local health departments are typically limited by a scarcity of public school system or local government funds. It is plausible that such agencies have a specific dollar amount reserved for interventions, and once this money is exhausted, no additional funds are available for treatment purposes.

Economists often consider another financial situation – that of the implicit budget constraint. Bala and Zarkin (2002) define an implicit budget constraint as the maximum amount (λ) that an agency is willing to pay for a one-unit gain in treatment effectiveness (e.g., a health system is willing to pay $5,000 per new case of breast cancer detected in its early stages). Agencies limited by implicit budget constraints often have more financial flexibility when it comes to implementing interventions; under implicit budget constraints, agencies essentially choose a price that they are willing to pay per one-unit gain in effectiveness, regardless of total per-person expenditures. As a result, agencies limited by implicit budget constraints are able to fund more effective interventions that may be higher in per-person total costs, provided that the intervention produces unit gains in effectiveness at costs lower than λ. For this reason, Bala and Zarkin (2002) state that agencies limited by implicit budget constraints are more able to keep pace with burgeoning technology compared to agencies limited by explicit budget constraints. For the purposes of this paper, we do not consider the implicit budget constraint scenario.

When decision makers are limited by explicit budget constraints, the choice of a cost-effective treatment combination is made based on two types of cost-effectiveness ratios. Average cost-effectiveness ratios (ACERs) provide insight into the cost for which a given treatment produces a one-unit change in outcome. For the purposes of this paper, a treatment's ACER indicated the cost for which the given IY treatment category produced a one standard deviation decrease in negative child behavior as measured by the two outcome measures previously described. However, depending on the nature of the health intervention, treatment ACERs may represent the cost per child vaccinated, the cost per death averted, or the cost per case of breast cancer detected. The formula for generating the ACER for hypothetical Treatment A is summarized below:

$$ACER_A = \frac{Treatment\ A's\ Average\ Total\ Cost\ Per\ Child\ (C_A)}{Treatment\ A's\ Average\ Total\ Effectiveness\ Per\ Child\ (E_A)}$$

Suppose Treatment A costs $1,100 per person and results in a per-person average of 0.22 standard deviation reduction in behavioral problems measured by a problem behavior outcome measure. The ACER for Treatment A would be $5,000 ($1,100 / 0.22), reflecting that, on average, Treatment A costs $5,000 to produce a one standard deviation reduction in problem behaviors.

Health decision makers also rely on a second category of ratios, known as incremental cost-effectiveness ratios (ICERs). Whereas ACERs provide information regarding the cost-effectiveness of one treatment, ICERs compare the *incremental* cost-effectiveness of one treatment relative to another. ICERs are expressed as monetary values and represent how much more an agency would pay per unit of effectiveness beyond that produced by the less effective treatment were they to implement the more effective treatment of the pair (Bala & Zarkin, 2002). For example, consider two treatments – Treatment X and Treatment Y. Treatment Y is both more effective and more expensive than Treatment X. $ICER_{XY}$ indicates the price an agency would pay per unit of effectiveness *above and beyond that produced by Treatment X* if they were to implement Treatment Y. Therefore, whereas ACERs focus on the cost and effectiveness of a single treatment, ICERs focus on whether a treatment that is both more expensive and effective than another treatment achieves its additional effectiveness at reasonable costs. ICERs are of primary importance to agencies limited by implicit budget constraints (Bala & Zarkin, 2002). However, such ratios are also important when agencies are limited by explicit budget constraints.

Identifying Strictly Dominated Treatment Categories

Information concerning treatment combinations' per-person cost and effectiveness allows health decision makers to identify occurrences of *strict dominance* among a series of potential treatment combinations. As described by Drummond, Stoddart, and Torrance (1997), one treatment strictly dominates another if it produces better results at lower costs. Strictly dominated treatment approaches are immediately eliminated from further consideration by health decision makers since one or more programs exist that are both cheaper and more effective. Therefore, identifying strictly dominated programs helps decision makers narrow down the field of choices from which they will choose an implementation format.

Economists often consider a second type of dominance among treatment alternatives. *Extended dominance* occurs when ICERs do not increase along with increasing program effectiveness (Bala & Zarkin, 2002; Drummond et al., 1997). An extendedly dominated program has an ICER higher than that of the next most effective program; in other words, an extendedly dominated program produces additional unit gains in effectiveness at incremental costs *higher* than that of the next most effective program. A decision to implement an extendedly dominated treatment means that an agency has missed an opportunity to achieve incremental gains in effectiveness at lower costs. Extended dominance becomes especially important in cases where health decision makers are limited by implicit budget constraints. However, for the purposes of this paper, only occurrences of strict dominance will be analyzed.

Results

Determining the Most Cost-Effective IY Implementation Strategy

When limited by explicit budget constraints, an agency should choose the implementation strategy that maximizes effectiveness without exceeding available budget constraints. It is helpful to illustrate treatments' costs and effectiveness, as well as agencies' budget constraints, graphically when choosing an implementation strategy. As noted by Bala and Zarkin (2002), graphing per-person cost and effectiveness data for competing programs allows health decision makers to easily recognize how budget constraint changes would affect implementation decisions. Graphs are also helpful for visually representing ACERs and ICERs of competing programs.

Treatment data are plotted graphically with the X-axis representing per-participant effectiveness and the Y-axis representing per-participant cost. The slope of any line segment connecting a program to the origin represents that program's ACER; the slope of any line segment joining two programs represents the ICER for that particular pair of treatments (Bala & Zarkin, 2002). A curve known as the *efficient frontier* (EF) is generated by excluding all programs that lie above a line segment joining any two programs or joining any program to the origin (Bala & Zarkin, 2002). The EF will always begin at the origin and end at the most effective program (that program lying furthest to the right of the graph). The key to creating an EF is to begin at the origin and draw line segments to join programs lying as far right as possible until the program lying furthest to the right is reached; when a series of line segments are drawn in this manner, it is easy to visually observe any programs that lie above the EF. Programs comprising the EF correspond to those with minimized ACERs and ICERs; the greater an ACER or ICER, the steeper the slope of the line segment that connects a program to the origin or two programs to each other, respectively. In that respect, EFs identify dominance among treatment categories; programs excluded from the EF have ACERs or ICERs greater than those of other programs being considered for implementation. In other words, any program located above the EF indicates that it is either strictly or extendedly dominated (Bala & Zarkin, 2002).

Figure 1 depicts the six IY treatment combinations' per-child cost and effectiveness as measured by the Behar Total Problem Behavior Score. Per-child costs are displayed along the Y-axis with per-child effectiveness (represented by standardized pre-post test difference scores) displayed along the X-axis. (The control condition is excluded from the figure because results indicated that behavior of control group children worsened over the duration of the studies). An EF connects the CT, CT+TT, and CT+PT treatment categories to one another. Because they do not lie along the EF, the PT, PT+TT, and CT+PT+TT treatment categories represent either strictly or extendedly dominated treatment categories. In this scenario, all three categories are strictly dominated; two treatments exist (CT and CT+TT) that are both cheaper and more effective than the three treatment categories excluded from the EF.

Figure 2 depicts each treatment categories' per-child cost and effectiveness measured as by the DPICS-R Negative Child Behavior Score. (Again, data for the control condition are excluded from the figure because results indicated that the behavior of control group children worsened over the duration of the studies). In this scenario, the EF consists of only one line segment joining CT+PT+TT to the origin; because this line segment connects a program to the origin, it represents the ACER for CT+PT+TT. Hence, CT+PT+TT has the lowest ACER (the line segment with the least steep slope that can be drawn from the origin to a program) when effectiveness is measured using the DPICS-R Negative Behavior outcome variable. Figure 2 indicates that the CT, PT, CT+TT, PT+TT, and CT+PT treatment categories are either strictly or extendedly dominated because they lie above the EF; however, only PT+TT is strictly dominated by another treatment combination; compared to PT+TT, PT produces a higher per-child effectiveness for a lower per-child cost. That is, even though PT is, itself, an extendedly dominated category, it strictly dominates PT+TT by producing greater gains in effectiveness at lower costs.

Figure 1: Treatment Category Per-Child Cost and Effectiveness as Measured by the Behar Total Problem Behavior Score

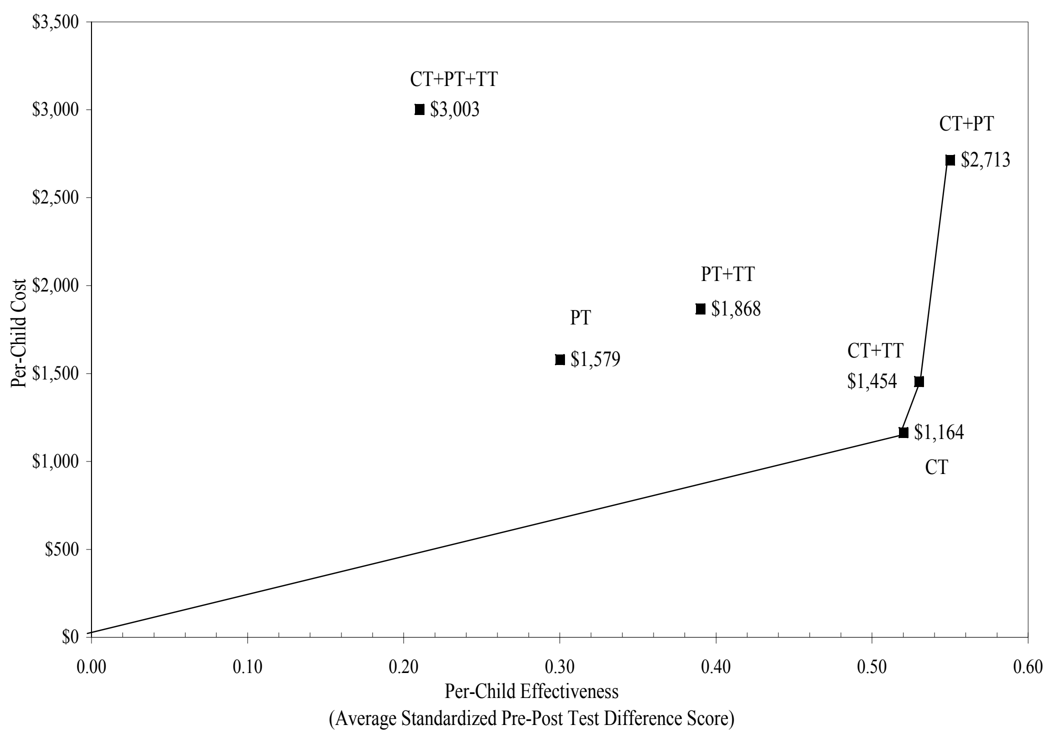

Figure 1: Per-child cost and effectiveness data for the six experimental Incredible Years treatment combinations are plotted. Standardized pre-post test difference scores are measured by the Behar Total Problem Behavior Score. The efficiency frontier excludes PT, PT+TT, and CT+PT+TT, indicating that these are dominated treatment categories; of these, all three are strictly dominated (both by CT and CT+TT).

Figure 2: Treatment Category Per-Child Cost and Effectiveness as Measured by the Combined 5-Item DPICS-R Negative Child Behavior Score

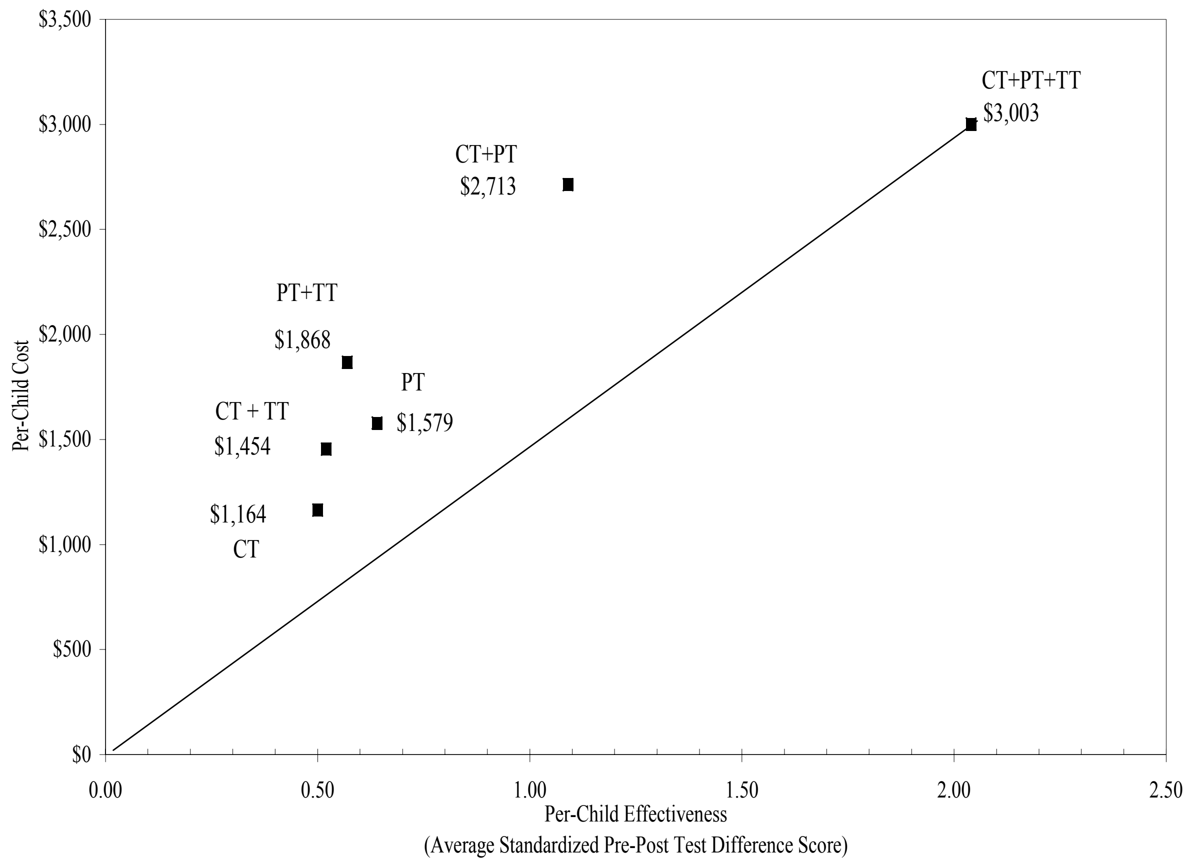

Figure 2: Per-child cost and effectiveness data for the six experimental Incredible Years treatment combinations are plotted. Standardized pre-post test difference scores are measured by the Combined 5-Item DPICS-R Negative Child Behavior Score. Because they lie above the efficiency frontier, CT, CT+TT, PT, PT+TT, and CT+PT are dominated treatment categories. Of these PT+TT is strictly dominated (by PT). The remaining treatment categories excluded from the efficiency frontier – CT, CT+TT, PT, and CT+PT are extendedly dominated.

Under explicit budget constraints, the goal is to select the treatment combination producing the greatest gains in effectiveness at a price less than or equal to D (the total dollar amount available per-child). When working under explicit budget constraints, agencies should first divide the available budget by the number of individuals to be treated within the target population; this will yield the per-person available budget (D). Next, health decision makers should plot the horizontal line Y=D so that it intersects with the EF. Below, the implementation decision process is outlined for three hypothetical explicit budget constraint scenarios. Agencies were hypothetically assumed to have the following per-child funds available for behavioral intervention: (1) $2,500 per child; (2) $1,250 per child; and (3) less than $1,164 per child (the per-child cost of CT, the cheapest treatment category considered here).

Behar Total Problem Behavior Score. Under the hypothetical explicit budget constraint of D=$2,500, if all children are to receive the same treatment, health decision makers should implement CT+TT; this category represents the most effective treatment with per-child costs less than or equal to D=$2,500 (see Figure 1). However, if children may receive different treatments, health decision makers are able to consult the EF to determine the combination of programs that would maximize benefits while remaining within per-child budget constraints. When the horizontal line Y=$2,500 is plotted, it intersects the EF at a point along the line segment connecting programs CT+TT and CT+PT. If children may receive different treatments, health decision makers should implement both CT+TT and CT+PT in the following line segment proportions: XB/AB receive treatment A and AX/AB receive treatment B, where letter A represents program CT+TT, letter B represents program CT+PT, and letter X represents the point at which the horizontal line Y=$2,500 intersects the EF (Bala & Zarkin, 2002). The point X, located on the EF between CT+TT and CT+PT, corresponds to a per-child cost equal to D, but with a higher per-child effectiveness than CT+TT; thus, point X represents maximized per-child effectiveness for a per-child cost of D. To maximize benefits without exceeding budget constraints, agencies can implement CT+TT and CT+PT in combination, so that on average, per-child cost and effectiveness correspond to those of point X. (The ability to implement two programs ensures that agencies come as close as possible to reaching per-child budget constraints without ever exceeding those constraints. However, when faced with the decision of whether to implement a combination of programs, agencies may wish to consider the logistics and morality of providing more than one type of treatment to a target population; if implementing more than one program proves to be difficult, agencies may be better off implementing the one program that produces the greatest benefits at a per-child cost cheaper than D.)

If an agency is able to spend $1,250 per child, and all children must receive the same treatment, health decision makers should implement CT. If children may receive different treatments, agencies are able to maximize per-child effectiveness while adhering to budget constraints by implementing a combination of CT and CT+TT. Using the proportions described above, XB/AB proportion of target children would receive CT and AX/AB proportion of children would receive CT+TT, where A represents CT, B represents CT+TT and X represents the point at which Y=$1,250 intersects the EF. Again, agencies should consider their unique situations to determine if implementing a combination of two programs would be a preferable intervention strategy.

Finally, if an agency is not able to spend at least $1,164 per child – the per-child cost of the cheapest treatment category (CT) – two options remain. First, an agency could move forward, implement CT, and treat as many children as possible until funds are exhausted; in this scenario, the agency would be forced to treat fewer children than originally planned. Or, second, an agency could attempt to locate another type of behavioral intervention with similar goals for a per-child cost lower than D.

The Behar Total Problem Behavior Score data reflect another interesting outcome: while the per-child treatment costs of CT, CT+TT, and CT+PT differ substantially ($1,164, $1,454, and $2,713, respectively), their per-child effectiveness (as measured by the Behar Total Problem Behavior Score) does not (0.52, 0.53, and 0.55 standard deviations decrease in negative child behavior, respectively). Therefore, if an agency has a hypothetical explicit budget constraint of $2,800 per child, and teacher skills training rather than parent skills training is the desired focus of the intervention, it should strongly consider implementing CT+TT rather than CT+PT (the most effective treatment category with per-child treatment costs less than or equal to D=$2,800); if an agency decided to implement CT+TT rather than CT+PT, it would be able to treat substantially more children for a very slight trade-off in effectiveness, while also narrowing in more accurately on the treatment goals of the agency. If, however, parent skills training (rather than teacher skills training) is the major focus of the intervention, health decision makers should consider implementing CT+PT because it more appropriately addresses the specific needs of target children, while still meeting the financial requirement of a program with per-child costs lower than D.

DPICS-R Negative Child Behavior Score. It is interesting to note that a combination of programs is not advised under this scenario (see Figure 2) because the EF consists of only one program (CT+PT+TT);

therefore, the line segment proportion rule described above would involve providing target children with a combination of CT+PT+TT or no treatment (corresponding to the origin) to reach the per-child cost and effectiveness corresponding to point X (where the horizontal line Y=D intersects the EF). As this is most likely not a preferable intervention strategy, agencies should seek to implement the one program that provides the greatest per-child gains while remaining within budget constraints.

Under the hypothetical explicit budget constraint of Y=$2,500 per child, health decision makers should implement PT only. Although PT does not lie along the EF, this treatment category represents the most effective treatment category with a per-child cost less than D=$2,500. (Note: if we were to analyze these results assuming an agency is limited by implicit (rather than explicit) budget constraints, the fact that PT is not located along the efficient frontier would factor into the decisions regarding implementation approaches. (Please refer to Bala and Zarkin (2002) for an overview of the implementation decision process for agencies limited by implicit budget constraints.) If an agency is able to spend $1,250 per child, health decision makers should implement CT. This treatment category maximizes child gains at a per-child cost less than D=$1,250. Finally, if an agency is not able to spend $1,164 per child (i.e., D < $1,164), agencies can either implement CT and treat fewer children than originally planned or search for another behavioral intervention with similar goals for a per-child cost lower than D.

The use of multiple outcome measures with CEA. The pooled IY Series data used for this study included seven outcome measures of treatment effectiveness (however, based on the objectives of this article, only two outcome measures were included for illustrative purposes). If health decision makers have per-child treatment effectiveness data for multiple child outcome measures, they should plot the line Y=D across graphs for each outcome variable. If a treatment category is selected for implementation across more than one outcome variable, health decision makers are increasingly confident in their decision to implement that particular treatment. For this paper, post-test difference scores for seven outcome variables were analyzed (results not presented here); five of these seven variables measured children's externalizing behaviors consistent with CD. Across four of the five externalizing measures, the PT+TT treatment category was immediately identified as a strictly dominated treatment and, therefore, eliminated from the pool of potential treatment approaches. On the other hand, the CT+PT+TT treatment category was not identified as strictly dominated across three of the five externalizing measures examined, indicating its strong potential as a cost-effective implementation strategy for the behavioral intervention. Such information, combined with information regarding agencies' treatment goals and target populations, will aid health decision makers when selecting program implementation formats.

Discussion

Additional points of consideration. It is important to note that decisions to implement a particular combination of treatment components should consider target children's unique behavioral symptoms. For example, if a child's behavior problems are confined to the home setting, it seems illogical for health decision makers to implement TT only (unless outcome data showed that TT was successful at reducing negative behaviors in the home setting). Therefore, while per-child cost and effectiveness data, as well as budget constraint information, guide the CEA decision-making process, it is important to consider children's specific needs as well. If a child displays pervasive behavior problems across multiple contexts, a treatment combination that targets these multiple foci within a child's life may be preferred despite its higher per-child costs. Similarly, if a child's negative behavior is confined to one setting (e.g., home or school), spending funds on a treatment combination that addresses multiple contexts may be considered excessive. As pointed out by Hester and Kaiser (1998), treatment effectiveness should be assessed using conceptually-driven outcome measures. For this reason, it is important for health decision makers to conduct CEA using appropriate outcome data. If health decision makers are primarily interested in reducing children's negative behaviors at home, they should consider performing CEA using outcome data gathered from a home observational measure. On the other hand, if the prime goal is to reduce negative behaviors in the classroom, they should consider evaluating treatment effectiveness as measured using teacher-report or classroom observational measures.

In addition to children's needs, treatment decisions should take into account familial aspects. A family's comfort and satisfaction with, and probability of adherence to, a treatment combination, as well as any quality of life adjustments that may be brought about by participation in such a program, should be considered prior to implementation. Furthermore, it is important to note that while a program may be considered cost-effective, whether or not agencies and schools choose to adopt these interventions will depend on their willingness and ability to pay for CD interventions, treatments, and training.

Finally, when choosing an implementation strategy, health agencies should also consider secondary populations served by each treatment combination. For example, combinations that include PT may provide additional benefits for those siblings of target children. Likewise, combinations that incorporate TT impact not only the target child, but the entire classroom of children and any future children with behavior problems that this teacher interacts with.

Policy implications. This paper used data from the IY Series to demonstrate cost-effectiveness methodology. The IY Series is an evidence-based, multi-component intervention designed to treat and prevent early-onset CD among very young children; it has been adopted by hundreds of agencies seeking to provide children and their families with a comprehensive behavioral intervention. As agencies continue to implement the IY Series both within the United States and abroad, they must determine which implementation strategy maximizes children's gains while remaining within agencies' budget constraints. CEA helps agencies implementing the IY Series to spend their resources in the most efficient manner, thus producing the largest possible effect size in the largest possible child population. The concepts and methodology presented in this article will be relevant for any public or private agency attempting to select a cost-effective intervention from a series of potential delivery approaches.

The CEA data generated in this paper have policy implications within the realm of juvenile justice systems, public school systems, and child welfare systems. Given the large literature detailing the enormous societal costs resulting from negative behaviors associated with CD, investigations into the economic appropriateness of CD prevention may yield new efforts to re-organize financial resources for widespread implementation of behavioral interventions. Again, it is important to realize that cost-effectiveness data should be combined with information regarding the specific needs of target children. Health decision makers should strive to match the nature of children's pervasiveness of negative behavior with a treatment program that targets the desired contexts while minimizing costs. By doing so, health decision makers are able to select the most cost-effective treatment combination likely to be effective for a particular group of young children. Additionally, health decision makers should consider that even the most expensive IY implementation strategy – CT+PT+TT – is considerably low in cost compared with the cost of incarceration, substance use, crime, and other negative outcomes that may result when children displaying early-onset conduct problems are not treated effectively (Jones et al., 2002).

Conclusions and Limitations

CEA is a useful analytic approach to gauge how competing programs do or do not maximize gains while minimizing costs. CEA is also practical for evaluating treatments and interventions targeted toward very young children. In such interventions, data involving crime, substance use, school drop-out rates, and other negative public health outcomes are not available for a number of years post-test. Whereas typical benefit cost-analysis would require prospective data, CEA provides immediate financial estimates by incorporating effectiveness measures without assigning monetary values.

The CEA methodology presented in this paper also allows health decision makers to examine a treatment's effectiveness according to a specific type of outcome. If health decision makers are most interested in a particular result, they can perform CEA to gain insight into treatment effectiveness for the primary outcome of interest. For example, if an agency considers parent skills training to be the most important proximal outcome, and child skills training is distal to parent change, decision makers are able to perform CEA analyses using parent behavior outcome data (i.e. parenting style or parent discipline outcome data). Therefore, CEA analysis aids decision makers not only in choosing a treatment combination that maximizes gains while minimizing costs, but in choosing a combination that maximizes *specifically desired* gains while minimizing costs. Despite its versatility and utility, however, CEA is best combined with additional information specific to an agency's unique situation for determining the "best" approach for treatment implementation.

The data employed in this study present a small number of methodological limitations. The first involves the design of the clinic-based studies that generated the child outcome data considered here. While participants were randomly assigned to treatment combinations, they were spread across multiple cohorts and comprise relatively small groups. It is not clear, however, how one could obtain the necessary information in any other way: randomly assigning large numbers of participants to multiple treatment combinations would be enormously expensive. As a result, some of the comparisons across treatment groups may confound treatment effects with cohort effects. It is important, however, to note that participants were drawn from a single geographic area and were identified using the same eligibility criteria.

As a result of the small sample sizes, considerable uncertainty surrounds the choice of a cost-effective program. Regardless of small sample sizes, however, a policy maker still may have to decide which treatment to implement; therefore, even data based on small samples are arguably more helpful to the decision-making process than a complete absence of such data. An informed decision, however, must also reflect the uncertainty surrounding that information.

Another limitation involves the generalizability of the results. The cost-effectiveness estimates generated here are based on immediate post-test behavioral outcomes of children age 3-8; therefore, estimates may not reflect the experiences of older children diagnosed with CD who may take part in the IY Series. Similarly, as noted, nearly all of the study's participants were Caucasian. Whether and how the cost-effective choice of treatments would differ for minority youth is an area for future research.

Future research should examine if and how strict dominance among treatment combinations varies when using immediate follow-up outcome data versus one-year follow-up outcome data; incorporating one-year follow-up assessments would offer insight into treatments' cost-effectiveness over time. Indeed, Craig and Digout (2003) highlight the need for longer follow-up following the completion of interventions. Furthermore, Miller et al. (2003) argue that cost-effectiveness ratio point estimates based on average cost and outcome differences among treatments (i.e. ACERs) fail to capture uncertainty within the data. To summarize the entire data distribution, cost-effectiveness acceptability curves – an advanced technique within the realm of CEA – should be generated (Miller et al., 2003). This methodology represents an avenue of future research involving IY data.

Finally, by using CEA alone to make judgments regarding the implementation of mental health interventions, health decision makers may fail to consider societal viewpoints regarding treatment worth. As noted in Jensen, Garcia, Glied, Crowe, Foster, Schlander, et al. (2005), there are no monetary threshold values that serve as guidelines for determining the precise cost at which a combination may be considered "cost-effective"; furthermore, announcing that one treatment combination is "cost-effective" while another is "not cost-effective" may imply judgment about societal values concerning the worth of treatment benefits. Therefore, while CEA offers insight into the financial feasibility of competing programs, a broader societal perspective on the treatment and prevention of CD should also be considered when selecting an intervention implementation approach.

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