Commentary: Demonstrating Cost-Effectiveness in Pediatric Psychology

Meghan E. McGrady, PhD

Division of Behavioral Medicine and Clinical Psychology, Center for Adherence and Self-Management, Cincinnati Children's Hospital Medical Center

All correspondence concerning this article should be addressed to Meghan E. McGrady, PhD, Division of Behavioral Medicine and Clinical Psychology, Center for Adherence and Self-Management, Cincinnati Children's Hospital Medical Centre, 3333 Burnet Avenue, MLC 7039, Cincinnati, OH 45229-3026, USA. E-mail: Meghan.McGrady@cchmc.org

Received November 22, 2013; revisions received March 18, 2014; accepted March 21, 2014

Objective Changes in the health care system and payment plans will likely require pediatric psychologists to illustrate the impact of their services. Cost-effectiveness analyses are one method of demonstrating the potential economic benefits of our services but are rarely used by pediatric psychologists. **Method** A hypothetical cost-effectiveness analysis was conducted, comparing the costs and outcomes between a behavioral adherence intervention and no intervention for youth with acute lymphoblastic leukemia. **Results** Results illustrate how pediatric psychologists can use cost-effectiveness analyses to demonstrate the economic impact of their work. **Conclusions** Efforts to conduct economic analyses could allow pediatric psychologists to advocate for their services. Implications and future directions are discussed.

Key words adherence; health policy; professional and training issues.

Recent changes in our health care system have resulted in an increased emphasis on cost containment and outcomes-based reimbursement (Orszag & Emanuel, 2010). For pediatric psychology to continue to grow in this new climate, it will be essential to demonstrate the impact of our services on health outcomes, patient satisfaction, and health care costs (Roberts, Canter, & Odar, 2012; Rozensky & Janicke, 2012). If we are unable to do so, pediatric psychologists may encounter low reimbursement rates under new payment models (i.e., bundled payment plans), potentially making it even more difficult to generate the revenue required to cover costs (Drotar, 2012; Talmi & Fazio, 2012).

One essential next step for the field is to demonstrate the cost offset associated with our services (Drotar, 2012; Roberts et al., 2012; Rozensky, 2013; Rozensky & Janicke, 2012). Many interventions provided by pediatric psychologists have the potential to reduce costs to the health care system and families. For example, a pediatric psychologist working in an endocrinology clinic may provide an

adherence-promotion intervention for an adolescent with type 1 diabetes that results in increased blood glucose monitoring frequency, improved hemoglobin A1c, and as a result, prevents hospitalizations for complications. The economic impact of this and other services can be examined using cost-effectiveness analyses, cost-utility analyses, cost-benefit analyses, and cost-minimization analyses (Muennig, 2008).

Pediatric psychologists, however, do not routinely use these methods (Rozensky & Janicke, 2012), and examination of economic outcomes in pediatric psychology is primarily limited to early work documenting the impact of clinical services on health care utilization (Finney, Riley, & Cataldo, 1991; Forgatch & Toobert, 1979). Our field has made significant advances in the development of evidence-based interventions, but our examination of economic outcomes has lagged behind. Thus, there remains a significant gap between our currently available interventions and our understanding of their potential economic impact. A primary limiting factor in the use of economic

methods in pediatric psychology may be a lack of training in this area. To address this potential barrier, the purpose of this article is to provide (1) an introduction to economic analyses relevant to pediatric psychology; (2) a hypothetical cost-effectiveness analysis of an intervention delivered by a pediatric psychologist; and (3) a discussion of the clinical and research implications of cost-effectiveness analyses.

Economic Analyses Relevant to Pediatric Psychologists

Definition of Terms

Cost-effectiveness analyses are used to compare the outcomes and costs associated with various interventions (Muennig, 2008). For example, consider a pediatric psychologist providing care in a pediatric neurology clinic. As recent findings suggest that cognitive behavioral therapy (CBT) reduces the number of headache days among children and adolescents with chronic migraine (Powers et al., 2013), the pediatric psychologist may be interested in determining if it would be worthwhile to provide CBT to all children and adolescents with chronic migraine. A cost-effectiveness analysis could be used to compare the costs per headache day avoided when patients receive CBT relative to no intervention. Comparisons between multiple interventions are computed using the incremental cost-effectiveness ratio (ICER), defined as follows

$$ICER = \frac{(total\ cost\ of\ intervention1 - total\ cost\ of\ intervention2)}{(effect\ of\ intervention1 - effect\ of\ intervention2)}$$

In this example, the ICER would be

$$ICER = \frac{(cost\ of\ CBT - cost\ of\ no\ intervention)}{(headache\ days,\ CBT - headache\ days,\ no\ intervention)}$$

While the terms are often used interchangeably, *cost-utility analyses* are cost-effectiveness analyses that apply a utility weight (e.g., number of healthy life years, quality-adjusted life years [QALYs]) to outcome measures (Muennig, 2008). The aforementioned example would be termed a cost-utility analysis if the intervention effect (headache days) was replaced with the number of healthy life years (QALYs) gained as follows:

$$ICER = \frac{(cost\ of\ CBT - cost\ of\ no\ intervention)}{(QALYs,\ CBT - QALYs,\ no\ intervention)}$$

Although beyond the scope of this article, increasing attention is being paid to the development and validation of pediatric-specific utility measures (i.e., EQ-5D, Youth

Version, Child Health Utility-9D; Gribsch, Coast, & Brown, 2005; Ungar, 2011).

Cost-benefit analyses apply monetary values to both the costs and the effectiveness (e.g., impact on disease control, suffering) of an intervention. By subtracting the monetized net benefits from the net costs, this method results in a final number indicating the net health benefit and assumes that any intervention associated with cost savings should be implemented and any intervention associated with additional costs should not be implemented (Muennig, 2002). While assigning a dollar value to life is often controversial, proponents argue that cost-benefit analyses allow for comparisons between investments in health and other domains (Drummond, Schulpher, Torrance, O'Brien, & Stoddart, 2005; Muennig, 2008). Finally, *cost-minimization analyses* are used in situations in which two interventions provide the same outcome with different costs (Muennig, 2002). For example, if a researcher found similar treatment effects for in-person and web-based pain management interventions, they may conduct a cost-minimization analysis to determine the least costly treatment.

Given the complications with assigning dollar values to health and the relative rarity of two psychosocial interventions that produce the same effect, cost-effectiveness and cost-utility analyses may be most relevant to pediatric psychologists. Cost-effectiveness analyses in psychology often use data from clinical trials (Ownby, Waldrop-Valverde, Jacobs, Acevedo, & Caballero, 2013). In the absence of these data, however, it is possible to model the hypothetical cost-effectiveness of an intervention using previously published data (Muennig, 2002). This is of particular relevance to pediatric psychologists who may not have access to data from large-scale studies but still must advocate for reimbursement. To illustrate this possibility, this article includes an illustration of a hypothetical cost-effectiveness analysis.

Hypothetical Cost-Effectiveness Analysis

Muennig (2002, 2008) describes several steps for developing a cost-effectiveness project: (1) develop a research question; (2) design the analysis; (3) obtain data; (4) adjust data; (5) construct a model; (6) test the model; and (7) conduct sensitivity analyses. As in other scientific research projects, cost-effectiveness analyses begin with a research question. In this step, it is essential to indicate the intervention, population, and outcome of interest. The design of the analysis includes obtaining an in-depth understanding of the impact of the interventions on the health or psychosocial outcome. As previously mentioned,

data can be obtained from clinical trials, collected studies, or electronic databases. In the absence of other evidence-based sources, data resulting from expert consensus (e.g., hypothesized cost of an intervention per senior researchers who have used similar interventions) may also be used. Data may require adjustments to accurately represent the research question (e.g., adjusting for inflation, adjusting charge data to reflect actual costs).

A model is then used to test the research question. As in pediatric psychology, health economics offers a variety of models that can be used to conduct cost-effectiveness analyses (see Kim & Goldie, 2008 for a review). Model selection is driven by multiple factors including the research question, illness of interest, available data (i.e., clinical trial-based vs. observational data), and resource constraints (Kim & Goldie, 2008; Stahl, 2008).

Finally, model uncertainty (or potential error) is addressed. In cost-effectiveness analyses, there may be uncertainty related to the true values of the probabilities and costs (parameters), uncertainty regarding relationships, and uncertainty due to the model selection (Kim & Goldie, 2008; Manning, Fryback, & Weinstein, 1996; Weinstein, Siegel, Gold, Kamlet, & Russell, 1996). The standard method of accounting for uncertainty related to parameters is the use of sensitivity analyses (Manning et al., 1996). Sensitivity analyses examine how the results might change in response to errors in the data or plausible variations in inputs that are of interest to the researcher (e.g., the cost of the intervention was \$500 vs. \$1,000). Methods for addressing other sources of uncertainty are beyond the scope of this article but have been detailed elsewhere (e.g., Briggs et al., 2012; Manning et al., 1996).

Research Question Development

Medication nonadherence is a modifiable behavior commonly targeted by pediatric psychologists (Wu et al., 2013). As nonadherence is a primary driver of health outcomes (Sabate, 2003), health care use (McGrady & Hommel, 2013), and health care costs (DiMatteo, 2004), adherence-promotion interventions have the potential to significantly improve outcomes and reduce costs. Although evidence-based interventions improve adherence (Graves, Roberts, Rapoff, & Boyer, 2010; Kahana, Drotar, & Frazier, 2008), pediatric psychologists often struggle to obtain reimbursement for these interventions (Wu et al., 2013). Adherence-promotion interventions, thus, represent an ideal candidate for cost-effectiveness analyses.

It is possible to examine the cost-effectiveness of adherence-promotion interventions (or any intervention delivered by a pediatric psychologist) across any population. Doing so, however, requires that nonadherence (or the

intervention target) has been previously related to a health outcome of interest. Pediatric acute lymphoblastic leukemia (ALL) was selected for this simulation, as nonadherence has been linked to health outcomes in this population. Bhatia et al. (2012) used electronic monitoring to assess adherence to oral mercaptopurine (MP) over 6 months in 327 children (ages: 1–21 years) with ALL in first continuous remission. Participants with <95% adherence were 2.5 times more likely to relapse during the 4 years following the study than participants with $\geq 95\%$ adherence. After adjusting for covariates, nonadherence was estimated to account for 59% of all relapses during the follow-up period (median = 3.7 years; Bhatia et al., 2012).

Method

Model Selection and Design

To determine the data necessary for the analysis, it is often helpful to select a model and create a visual depiction of the events that could occur before or after the adherence intervention. Of the available modeling approaches, a decision tree was selected, as it answers the proposed research question, is the most commonly used model in health economic evaluations, and is relatively simple (Kim & Goldie, 2008). Figure 1 includes a visual representation of the research question using a decision tree.

Decision trees include (1) a decision node (the choices we wish to evaluate, represented by a square); (2) the decision (represented by a circle); (3) chance nodes (the probability of events, e.g., “p_remission”); and (4) terminal nodes (the outcome of interest, represented by a triangle) (Muennig, 2002, 2008). Relevant outcomes will differ by the medical population of interest and may include disease indicators (e.g., hemoglobin A1c, CD4 count) or health states (e.g., disease remission). When selecting an outcome, researchers should ensure that data regarding the costs associated with each outcome and the effects of the decision (intervention) on the outcome are available.

In this instance, our decision is to provide no intervention or an adherence intervention. If no intervention is provided, individuals have a probability (chance node) of remission or relapse within 5 years (terminal nodes). While the U.S. Panel on Cost-Effectiveness Analysis (Weinstein et al., 1996) recommends examining outcomes over the patient’s lifetime, there are no studies examining the relationship between adherence and outcomes over the lifetime of youth with ALL. Thus, a 5-year time frame was chosen, as it is the longest time horizon for which the relationship between adherence and outcomes among youth with ALL has been examined (Bhatia et al., 2012).

For intervention, the options following treatment termination include being classified as adherent ($\geq 95\%$ of

Figure 1. Decision tree used in cost-effectiveness analysis.

doses) or nonadherent (<95%). Within each of these groups (adherent and nonadherent), a subset of patients will remain in remission for 5 years, while others will experience relapse within 5 years. Figure 1 thus represents a model comparing the costs and outcomes associated with an adherence intervention and no intervention for children and young adults (ages: 1–21 years) with ALL in first continuous remission.

Data Sources and Adjustments

In a decision tree, required input data include the probabilities at each node and the costs associated with each endpoint (represented by a triangle). In this example, required input data included probabilities of remission and relapse if no intervention is provided ($p_{\text{remission_ni}}$ and $p_{\text{relapse_ni}}$) and probabilities of remission and relapse associated with specific rates of adherence and nonadherence (i.e., $p_{\text{remission_na}}$ and $p_{\text{relapse_na}}$). Bhatia et al. (2012) reported on remission and relapse rates in a general population of youth with ALL and within adherent and nonadherent subgroups. These rates were used as probabilities in this model (see Table I and Figure 1) because the time horizon of interest (5 years) was equivalent to the period examined by Bhatia et al. (2012). When the time horizon of interest differs from the period for which rates are available, probabilities must be adjusted accordingly (Muennig, 2008).

The remaining probability, the likelihood of being adherent following the intervention (p_{adherent}), was

initially set at 60%. As this is a hypothetical example including a generic “effective” adherence promotion intervention, the actual percent of patients classified as adherent following the intervention is unknown. Sixty percent was chosen, as it represents an increase in the percentage of adherent patients in pediatric oncology populations documented by previous studies (Bhatia et al., 2012; Pritchard, Butow, Stevens, & Duley, 2006) and is consistent with success rates of previously published adherence interventions (Graves et al., 2010; Kahana et al., 2008).

Cost-effectiveness analyses can be conducted from a variety of perspectives, taking into account the costs to the insurance company (e.g., ambulatory care, hospitalization, medication), the government (e.g., public insurance reimbursement), or society (e.g., patient time, lost wages) (Muennig, 2002, 2008). The question answered by a cost-effectiveness analysis is dependent on the perspective selected. In this example, using the perspective of the insurance company could answer the question of whether reimbursing a psychologist for providing an adherence intervention would save money for the insurance company. The government perspective could be used to determine whether using public insurance funds to cover adherence interventions would save costs. By including the overall costs to everyone in society, the societal perspective could be used to determine the costs associated with enacting legislation mandating the provision of adherence interventions for youth with ALL.

Table 1. *Cost and Probability Factors*

Factor	Estimate	Source
Cost (per patient)		
Hospitalization for relapse (per year)	\$103,804	http://hcupnet.ahrq.gov
Hospitalization for remission (per year)	\$10,116	http://hcupnet.ahrq.gov
Ambulatory care (per year)	\$15,433	http://meps.ahrq.gov
Medication (6-mercaptopurine, assuming 100% adherence, per year)	\$11,308	Medi Span
Adherence intervention	\$1,000	Chapman et al. (2010) Goldie et al. (2003), Rasu et al. (2013)
Probability		
Success of intervention (percent adherent postintervention)	.60	Selected to represent an effective intervention
Remission without intervention (over 5 years)	.89	Bhatia et al. (2012)
Relapse without intervention (over 5 years)	.11	Bhatia et al. (2012)
Remission if nonadherent (over 5 years)	.83	Bhatia et al. (2012)
Relapse if nonadherent (over 5 years)	.17	Bhatia et al. (2012)
Remission if adherent (over 5 years)	.95	Bhatia et al. (2012)
Relapse if adherent (over 5 years)	.05	Bhatia et al. (2012)

Given the current challenges faced by pediatric psychologists in securing sufficient reimbursement and the potential shift to new payment models (i.e., bundled payment plans), it is particularly timely to consider the perspective of the insurance company. Conducting cost-effectiveness analyses from this perspective could illustrate how allocating funds to adherence interventions could impact overall costs for a particular patient. To demonstrate how pediatric psychologists could use these results to advocate for increased reimbursement rates, this study took the perspective of the insurance company and included the costs of ambulatory care, hospitalizations, and medications (see Table 1).

As cost data are often difficult to obtain, researchers frequently use national databases (e.g., Healthcare Cost and Utilization Project-3, National Hospital Discharge Survey, Medical Expenditure Panel Survey; see Muennig, 2002, p. 80 for additional sources). In some cases, researchers may only be able to obtain charge data, or the amount billed to the patient, and not cost data (the actual incurred costs of the resources used). To adjust charge data to reflect the accurate market value of services, a cost-to-charge ratio can be used. The example below illustrates how charge data for a hospitalization could be computed to the estimated cost of a hospitalization (Muennig, 2008):

$$\text{cost} = \text{charge for hospitalization} \\ * \frac{\text{amount reimbursed by Medicare}}{\text{charge to Medicare}}$$

The hospitalization costs associated with remission and relapse for ALL were obtained from the Agency for Healthcare Research and Quality Healthcare Cost and Utilization Project Kids' Inpatient Database. The national

average cost of ambulatory care for ALL was obtained from the Medical Expenditure Panel Survey. For illustrative purposes, it was assumed that all participants were taking 75 mg/day 6-MP, a medication prescribed as part of many treatment protocols for ALL (Relling, Hancock, Boyett, Pui, & Evans, 1999). The average wholesale price of 6-MP (assuming all prescriptions were refilled) was obtained from Medi Span Price Rx (Bayer HealthCare, 2013). To our knowledge, there are no studies documenting the cost of an adherence promotion intervention for youth with ALL. As a result, the costs of adult adherence promotion interventions (i.e., mailed reminders, electronic monitors, behavioral intervention, in-home observation of medication taking) were reviewed (Chapman et al., 2010; Goldie et al., 2003; Rasu et al., 2013). Per-patient costs ranged from \$19 (mailed reminders) to \$1,559 (in-home observation). While these costs are likely not a perfect estimate of the services delivered by pediatric psychologists, this information was used to set the initial cost of an adherence promotion intervention at \$1,000.

Costs spanning multiple years should be adjusted for inflation and hence discounted (Muennig, 2008; Weinstein et al., 1996). Discounting includes an adjustment to account for the phenomenon that individuals place a lower value on future events than current events (Muennig, 2008). As our outcome of interest was remission or relapse over 5 years, cost data (in U.S. dollars) were adjusted according to the medical care component of the Consumer Price Index and discounted as recommended by the Panel on Cost-Effectiveness in Health Care (discount rate = 3%, U.S. Bureau of Labor Statistics, 2013; Weinstein et al., 1996).

Model Testing and Sensitivity Analyses

The decision tree (Figure 1) was then used to calculate the ICER or the differences between the costs and outcomes of the adherence intervention relative to no intervention. The equation for the ICER in this example is as follows:

$$ICER = \frac{(cost\ of\ adherence\ intervention - cost\ of\ no\ intervention)}{(remission,\ adherence\ intervention - remission,\ no\ intervention)}$$

The total cost and effect of each intervention are calculated by “rolling back” the decision analysis tree, or multiplying each terminal node cost by its preceding probabilities (Muennig, 2008). For example, the total per-patient cost of “no intervention” is calculated by using the following formula: $cost\ of\ nointervention = (premission_{ni} * c_{remission} + prelapse_{ni} * c_{relapse})$. Inserting the values in Figure 1, the cost (per patient) of no intervention in this scenario is as follows: $\$47,163 = (.89 \times 36,857 + .11 \times 130,545)$.

Univariate sensitivity analyses can be used to examine the effect of varying probabilities and costs within a model and are of particular importance when there is uncertainty about the assumptions of the model. As the predicted success rate of the intervention and the cost of the intervention were not obtained from previous research with pediatric ALL, sensitivity analyses were used to examine the effect of varying the success rate of the intervention (50–80% probability of patient demonstrating adherence postintervention) and the cost of the intervention (from \$500 to \$5,000). A large range of plausible values was included in each instance given the uncertainty of these values in actual clinical practice. All analyses were performed using Microsoft Excel.

Results

The ICER represents the difference in cost and effectiveness between the two interventions and can be graphically represented on a cost-effectiveness plane (see Figure 2). The x-axis of the cost-effectiveness plane represents the differences in intervention effects (patient in remission vs. relapse). The y-axis represents the difference in cost between the adherence intervention and no intervention. The ICER may fall in one of the four quadrants. If one intervention is both more effective and less expensive than its comparator, it falls in quadrant II and is said to be dominant (Muennig, 2002, 2008). In this instance, assuming an adherence promotion intervention delivered by a pediatric psychologist results in 60% of patients being adherent, the adherence intervention dominates. It is less expensive (\$47,039 vs. \$47,163 per patient) and more

Figure 2. Cost-effectiveness plane. Adapted from Black (1990).

Figure 3. Dollars per additional success (patient in remission vs. relapse) with adherence intervention varying probability of adherence postintervention.

effective (90% chance of remission vs. 89% chance of remission) than no intervention.

The ICER is sensitive to the probability of adherence following the intervention and the cost of the intervention. The results of the sensitivity analyses are displayed in Figures 3 and 4. The points on these figures represent the costs associated with an additional success (one additional youth being in remission vs. relapse) at varying levels of intervention effectiveness (Figure 3) and intervention cost (Figure 4) when holding the other variable constant. In both analyses, there is a value at which these points cross the x-axis. These values represent the threshold at which the adherence intervention results in better outcomes and costs less than no intervention (or dominates). The range of values for which the adherence intervention dominates is depicted by a bracket. As seen in Figure 3,

Figure 4. Dollars per additional success (patient in remission vs. relapse) with adherence intervention varying cost of an adherence intervention.

when the probability of a patient being adherent following the intervention (that costs \$1,000) is $\geq 60\%$, the adherence intervention is more effective and less costly than no intervention (dominates). Assuming that 60% of patients are adherent following the intervention, the adherence intervention also dominates when the cost of the intervention is $< \$1,500$ (see Figure 4).

Discussion

Interpretation

The results of this hypothetical model suggest that providing an effective adherence intervention ($\geq 60\%$ of patients are adherent following the intervention) for youth with ALL has the potential to be a cost-effective method of improving health outcomes. In this example, if an insurance company spent up to \$1,500 per youth with ALL to provide an adherence intervention, the patient would have a higher chance of being in remission (vs. relapse) and incur fewer costs over a 5-year period than if no intervention were provided. By using sensitivity analyses, it is also possible to illustrate the situations in which the intervention would lead to better health outcomes and lower costs. This feature may be particularly helpful when there are unknown variables (e.g., success rate of intervention).

Limitations

These clinical implications, however, are purely for illustrative purposes, as they are based on hypothetical data. The probabilities and costs associated with each option were based on previous literature and national databases (as opposed to results from clinical trials). To demonstrate

the value added of our work, future studies should collect data as part of clinical trials (for guidelines see Ramsey et al., 2005). Second, as utility weights are not available for youth with ALL in remission and relapse, it was not possible to examine the hypothetical impact of an adherence intervention on QALYs using a cost-utility analysis. The use of QALYs enables researchers to compare the value of an intervention of interest with the value of other interventions. For example, by comparing the costs/QALYs for adherence-promotion interventions for adults taking anti-hypertensive and lipid-lowering medications, Chapman et al. (2010) identified the most cost-effective intervention strategies (i.e., self-monitoring, reminders, and education and a pharmacist/nurse management program). As such comparisons may be used to drive policy-level decisions, future research should include pediatric-specific utility measures.

In addition, this demonstration simplified many of the complex considerations of cost-effectiveness analyses (e.g., assuming 100% refill adherence and thus equal medication costs for adherent and nonadherent patients, assuming all patients were prescribed the same drug and thus incurred identical medication costs) and only examined costs over a 5-year period. Future studies should account for these variations and examine costs over a lifetime horizon when possible. Of note, Markov models (an alternative to decision trees) allow researchers to model changes in progression in disease states over time and may be particularly well suited to future more complex studies (Muennig, 2008).

Conclusions

This commentary responds to calls from leaders in our field to consider the potential economic impact of our work (Drotar, 2012; Roberts et al., 2012; Rozensky & Janicke, 2012). The hypothetical cost-effectiveness analysis provided in this article illustrates how pediatric psychologists can use economic data to demonstrate the value of their services. Collection and analysis of these data (i.e., costs of health care products, health care services, patient and caregiver time, patient and caregiver travel) will be essential to ensuring the continued growth of our field. Pediatric psychologists researching and delivering evidence-based treatments that ultimately impact health care utilization (e.g., adherence, pain, health promotion) may particularly benefit from these methods (Kahana et al., 2008; Waters et al., 2011).

Future research efforts should consider economic outcomes and include cost-effectiveness analyses when

possible. To ensure cost-effectiveness analyses are conducted in accordance with the U.S. Public Health Service's Panel on Cost-Effectiveness in Health and Medicine standards (Weinstein et al., 1996), individuals interested in implementing these methods should receive specialized training. Available training opportunities include formal in-person course work, OpenCourseWare free online courses (e.g., Understanding Cost-Effectiveness Analysis in Health Care via Johns Hopkins Bloomberg School of Public Health), and conference programming (e.g., short courses at the Annual Meeting of the Society for Medical Decision Making). Training programs may also wish to consider including introductory coursework on this topic (Rozenky, 2013). Finally, given the complexity of cost data and the nuances of sophisticated cost-effectiveness analyses, pediatric psychologists should consider collaborations with health economists specializing in these methods.

While cost-effectiveness analyses represent an important consideration in health care policy, they are not the sole driver of policy decisions (Neumann, 2004; Neumann, Rosen, & Weinstein, 2005). Unlike the reimbursement authorities in other countries, Medicare does not formally consider cost-effectiveness when determining coverage (Neumann et al., 2005). Even when pediatric psychologists are able to demonstrate service cost-effectiveness, it is important to continue to gather data on other patient, family, and systems-level outcomes. Further, as these analytic techniques assume a relationship between the intervention and outcome variable of choice, additional research in some areas may be required before cost-effectiveness analyses can be conducted.

The challenges in reimbursement faced by pediatric psychologists will likely continue to grow in the changing health care system. This commentary provides an example of how pediatric psychologists can use economic analyses to respond to these challenges. It is hoped that this commentary will encourage pediatric psychologists to receive additional training in the area of cost-effectiveness and to use cost-effectiveness analyses in their future research efforts.

Acknowledgments

I would like to acknowledge Kevin Frick, PhD (Professor and Vice Dean for Education, Johns Hopkins Carey Business School) for his mentorship. I would also like to thank Dennis Drotar, PhD (Cincinnati Children's Hospital Medical Center) for his feedback and guidance on this commentary.

Funding

National Institutes of Health grant T32HD068223.

Conflicts of interest: None declared.

References

- Bayer HealthCare. (2013). *Information for Vermont prescribers of prescription drugs*. Retrieved from http://www.compliance.bayerweb.com/AWP/Nexavar_Long_Form_Sept%202013.pdf.
- Bhatia, S., Landier, W., Shangguan, M., Hageman, L., Schaible, A. N., Carter, A. R., . . . Wong, F.L. (2012). Nonadherence to oral mercaptopurine and risk of relapse in Hispanic and non-Hispanic white children with acute lymphoblastic leukemia: A report from the Children's Oncology Group. *Journal of Clinical Oncology*, 30, 2094–2101. doi:10.1200/jco.2011.38.9924
- Black, W. C. (1990). The cost-effectiveness plane: A graphic representation of cost-effectiveness. *Medical Decision Making*, 10, 212–215.
- Briggs, A. H., Weinstein, M. C., Fenwick, E. A. L., Karnon, J., Sculpher, M.J., & Paltiel, A.D. (2012). Model parameter estimation and uncertainty: A report of the ISPOR-SMDM Modeling Good Research Practices Task Force-6. *Value in Health*, 15, 835–842. doi:<http://dx.doi.org/10.1016/j.jval.2012.04.014>
- Chapman, R. H., Kowal, S. L., Cherry, S. B., Ferrufino, C. P., Roberts, C. S., & Chen, L. (2010). The modeled lifetime cost-effectiveness of published adherence-improving interventions for antihypertensive and lipid-lowering medications. *Value in Health*, 13, 685–694. doi:10.1111/j.1524-4733.2010.00774.x
- DiMatteo, M. R. (2004). Variations in patients' adherence to medical recommendations: A quantitative review of 50 years of research. *Medical Care*, 42, 200–209. doi:10.1097/01.mlr.0000114908.90348.f9
- Drotar, D. (2012). Introduction to the special section: Pediatric psychologists' experiences in obtaining reimbursement for the use of health and behavior codes. *Journal of Pediatric Psychology*, 37, 479–485. doi:10.1093/jpepsy/jss065
- Drummond, M. F., Schulpher, M. J., Torrance, G. W., O'Brien, B. J., & Stoddart, G. L. (2005). *Methods for the economic evaluation of health care programmes*. Oxford, NY: Oxford University Press.
- Finney, J. W., Riley, A. W., & Cataldo, M. F. (1991). Psychology in primary health care: Effects of brief targeted therapy on children's medical care

- utilization. *Journal of Pediatric Psychology*, 16, 447–461. doi:10.1093/jpepsy/16.4.447
- Forgatch, M. S., & Toobert, D. J. (1979). A cost-effective parent training program for use with normal pre-school children. *Journal of Pediatric Psychology*, 4, 129–145. doi:10.1093/jpepsy/4.2.129
- Goldie, S. J., Paltiel, A. D., Weinstein, M. C., Losina, E., Seage, G. R. III, Kimmel, A. D., . . . Freedberg, K. A. (2003). Projecting the cost-effectiveness of adherence interventions in persons with human immunodeficiency virus infection. *The American Journal of Medicine*, 115, 632–641. doi:10.1016/j.amjmed.2003.07.007
- Graves, M. M., Roberts, M. C., Rapoff, M., & Boyer, A. (2010). The efficacy of adherence interventions for chronically ill children: A meta-analytic review. *Journal of Pediatric Psychology*, 35, 368–382. doi:10.1093/jpepsy/jsp072
- Griebsch, I., Coast, J., & Brown, J. (2005). Quality-adjusted life-years lack quality in pediatric care: A critical review of published cost-utility studies in child health. *Pediatrics*, 115, e600–e614. doi:10.1542/peds.2044-2127
- Kahana, S., Drotar, D., & Frazier, T. (2008). Meta-analysis of psychological interventions to promote adherence to treatment in pediatric chronic health conditions. *Journal of Pediatric Psychology*, 33, 590–611. doi:10.1093/jpepsy/jsm128
- Kim, S. Y., & Goldie, S. J. (2008). Cost-effectiveness analyses of vaccination programmes: A focused review of modelling approaches. *Pharmacoeconomics*, 26, 191–215. doi:1170-7690/08/0003-0191/\$48.00/0
- Manning, W. G., Fryback, D. G., & Weinstein, M. C. (1996). Reflecting uncertainty in cost-effectiveness analysis. In M. R. Gold, J. E. Siegel, L. B. Russell, & M. C. Weinstein (Eds.), *Cost-effectiveness in health and medicine* (pp. 247–275). New York, NY: Oxford University Press.
- McGrady, M. E., & Hommel, K. A. (2013). Medication adherence and health care utilization in pediatric chronic illness: A systematic review. *Pediatrics*, 132, 730–740. doi:10.1542/peds.2013-1451
- Muennig, P. (2002). *Designing and conduct cost-effectiveness analyses in medicine and health care*. San Francisco, CA: Jossey-Bass.
- Muennig, P. (2008). *Cost-effectiveness analysis in health: A practical approach*. San Francisco, CA: Jossey-Bass.
- Neumann, P. J. (2004). Why don't Americans use cost-effectiveness analysis? *American Journal of Managed Care*, 10, 308–312.
- Neumann, P. J., Rosen, A. B., & Weinstein, M. C. (2005). Medicare and cost-effectiveness analysis. *New England Journal of Medicine*, 353, 1516. doi:10.1056/NEJMs050564
- Orszag, P. R., & Emanuel, E. J. (2010). Health care reform and cost control. *The New England Journal of Medicine*, 363, 601–603. doi:10.1056/NEJMp1006571
- Ownby, R. L., Waldrop-Valverde, D., Jacobs, R. J., Acevedo, A., & Caballero, J. (2013). Cost effectiveness of a computer-delivered intervention to improve HIV medication adherence. *BMC Medical Informatics and Decision Making*, 13, 29. doi:10.1186/1472-6947-13-29
- Powers, S. W., Kashikar-Zuck, S. M., Allen, J. R., LeCates, S. L., Slater, S. K., Zafar, M., . . . Hershey, A. D. (2013). Cognitive behavioral therapy plus amitriptyline for chronic migraine in children and adolescents: A randomized clinical trial. *Journal of the American Medical Association*, 310, 2622–2630. doi:10.1001/jama.2013.282533
- Pritchard, M. T., Butow, P. N., Stevens, M. M., & Duley, J. A. (2006). Understanding medication adherence in pediatric acute lymphoblastic leukemia: A review. *Journal of Pediatric Hematology/Oncology*, 28, 816–823. doi:10.1097/01.mph.0000243666.79303.45
- Ramsey, S., Willke, R., Briggs, A., Brown, R., Buxton, M., Chawla, A., . . . Reed, S. (2005). Good research practices for cost-effectiveness analysis alongside clinical trials: The ISPOR RCT-CEA Task Force Report. *Value in Health*, 8, 521–533. doi:10.1111/j.1524-4733.2005.00045.x
- Rasu, R. S., Malewski, D. F., Banderas, J. W., Malomo Thomson, D., & Goggin, K. (2013). Cost of behavioral interventions utilizing electronic drug monitoring for antiretroviral therapy adherence. *Journal of Acquired Immune Deficiency Syndromes*, 63, e1–e8. doi:10.1097/QAI.0b013e318285d951
- Relling, M. V., Hancock, M. L., Boyett, J. M., Pui, C.-H., & Evans, W. E. (1999). Prognostic importance of 6-Mercaptopurine dose intensity in acute lymphoblastic leukemia. *Blood*, 93, 2817–2823.
- Roberts, M. C., Canter, K. S., & Odar, C. C. (2012). Commentary: A call to action to secure the future of pediatric psychology—Resonating to the points of Rozensky and Janicke (2012). *Journal of Pediatric Psychology*, 37, 369–375. doi:10.1093/jpepsy/jss053
- Rozensky, R. H. (2013). Quality education in professional psychology: Flowers blooming, Flexner, and the

- future. *American Psychologist*, 68, 703–716. doi:10.1037/a0033771
- Rozensky, R. H., & Janicke, D. M. (2012). Commentary: Healthcare reform and psychology's workforce: Preparing for the future of pediatric psychology. *Journal of Pediatric Psychology*, 37, 359–368. doi:10.1093/jpepsy/jsr111
- Sabate, E. (2003). *Adherence to long-term therapies: Evidence for action*. Geneva, Switzerland: World Health Organization.
- Stahl, J. E. (2008). Modelling methods for pharmacoeconomics and health technology assessment: An overview and guide. *Pharmacoeconomics*, 26, 131–138. doi:10.2165/00019053-200826020-00004
- Talmi, A., & Fazio, E. (2012). Commentary: Promoting health and well-being in pediatric primary care settings: Using health and behavior codes at routine well-child visits. *Journal of Pediatric Psychology*, 37, 496–502. doi:10.1093/jpepsy/jss047
- Ungar, W. J. (2011). Challenges in health state valuation in paediatric economic evaluation: Are QALYs contraindicated? *Pharmacoeconomics*, 29, 641–652. doi:10.2165/11591570-000000000-0000
- US Bureau of Labor Statistics. (2013). *Consumer price index: Medical care datatable*. Retrieved from <http://data.bls.gov/timeseries/CUUR0000SAM>.
- Waters, E., de Silva-Sanigorski, A., Hall, B. J., Brown, T., Campbell, K. J., Gao, Y., . . . Summerbell, C. D. (2011). Interventions for preventing obesity in children. *The Cochrane Database of Systematic Reviews*, 12, Cd001871. doi:10.1002/14651858.CD001871.pub3
- Weinstein, M. C., Siegel, J. E., Gold, M. R., Kamlet, M. S., & Russell, L. B. (1996). Recommendations of the panel on cost-effectiveness in health and medicine. *Journal of the American Medical Association*, 276, 1253–1258. doi:10.1001/jama.1996.03540150055031
- Wu, Y. P., Rohan, J. M., Martin, S., Hommel, K., Greenley, R. N., Loiselle, K., . . . Fredericks, E. M. (2013). Pediatric psychologist use of adherence assessments and interventions. *Journal of Pediatric Psychology*, 38, 595–604. doi:10.1093/jpepsy/jst025