The Cost-Effectiveness of Intensive Interdisciplinary Pediatric Chronic Pain Rehabilitation

Jenny R. Evans, PhD, Ethan Benore, PhD, and Gerard A. Banez, PhD

Cleveland Clinic Children’s

Abstract

Objective  Examine the cost-effectiveness of a 3-week interdisciplinary pediatric chronic pain rehabilitation program.  Methods  Self-reported health care utilization and parent missed work of youth with chronic pain (n = 127) at admission and 1-year follow-up were compared. Financials were calculated from program revenue and established national costs for health care and wages.  Results  Data indicate significant reductions in days hospitalized, physician office visits, physical/occupational therapy services, psychotherapy visits, and parental missed work. Estimated health care expenses were $61,988 in the year before admission and $14,189 in the year after admission (−$58,839). Estimated cost of missed work was $12,229 in the year prior and $1,189 in the year after (−$11,039).  Conclusions  Comparing estimated expenses before ($74,217) and after ($15,378) minus program costs ($31,720), yielded estimated savings of $27,119 per family in the year following admission. These findings extend the benefit of the program beyond clinical improvement, to outcomes important to both families and insurers.

Key words: cost-effectiveness; outcomes; pediatric chronic pain; treatment.
hypothesized that interdisciplinary pain rehabilitation would lead to reductions (a) in health care utilization and (b) parents missed days of work. Moreover, we hypothesized that reductions in health care spending and missed work would result in a net cost savings, even after accounting for the program costs.

**Method**

**Procedure**

**Data Collection**

Data were gathered from a retrospective chart review of information routinely collected as part of clinical care. Patients completed our program survey instrument in which they reported on a variety of health care utilization variables, as well as related variables such as missed school. Patients reported on the previous 30 days for all variables except emergency department (ED) usage, which was reported for the last 7 days and extrapolated for all analyses to the 30-day period.

Patients were specifically asked to provide data based on their health care utilization related to pain. Based on typical variability in chronic pain symptoms and locations, they were not directed to distinguish between pain present at admission and any pain that may have developed subsequently. Data were provided on admission and again at 1-year follow-up (by mail). This clinical database was approved by the institutional review board.

**Treatment Intervention**

The interdisciplinary pain rehabilitation program typically consists of a 2-week inpatient stay and 1 week of day hospital. Weekly schedule includes individual physical/occupational therapy (PT/OT) (5 hr), on-land and aquatic group exercise (10 hr), recreational and art therapies (6 hr group, one family), psychology (3 hr individual, 3 hr cognitive-behavioral group), parent psychoeducation/support group (3 hr), school (7–9 hr). The treatment approach integrates rehabilitation therapies, behavioral health, and subspecialty medical care, with an emphasis on interdisciplinary collaboration and cotreatment. The primary goal of the program is to enhance daily functioning (i.e., return to school and activities) despite presence of chronic pain.

Though interdisciplinary in nature, psychologists play an integral role in the approach to pain management. The program strongly emphasizes lifestyle and cognitive-behavioral approaches to improve daily functioning, facilitate school reentry, and reduce the need for additional medical care (e.g., procedures, visits, medications). Psychologists frequently assist occupational/physical therapists with applying pain-coping strategies during difficult sensory desensitization or strengthening/endurance exercises. In addition, psychoeducation with parents is provided to develop family strategies for managing pain behaviors and overcoming potential obstacles to normal functioning and successful transition to home, school, and recreational activities. A thorough description of the program, including clinical outcomes data demonstrating its effectiveness, has been published in Banez et al. (2014).

**Participants**

At admission, youth ranged in age from 8 to 22 years ($m = 15.2$, $SD = 2.60$), were 74.6% female, and 91% Caucasian. The most common pain conditions were complex regional pain syndrome (35%), headache (19%), abdominal pain (15%), and back pain (10%). Pain diagnoses were made by a board-certified physiatrist following a review of medical records and clinical exam, as a part of a comprehensive interdisciplinary evaluation process. Patient-reported pain intensity during the last 24 hr averaged 6.8 ($SD = 2.25$) on a scale of 0–10. Mean chronicity of pain was 28 months ($SD = 21.98$). Of the 675 charts reviewed, both admission and 1-year follow-up data were available for 127 patients admitted between 2007 and 2013. The majority of patients were lost at the 1-month follow-up time, with 512 patients providing data at admission and just 162 of those providing complete data at admission and 1-year follow-up. This low response rate is likely owing to several factors including the fact that no incentives were offered for providing data and packets were mailed to participants with limited follow-up contact regarding the completion of the packets. Based on available data, those who were included in the study did not differ from those who were not included on age, gender, pain location, intensity, or chronicity.

**Measures and Materials**

Our previous outcomes study demonstrated the program’s clinical effectiveness (Banez et al., 2014); thus, the present study focused solely on its cost-effectiveness. Proxy measures of functioning and functional improvement include health care utilization variables and parent missed work.

**Self-Reported Pain**

Although not used for calculating cost of the program, self-reported pain was included to provide a “snap shot” of the program’s clinical effectiveness. Patients reported on pain during the past 24 hr on a Likert scale of 0 (no pain) to 10 (worst pain). Additional outcome variables targeting child functioning have been published in (Banez et al., 2014).
Health Care Usage and Family Impact
Our clinical database collected information on the following: (a) days hospitalized inpatient, (b) ED visits owing to pain, and visits with (c) specialty physicians, (d) primary care/pediatrician, (e) PT/OT, and (f) psychology. All variables were reported on for the past 30 days, with the exception of ED visits, which were reported for the previous 7 days and extrapolated to the same time frame as the other variables. Patients also reported on parental work days missed in the past month.

Economic Impact
The 2011 Household Component Event files from the Medical Expenditure Panel Survey (MEPS; Agency for Healthcare Research and Quality, 2011) data were used to estimate health care costs for our sample. MEPS data are collected by the Agency for Healthcare Research and Quality and contain detailed information on a wide variety of health care services, including utilization and expenses. Table I presents a summary of our clinical data and the MEPS variables used and the estimated costs for each item. Based on the model of Groenewald et al. (2014), cost estimates were calculated using the total expenditure variable, which includes the facility and provider charges. Any office visits that did not involve face-to-face contact were excluded. Owing to skewness in MEPS data, cost estimates were generated using the more conservative median values rather than means. All files used and syntax created to recode variables for the present analyses are available by contacting the corresponding author.

As in the Groenewald et al. (2014) study, cost estimates for missed work were calculated using the May 2011 national occupational employment and wage estimates published by the Bureau of Labor Statistics (May, 2011) and were based on an 8-hr work day. Mean hourly wage for “All Occupations” (Occupations Code 00-0000) was $21.74, resulting in an estimated cost of $173.90 per day of missed work.

The cost estimate for the pain rehabilitation program was $31,720, which was the mean total charges billed from 2011 program revenue data.

Cost-Effectiveness Model Selection
There is increasing recognition of the importance of demonstrating both the cost-effectiveness and clinical effectiveness of pediatric psychological services (McGrady, 2014). A cost-effectiveness analysis can be defined as a technique for weighing the relative costs and benefits of specific intervention for a specific population (McGrady, 2014, Muennig, 2008). A variety of methods exist to evaluate cost-effectiveness, each with their own strengths and limitations. In the present study, we sought to examine the cost-effectiveness of interdisciplinary pediatric chronic pain rehabilitation program based on clinical outcomes data. We considered many approaches to this analysis and factored in three primary goals: (1) to present the data we have in the most accurate way possible given the constraints of a longitudinal clinical data set (e.g., subject attrition), (2) to present the data in such a way that it would be as comparable as possible with existing studies on the economic impact of pediatric chronic pain in the United States (Groenewald et al., 2014), and (3) to present the data in the most conservative way possible so as to not overestimate the economic impact of the program. Follow the recommendations outlined by the Consolidated Health Economic Evaluation Reporting Standards (Husereau et al., 2013); the ‘Discussion’ section highlights important considerations specific to the cost-effectiveness analysis including model assumptions, uncertainty, limitations, as well as future directions for subsequent cost-effectiveness analyses.

Table I. Medical Expenditure Panel Survey Data Extraction Summary

<table>
<thead>
<tr>
<th>Variablea</th>
<th>Corresponding MEPS variable</th>
<th>Estimated event costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical care:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ED visits for pain</td>
<td>Total expenditure for:</td>
<td><strong>$381.89</strong> (Median)</td>
</tr>
<tr>
<td>Days hospitalized</td>
<td>Event/number of days in hospital</td>
<td><strong>$1,668.78</strong> (Median)</td>
</tr>
<tr>
<td>Office visits:</td>
<td>Total expenditure for office visits when:</td>
<td><strong>$498.02</strong> (Median)</td>
</tr>
<tr>
<td>Specialty physician</td>
<td>Specialty: Anesthesiology, Neurology, Gastroenterology, Rheumatology, Orthopedic, or Cardiology</td>
<td><strong>$498.02</strong> (Median)</td>
</tr>
<tr>
<td>Primary care physician</td>
<td>Specialty: family practice, general practice, or pediatrician</td>
<td><strong>$152.13</strong> (Median)</td>
</tr>
<tr>
<td>PT/OT</td>
<td>Service was physical or occupational therapy</td>
<td><strong>$120.00</strong> (Median)</td>
</tr>
<tr>
<td>Psychologist/counselor</td>
<td>Service was psychotherapy and seen by psychologist, social worker, or psychiatrist</td>
<td><strong>$145.20</strong> (Median)</td>
</tr>
</tbody>
</table>

Note. MEPS = Medical Expenditure Panel Survey; ED = emergency department; PT/OT = physical/occupational therapy.
Variables collected at admission and 1-year follow-up using our clinical database.
Data extracted from MEPS files as follows: aMEPS HC-144E: 2011 Emergency Room Visits File, bMEPS HC-144D: 2011 Hospital Inpatient Stays File, cMEPS HC-144G: 2011 Office-Based Medical Provider Visits File.
Statistical Plan of Analysis

Preliminary Analyses

Data screening indicated positive skew across study variables, and thus nonparametric analyses of variance (Wilcoxon Signed Rank Tests) were used to examine differences in health care utilization, missed work, pain, and functioning. Pearson’s $r$ was used to calculate effect size.

Self-Reported Pain

Descriptive analyses were used to examine differences in pain and functional disability. Pearson’s $r$ was used to calculate effect size.

Health Care Utilization and Family Impact

Our clinical database contained information on the previous 30 days for all variables except ED usage, which was reported for the previous 7 days. Therefore, annualized estimates of utilization and missed work were generated by multiplying by 12, or in the case of ED usage by 52. Next, the estimated events costs (see Table I) were used to calculate annualized spending for each variable in the year before admission and the year following admission.

Economic Impact

Descriptive analyses were used to examine mean estimated cost savings in the year following admission to the pain rehabilitation program. As noted previously, our data were skewed, suggesting that examining median usage may be more appropriate. When this was done, the pattern of findings did not change; however, it appeared to convey an overly favorable presentation of program impact, with median health care utilization at 1-year follow-up zero for all variables. Although statistically accurate, we believed that this would be misleading, and thus, mean values are presented instead.

Cost-Effectiveness

Our cost-effectiveness analysis examined the difference between estimated expenses in the year before admission and estimated expenses in the year after admission combined with the cost of the program itself (see Figure 1).

<table>
<thead>
<tr>
<th>Estimated Annual Cost Pre-Admission</th>
<th>Estimated Annual Cost Post-Admission</th>
<th>Program Cost</th>
<th>Estimated Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Healthcare + Missed Work</td>
<td>Healthcare - Missed Work</td>
<td>$31,720</td>
<td>$58,839</td>
</tr>
</tbody>
</table>

Figure 1. Cost-effectiveness analysis calculation.

Results

Self-Reported Pain

On admission, pain during the previous 24 hr averaged 6.8 ($SD = 2.25$) and 4.8 ($SD = 3.15$) at follow-up. This represented a large, clinically significant decrease ($z$-score $= -5.924$, $p < .001$, $r = -.37$).

Health Care Usage and Family Impact

Figure 2 presents a summary of changes in health care usage and parent missed work from admission to 1 year later. In brief, there were statistically significant reductions in all variables except ED usage, whose range was highly restricted with mean usage at <0.5 visits per month at admission and 1 year later. The largest reductions were observed in missed work ($r = -.45$), pain ($r = -.37$), PT/OT services ($r = -.29$), and specialty physician office visits ($r = -.28$).

Economic Impact

Estimated health care spending in the year before and year after admission is summarized by expense category in Table I. The largest decreases were observed for days hospitalized inpatient ($38,248$) and specialty physician visits ($5,259$). Total estimated health care expenses were $61,988$ in the year before admission and $14,189$ in the year after admission, a difference of $58,839$. The estimated cost of lost work was $12,229$ in the year before admission and $1,189$ in the year after admission, a difference of $11,039$.

Cost-Effectiveness

The difference in total estimated costs in the year before admission ($74,217$) and total estimated costs in the year after admission ($15,378$) minus the cost of the program itself ($31,720$) translated to an estimated savings of $27,119 per family in the year following admission (see Figure 2).

Discussion

The present study examined whether intensive, interdisciplinary pain rehabilitation treatment is a cost-effective intervention. Overall, health care utilization was reduced in the year following treatment, and there were significant reductions in days hospitalized inpatient, physician office visits, PT/OT services, and psychology, as well as parental missed work. Only differences in ED usage were not statistically significant; however, ED usage was low at admission and
thus there significant reductions were unlikely. Our hypothesis that savings would exceed program expenses was supported and average expenses were estimated to be $58,839 less per family in the year following intensive, interdisciplinary pain rehabilitation. Including the cost of the program, average estimated expenses were $27,119 less. Thus, despite high initial costs, the program appears to lead to substantial savings in the year following admission.

As noted previously, our health care utilization data were positively skewed with some patients reporting much higher rates of utilization than the

Table II. Health Care Utilization and Pain Impact in Previous 30 Days, Pre- and Postadmission

<table>
<thead>
<tr>
<th>Variable</th>
<th>Preadmission</th>
<th>1-year postadmission</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Median</td>
</tr>
<tr>
<td>PT/OT visit</td>
<td>3.0</td>
<td>4.50</td>
<td>1</td>
</tr>
<tr>
<td>Specialty physician visit</td>
<td>1.7</td>
<td>2.12</td>
<td>1</td>
</tr>
<tr>
<td>Days hospitalized inpatient</td>
<td>2.1</td>
<td>7.18</td>
<td>0</td>
</tr>
<tr>
<td>Psychologist/counselor</td>
<td>1.5</td>
<td>1.81</td>
<td>1</td>
</tr>
<tr>
<td>General practitioner visit</td>
<td>0.7</td>
<td>0.92</td>
<td>0</td>
</tr>
<tr>
<td>Emergency department visit</td>
<td>0.4</td>
<td>1.73</td>
<td>0</td>
</tr>
<tr>
<td>Missed work days</td>
<td>5.9</td>
<td>9.90</td>
<td>1</td>
</tr>
<tr>
<td>Pain</td>
<td>6.8</td>
<td>2.25</td>
<td>7</td>
</tr>
</tbody>
</table>

Note. PT/OT = physical/occupational therapy. Significance testing is based on Wilcoxon Signed Rank Tests nonparametric analyses of variance.

Figure 2. Cost-effectiveness analysis calculation with estimated values.

Figure 3. Estimated economic impact before and 1 year after pain rehabilitation.
general sample. This pattern is consistent with previous research on the economic costs of pediatric chronic pain, which found that 30% of total costs were generated by just 5% of the sample (Groenewald et al., 2014). In the present study, we did not differentiate between low and high health care consumers, and it is possible that a more fine-tuned analysis will identify key moderators of the relationship between pre- and postrehabilitation health care utilization. For example, it is possible that certain service usage patterns may be significantly influenced by outside factors at the individual-level (e.g., pain diagnosis), family-level (e.g., parent beliefs or responses to pain), provider-level (e.g., provider reliance on low vs. high cost interventions) or systems level (e.g., access to care).

Study Limitations
The present study was based on self-reported health care utilization, and certain methodological limitations exist. Principally, these analyses were based on the assumption that without intensive rehabilitation services, the frequency of health care utilization would remain stable, arguably a fair assumption given the average duration of pain in our population is 28 months. In addition, the study was based on clinical outcomes data from our program impact survey, which has not been previously validated. Moreover, there were some limitations to the available data (e.g., ED usage was reported on for a 7- rather than 30-day period).

An additional limitation relates to the study attrition and low response rate for the 1-year follow-up data. It remains unknown whether the nonresponders did not respond because they did not feel the program was helpful (in which case cost-effectiveness may be overestimated), or whether patients simply did not respond because their pain had resolved and they felt they no longer needed to follow-up (in which case cost-effectiveness would be underestimated). It would be important for future studies to attempt investigations that do not require ongoing, active participation (such as large-scale chart review) to better understand the cost-effectiveness of the program for all patients.

Finally, the present sample, though consistent with other pediatric pain samples, was predominantly female and Caucasian; thus, findings may not generalize to other demographic groups, whose access to care and health care expense may differ based on socioeconomic factors.

Model Uncertainty
In examining cost-effectiveness, there are a number of potential approaches, each of which introduces model-related uncertainty (McGrady, 2014). The present model relied on estimated health care cost and a longitudinal clinical database collected over the course of several years, and it is possible that actual health care costs may vary from the present estimates. For example, it was not possible to exactly match governmental spending estimates to a patient’s specific year of treatment and consequently, actual costs per patient could vary significantly based on factors such as (a) contracted rates for their specific insurer (e.g., low reimbursing state-funded health coverage vs. a “premium” commercial insurance) or (b) coverage limitations and whether restrictions to the number of allowed sessions in a year may influence access to care, and thereby health care utilization and costs, over the course of a year. As noted previously, our data were significantly skewed in the positive direction and we chose to use the more conservative median, rather than mean, estimates. This decision was made to avoid overestimating cost-savings; however, it consequently increased the likelihood of underestimating cost savings.

An additional source of uncertainty relates to costs associated with parent missed work. Some research has described pediatric chronic pain samples as having a higher than average socioeconomic status (SES; Huguet & Miró, 2008), while others have identified low SES as a risk for increased pain (King et al., 2011). Given that SES was not the primary outcome of interest in these studies, it appears that the relationship between pediatric chronic pain and SES is not entirely clear. To enhance comparability with previous research on the economic costs of pediatric pain in the United States, the present analysis used mean wage data from the Bureau of Labor for all occupations, which likely underrepresents the costs of lost work days to some families in our sample and overestimates for others. Moreover, the available data and model used did not allow us to measure the impact of program participation on parents’ lost work. For example, we were not able to examine the percentage of families for whom either one or both parents (a) take unpaid leave from work for the purpose of participating in the program versus those who we already on unpaid leave or had stopped working entirely owing to their child’s disability, or (b) those who relied on paid vacation days or flexible “remote” work options.

Finally, questions exist regarding the potential impact of Affordable Care Act (ACA) on the cost-effectiveness of intensive rehabilitation programs. Data were collected before the wide-spread introduction of the ACA; thus, it is not possible to provide definitive answer based on the present study. Likely, some individuals will experience reduced access to care as higher deductible plans shift greater financial responsibility to patients. Presumably, greater access to coverage will lead to increased health care utilization for others. The recent publication examining
the impact of Medicare on health care utilization for older adults suggests a possible net benefit as access to care expands (Krumholz, Nuti, Downing, Norman, & Wang, 2015). Ideally, those who truly require intensive pain rehabilitation will have access, and those who would be well served with less costly options would have access to those services. Potentially, as health care systems move toward greater net efficiencies, it may be possible to achieve both greater cost-efficiencies and more efficient utilization of care.

Model Limitations
In addition, these analyses were based on the assumption that without intensive rehabilitation services, the frequency of health care utilization would remain stable, arguably a fair assumption given the average duration of pain in our population is 28 months. Finally, the present sample, though consistent with other pediatric pain samples, was predominantly female and Caucasian; thus, findings may not generalize to other demographic groups, whose access to care and health care expense may differ based on socioeconomic factors.

Future Directions
To extend the present findings, it would be important to examine direct-source health care data, based potentially on an analysis of the charges and health care utilization of patients who have received all of their care within one system. In addition, the present study examined estimated costs to the system; an examination of “out of pocket spending” may shed additional light on the economic impact on families. Lastly, it would be interesting to conduct a more fine-tuned analysis to examine the most cost-effective level of care based on a patient’s level of impairment. In the present sample most youth experienced a high degree of pain-related disability (Banez et al., 2014), and it would be important to better understand the generalizability of the present findings to youth with less functional impairment. One avenue of examination could be using matched-patient controls of youth who (a) are experiencing low versus high levels of impairment or (b) do not participate in intensive rehabilitation services.

Conclusions
The present study supports the cost-effectiveness of intensive, interdisciplinary rehabilitation for pediatric chronic pain. Previous research has demonstrated the high cost of pain (Groenewald et al., 2014) and that intensive interdisciplinary rehabilitation leads to functional improvement (Banez et al., 2014; Simons et al., 2013); however, to date, little research has been published examining the economic impact of this costly intervention. Our research examined the systems-level costs of interdisciplinary pain rehabilitation and it would be important for future research to consider additional aspects such as family-level (i.e., “out of pocket”) costs and costs to the system, potentially measured using direct-source health care utilization data and expenditures. Questions exist regarding how recent changes in health care access and cost management strategies may impact the cost-effectiveness of similar programs in the future. In summary, the present findings extend the benefits of intensive, interdisciplinary pediatric chronic pain rehabilitation beyond clinical improvement, to economic outcomes important to both families and insurers.

Conflicts of interest: None declared.

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Standards (CHEERS)—explanation and elaboration: A report of the ISPOR health economic evaluation publication guidelines good reporting practices task force. *Value in Health* 16, 231–250.


