Increasing Attention-Deficit/Hyperactivity Disorder Treatment Outcomes Through Use of a Collaborative Consultation Treatment Service by Community-Based Pediatricians

A Cluster Randomized Trial

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Objective: To test whether adoption of a collaborative consultative service model results in improved patient outcomes.

Design: Twelve pediatric practices were randomly assigned to receive access to collaborative consultative services or to a control group.

Setting: Community-based pediatric offices.

Participants: Fifty-two pediatricians and their 377 patients with attention-deficit/hyperactivity disorder (ADHD).

Intervention: A collaborative consultative service promoting the use of titration trials and periodic monitoring during medication maintenance.

Main Outcome Measure: Physician practice behaviors and child ADHD symptomatology.

Results: Using self-report of pediatricians, the collaborative consultative service increased the use of evidence-based practices by pediatricians, but no difference in children's ADHD symptomatology was observed between the groups. However, many pediatricians did not fully use the collaborative consultative services. Those children who actually received collaborative consultative services showed significant behavioral improvement compared with children not receiving these services.

Conclusions: When actually implemented by pediatricians, the collaborative consultative service appears to be an effective method for facilitating evidence-based treatment procedures for ADHD and use of these procedures appear to improve children's outcomes. Barriers to implementation of collaborative consultative service in pediatric practice need to be further understood.

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ADHD have been described elsewhere and are reported to be successful at improving adherence to practice behaviors recommended by the American Academy of Pediatrics. Similar collaborative consultation service models have been used to promote the use of titration trials and periodic monitoring during medication maintenance. An important limitation of this work, however, is that impact of such a service on children's treatment outcomes has not been evaluated. Our study was intended to address this gap in the literature by examining whether a collaborative consultation model to promote the use of titration trials and systematic monitoring would increase the use of these practices across multiple pediatric groups and whether this would yield better management of core ADHD symptoms in children with the disorder.

**METHODS**

**PARTICIPANTS**

Pediatricians

Twelve pediatric practice groups (ie, >1 health care provider) that had no on-site psychologist or psychiatrist and that

used a computerized billing system were identified using a statewide physician directory. The recruitment goals were to get consent from and enroll the maximum number of pediatricians at the minimum number of practices and to select typical office settings. Across the 12 practices, a total of 52 pediatricians (27 men and 25 women) or associated health care professionals (eg, physician assistants) participated.

**Children**

After consenting to participate in the study, physicians consented for and enrolled stimulant-naive children in first through fifth grades who presented with an ADHD-related problem (377 children). A randomly selected sample of 146 children, all of whom met Diagnostic and Statistical Manual of Mental Disorders (Fourth Edition) (DSM-IV) criteria for ADHD, as determined by parent and teacher versions of the Conners Rating Scale, was recruited for follow-up to assess child outcomes. An attempt was made to select equal numbers of patients across pediatricians by randomly selecting a single child from each pediatrician every 2 months. Hence, the maximum number of children included in the study seen by a single pediatrician was 6, but could be fewer if a pediatrician did not see a child who met inclusion criteria during a 2-month period. Ninety-three of these children were boys. Most participants were white (white, n=116 [79%]; African American, n=24; American Indian, n=1; Hispanic, n=1; multiracial, n=3; not reported, n=1). Mean age was 7.8 years (SD, 1.5 years).

**DESIGN**

The 12 practices were randomly assigned to receive the collaborative consultation service or not (control group). Practices representing similar geographic location and size were randomized in blocks of 2. In practices assigned to the collaborative consultation service group, pediatricians were assisted in using titration service models to determine optimal dosages for children and using rating scales to monitor medication efficacy and side effects during medication maintenance. They were encouraged to use these services with all of their stimulant-naive patients with ADHD in grades first through fifth for whom they opted to prescribe medication. Control group practices did not have access to consultative model services. The flowchart for this cluster randomized trial is shown in Figure 1. The study was approved by the Duke University Medical Center institutional review board.

**COLLABORATIVE CONSULTATION SERVICE**

Physicians were taught to prescribe 4 different weekly doses of stimulant medication during a titration trial. For purposes of this study, the following doses were packaged together: placebo and 18 mg, 36 mg, and 54 mg of methylphenidate hydrochloride. The order of weekly doses was blinded but standardized across all patients (week 1, 18 mg; week 2, placebo; week 3, 36 mg; week 4, 54 mg). These packaged medications were made available through local pharmacies. At the end of each week, parents and teachers completed weekly behavioral (Conners Global Index) and side effect (6) rating scales. These were returned to the Duke University Medical Center ADHD Clinic, where data were analyzed by Duke psychiatrists to determine a best starting dosage of medication. A report describing the titration results was faxed back to pediatricians. Subsequently, parents and teachers completed monthly behavioral and side effect rating scales. These were sent to the Duke University Medical Center ADHD Clinic, where reports were prepared to alert pediatricians to any behavioral deteriorations or appearance of side effects.

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**Figure 1.** Flowchart for the cluster randomized trial. ADHD indicates attention-deficit/hyperactivity disorder; HCP, health care professional.
MEASURES

Study measures were incorporated, which measured both pediatricians’ behaviors and child outcomes. Practice behaviors, knowledge related to the use of titration trials, and systematic monitoring of medication effectiveness were assessed using surveys that were administered preintervention and postintervention. Specifically, pediatricians were asked about how frequently they used titration trials and systematic monitoring of medication treatment over time and the obstacles they experienced in using these practices (eg, lack of time).

To assess children’s core ADHD symptoms over the course of the study, researchers used the Conners Parent Rating Scale and the Conners Teacher Rating Scale at 0, 3, and 12 months after study entry. The DSM-IV symptoms scores from the Conners Parent Rating Scale and the Conners Teacher Rating Scale served as the primary child outcome measures. Parents and teachers were compensated for completing research forms. No compensation was provided for completion of clinically related questionnaires and forms.

ANALYSES

In this randomized design, pediatricians were nested within practice and children were nested within pediatrician and practice. Hierarchical linear models were used to account for these nested effects. Pediatric office and pediatrician were introduced as effects in the models. Across all analyses, however, the variance components associated with these nested random effects were negligible. Hence, we dropped practice and pediatrician from the analyses.

Each pediatrician had 2 repeated observations on each variable (preintervention and postintervention), and children had 3 repeated observations on each variable (at baseline and 3 and 12 months). Multivariate normal regression models were conducted using time (preintervention and postintervention) and group status (collaborative consultation service or control group) as independent variables. For analyses of child effects, an additional variable for the rater was included so that parent and teacher ratings could be included in a single analysis. Significant group x time interaction terms would indicate any intervention effects.

For children randomly selected for follow-up, data collection was to occur at baseline and 3 and 12 months. Of 146 participants selected for follow-up, 45 had data from all 3 data points. The remaining 101 participants had at least 1 missing data point. These missing data points reflect the difficulty of obtaining completed rating scales from a number of parents and teachers despite multiple requests via telephone and mail. Data were assumed to be missing at random. Indeed, a comparison of children with missing data on DSM-IV–defined ADHD symptomatology at baseline with those who had complete data demonstrated no group differences (F1,144=1.10, P=.30). This supported the missing-at-random assumption and hence all observations were kept in the analyses.

RESULTS

PEDIATRICIAN PRACTICE BEHAVIOR

Randomizing the 12 practice groups resulted in 25 pediatricians in the collaborative consultation service group and 27 in the control group. The 2 groups did not differ in sex composition (P=.25) or number of years since their residency (collaborative consultation service group mean, 9.76 years [SD, 10.13]; control group mean, 9.07 years [SD, 7.25]; P=.78). In addition, the percentage of physicians in each group (84% of the collaborative consultation service group; 93% of the control group) did not differ (P=.31). Five pediatricians in the control group (24%) and 9 pediatricians in the intervention group (36%) did not enroll any children in the study. Responses from these pediatricians on the preintervention and postintervention questionnaire were not included in the analyses reported subsequently.

There were greater preintervention to postintervention improvements in the use of titration trials among the collaborative consultation service pediatricians compared with control-group pediatricians (interaction, β=-.283; SE, 0.09; P<.01) (Figure 2). Specifically, titration trials in the intervention group increased from 9% to 68% compared with no increase in the control group (P<.001). Although both groups increased their use of monthly rating scales to monitor medication during maintenance (40%-64% for the collaborative consultation service group and 29%-50% for the control group; time effect, β=.200; SE, 0.07; P<.01), monitoring did not increase more among pediatricians in the collaborative consultation service group, and more than one-third were still not conducting regular, systematic monitoring of medication treatment. Pediatricians with access to the collaborative consultation service reported decreases across all obstacles. The greatest decreases were on items concerning lack of time to conduct a titration trial (odds ratio, 6.3; SE, 3.5), lack of knowledge about how to conduct a titration trial (odds ratio, 5.5; SE, 3.1), and how to interpret monthly rating scale scores during medication maintenance (odds ratio, 3.7; SE, 2.1) (Table).

CHILD OUTCOMES

Collaborative consultation service pediatricians enrolled 162 patients (mean, 8.5 patients per physician [SD, 5.2]) while control-group practices enrolled 215 patients (mean, 8.2 patients per physician [SD, 4.6]). Of
the 146 children who were randomly selected for follow-up, 59 were patients of collaborative consultation service pediatricians and 87 were patients of control-group pediatricians. Parents, in comparison with teachers, rated the children as having less ADHD symptomatology overall (\(F_{1,144}=-31.74, P<.001\)). Although ADHD symptomatology decreased over time (\(F_{2,144}=143.65, P<.001\)), child outcomes did not differ by group (\(F_{1,144}=0.05, P=.83\)) and the interaction testing for the intervention effect (ie, group \times time) was nonsignificant (\(F_{2,144}=0.44, P=.65\)).

However, only 29 of the 59 randomly selected follow-up patients of collaborative consultation service pediatricians received a titration trial and even fewer participated in the monthly medication monitoring (n=13). An additional set of analyses were performed to detect whether patients who were minimally exposed to the intervention, defined by experiencing a titration trial, had better outcomes than nonexposed children. In this analysis, groups of collaborative consultation service compliers (those receiving a titration trial [n=29]) and collaborative consultation service noncompliers (those not receiving a titration trial [n=30]) were compared with each other and to children treated by control-group physicians. A preliminary analysis indicated that these groups were comparable at baseline on both parent (\(F_{1,57}=1.80, P=.05\)) and teacher ADHD ratings (\(F_{1,40}=0.22, P=.05\)).

After treatment began, the 3 groups were rated differently overall (\(F_{2,143}=3.45, P<.05\)) and the intervention effect (group \times time) was significant (\(F_{4,124}=3.80, P<.01\)), with children in the collaborative consultation service–complier group having better treatment trajectories than children in the collaborative consultation service–noncomplier and control groups (Figure 3). Children in the collaborative consultation service–complier group demonstrated a 27% reduction in DSM-IV symptomatology compared with an 18% reduction in the control group and a 13% reduction in the noncompliers. The reduction in the compliers group was significantly greater than that seen in the control group (\(t_{114}=-2.72, P=.008\), effect size=0.25) and in the noncomplier group (\(t_{57}=-3.568, P<.001\), effect size=0.47).

EXPLORATORY ANALYSIS OF OUTCOME DIFFERENCE BETWEEN COMPLIERS, NONCOMPLIERS, AND CONTROLS

We were particularly interested in whether group differences were related to differences in the medication treatment, specifically whether children who received titra-

### Table. Pediatricians Who Cited Obstacles Preventing Implementation of Evidence-Based ADHD Treatment

<table>
<thead>
<tr>
<th>Obstacle</th>
<th>Preintervention, %</th>
<th>Postintervention, %</th>
<th>Precontrol, %</th>
<th>Postcontrol, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Titration trials</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of access to medications packaged for titration trial</td>
<td>43</td>
<td>37</td>
<td>67</td>
<td>70</td>
</tr>
<tr>
<td>Lack of knowledge about how to conduct trial</td>
<td>35</td>
<td>5</td>
<td>33</td>
<td>26</td>
</tr>
<tr>
<td>Lack of time</td>
<td>48</td>
<td>11</td>
<td>30</td>
<td>43</td>
</tr>
<tr>
<td>Concern about parental interest</td>
<td>35</td>
<td>21</td>
<td>15</td>
<td>26</td>
</tr>
<tr>
<td>Monthly medication maintenance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of knowledge about logistics</td>
<td>26</td>
<td>21</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>Lack of knowledge about interpretation</td>
<td>22</td>
<td>11</td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td>Lack of time</td>
<td>30</td>
<td>11</td>
<td>37</td>
<td>26</td>
</tr>
<tr>
<td>Concern about parental interest</td>
<td>36</td>
<td>16</td>
<td>33</td>
<td>26</td>
</tr>
</tbody>
</table>

Abbreviation: ADHD, attention-deficit/hyperactivity disorder.
titration trials were more likely to be receiving medication at long-term follow-up and whether there is a difference in the dosage or type of medication that they received. Not surprisingly, children whose parents refused the titration trial were less likely to be receiving medication at 12 months (53%) than compliers (91% [n=40]; $\chi^2=7.67, P<.01$) or controls (87% [n=79]; $\chi^2=8.36, P<.01$).

We next examined whether there were differences in the dosage of medication that compliers and control participants were receiving. Because methylphenidate was the medication used in titration, it is not surprising that a larger percentage of compliers than control participants were receiving methylphenidate at 12 months (73% vs 41%). However, it is noteworthy that the mean daily dosage of methylphenidate hydrochloride was significantly higher for compliers than controls (33 mg vs 23.8 mg [$F_{1,55}=5.60, P<.05$]) and that control participants were more likely to be on the lowest possible daily dosage of 18 mg (12 of 22 controls [55%] vs only 3 of 15 compliers [20%]; $\chi^2=4.42, P<.05$).

COMMENT

Overall, the consultation model increased the use of some evidence-based ADHD treatment strategies among community pediatricians. Furthermore, although the intent-to-treat analyses were not significant, there was evidence that children receiving a medication trial had lower rates of core ADHD symptoms at 12 months, perhaps because they were more likely to be maintained on an appropriate therapeutic dosage. These findings echo results from the Multimodal Treatment Study of ADHD, where children receiving medication in community settings received lower dosages than children whose treatment began with a titration trial to determine the optimal starting maintenance dosage.2 To our knowledge, this is the first demonstration that the use of titration trial procedures by community pediatricians, albeit with support provided by university-based consultation, is associated with better management of ADHD symptoms.

Despite these encouraging findings, many pediatricians either failed to use the collaborative consultation services entirely or did not take full advantage of collaborative consultation services. Hence, our results also highlight the difficulties of changing practice behaviors and are consistent with a prior report in which low rates of use of consultative ADHD treatment services were found.11 In our study, the collaborative consultation service that was most inconsistently used was the periodic treatment monitoring during medication maintenance. This is especially troubling given that systematic treatment monitoring is an important recommendation in the American Academy of Pediatrics’ treatment guidelines17 and may be especially important for promoting the long-term success of children with ADHD.18 It is clear that additional strategies are necessary to promote the use of periodic monitoring of medication efficacy and side effects by pediatricians. Additional research is necessary to determine what the barriers were that impeded implementation. Perhaps adoption of quality-improvement methodology, whereby practices monitor their own compliance with prescribed guidelines, would have been useful.19 If such data were regularly acquired, physicians could be provided with periodic feedback on their own performance in comparison with other pediatricians. Such quality-improvement methods have been shown to change physicians’ practice behaviors with other medical conditions.20

There are several important limitations to our study, which should be noted. First, the collaborative consultation service focused entirely on pharmacological treatment, whereas studies such as the Multimodal Treatment Study of ADHD have suggested that a multimodal treatment strategy may result in better outcomes among children with diagnosed ADHD.3 Other studies that promote evidence-based psychosocial treatment for children with ADHD in pediatric settings are thus necessary. Another limitation is that pediatrician practice behavior was measured through self-report, which can be inaccurate owing to response bias. However, based on medical record review, we found that pediatricians’ self-report about use of titration trials was largely consistent with what was documented for the randomly selected sample of follow-up children during that year (68% vs 59%). Thus, it does not appear that collaborative consultation service pediatricians were grossly inflating their use of this practice.

Further, in evaluating child outcomes, total ADHD symptomatology as measured by parent and teacher report was selected a priori as the primary outcome measure. We focused on core ADHD symptoms, because Multimodal Treatment Study of ADHD results indicated that a pharmacological treatment strategy produced the largest effect on this outcome. However, we recognize that a more comprehensive test of medication effects would have included measurement of other child outcomes (eg, functional impairment). This broader assessment of outcomes was not feasible in our study, but should be included in future work. Another important limitation is that, because practices volunteered for the study, it is likely that participants were those who believed they could benefit from the intervention and were open to practice change. Not all pediatricians or pediatric practices are necessarily open to practice change, however. Had a random sample of pediatric practices been selected to participate, regardless of their interest in the project, compliance would likely have been attenuated.

We experienced several methodological limitations inherent to evaluating a community-based model such as this. First, randomization was complicated because it needed to occur at the practice level as opposed to the patient level; this created a nested design, which poses several statistical challenges. Second, the researchers had no clinical contact with the patients on whom outcome data were being collected, and all research-related data was collected through the mail or over the telephone. A consequence of no researcher-patient contact was inflated rates of drop-out and missing data compared with clinic-based studies. We also do not know how many children who may have been appropriate for the study were not enrolled. We used statistical strategies, where possible, to correct for some of these methodological deficiencies in our community-based design. However, these
strategies may be limited in fully correcting these methodological challenges, which, in addition to accompanying limitations, are inherent to community-based research and must be weighed against the value of conducting this type of research.

Finally, we acknowledge that the lack of statistically significant between-group differences in the initial intent to treat may have been caused by low rates of collaborative consultation services use by the physicians. Had more of the children in the intervention group experienced titration trials and monitoring of medication maintenance, the power of the overall analyses to detect treatment differences would have likely improved and the primary analyses might have reached statistical thresholds for significance.

Although promoting this collaborative consultation service model to all pediatricians may prove difficult, we believe that there is a compelling need for this type of service. Many pediatricians in this study expressed the need for expert assistance and consultation when treating children with ADHD. If such a collaborative consultation service intervention were to be disseminated on a wider basis, consideration would need to be given to alternative modes of data collection and report delivery. Alternative modalities for delivering the described services need exploration. Such modalities may include the Internet or personal handheld devices.22

In summary, the consultative model used here and described by others11 provides an example of how the divide between science and practice can be bridged in the treatment of ADHD. Pediatricians have to address a multitude of physical and mental disorders during the course of daily practice, and applying evidence-based methods to all these disorders, even when prescribed by the American Academy of Pediatrics, can be quite difficult.21 This model helped pediatricians overcome many of the common obstacles to conducting careful medication trials21 and showed promise in helping pediatricians’ practice behaviors more closely approximate the evidence-based techniques recommended by the American Academy of Pediatrics. Furthermore, use of these evidence-based practices appeared to promote greater reduction in core ADHD symptoms in the subgroup of children who were exposed to the intended treatment. In subsequent work, it will be important to identify methods to further reduce physicians’ obstacles to more fully using the consultation services that were provided and to evaluate the impact of these services on a wider range of child outcomes.

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