HHS Public Access

Author manuscript

J Am Acad Child Adolesc Psychiatry. Author manuscript; available in PMC 2017 April 01.

Published in final edited form as:

J Am Acad Child Adolesc Psychiatry. 2016 April ; 55(4): 289–294. doi:10.1016/j.jaac.2016.02.001.

Relationship Between Attention-Deficit/Hyperactivity Disorder Care and Medication Continuity

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Abstract

Objective—To describe the relationships between attention-deficit/hyperactivity disorder (ADHD) care practices and subsequent medication use.

Method—A retrospective cohort from a random sample of medical records in 50 pediatric practices with 188 providers, including 1,352 children who started ADHD medication, was studied. Independent variables included physician behaviors related to medication titration and monitoring of treatment response. Primary outcomes were number of days covered with ADHD medication during the first year of treatment and time from starting medicine to the first 30-day gap in medication supply. We hypothesized that after prescribing medication, the less time that elapsed until the physician had contact with the family, titrated medication, or assessed treatment response by collecting a behavioral rating scale would be associated with better continuity of medication treatment.

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Disclosure: Dr. Brinkman has received grant funding from the National Institute of Health (NIH), the Agency for Healthcare Research and Quality (AHRQ), and the Cincinnati Children's Research Foundation (CCRF). He has been paid as a consultant by the American Board of Pediatrics. Dr. Baum has received research support from the NIMH, the Centers for Medicare and Medicaid Services for the Health Care Innovation Challenge, and the Medicaid Technical Assistance and Policy Program for the Children's Mental Health Learning Collaborative. She has been paid as a consultant by the American Academy of Pediatrics. Dr. Kelleher has received research support from the NIH/National Institute on Minority Health and Health Disparities (NCMHD), the Centers for Medicare and Medicaid Services/Department of Health and Human Services, the Patient Centered Outcomes Research Institute (PCORI), and the Research Institute at Nationwide Children's Hospital. Dr. Gardner has received research support from the Canadian Institute for Health Research (CIHR) and the Scotia-McLeod and ScotiaBank Foundation. Dr. Lichtenstein has received research support from NIH. He has served as a curriculum development consultant and speaker for the National Association for Continuing Education on a research project funded by a Pfizer Independent Grant for Learning and Change. Dr. Langberg has received grant funding from NIH and the Institute of Education Sciences (IES) and has received book honorarium from the National Association for School Psychologists (NASP). Dr. Epstein has received research grant support from the NIH. He has been paid as a consultant by the American Academy of Pediatrics. He has received royalties from Optimal Medicine for the licensing of mehealth.com/adhd software. Dr. Peugh reports no biomedical financial interests or potential conflicts of interest.

Results—Children had an average medication supply of 217 days in the first year. Half experienced a 30-day gap in medication supply in the first 3 months. Nearly three-fourths had a medication adjustment in the first year with the first adjustment usually being a dosage change. The average time to the first medication adjustment was over 3 months. Physician's first contact with parents occurred in the first month of treatment for less than half, with the average time being over 2 months. Little variation related to ADHD care quality was accounted for at the physician level. Early titration and early contact were related to greater medication supply and continuity of treatment.

Conclusion—Earlier physician-delivered ADHD care (e.g., contact with parent after starting medication and medication adjustment) is related to greater medication supply and continuity. It remains to be determined whether interventions that improve the quality of titration and monitoring practices for children with ADHD would also improve medication continuity.

Keywords

attention-deficit/hyperactivity disorder; adherence; clinical practice guidelines; quality of care; pharmacotherapy

Medication is the most common[1] and efficacious[2] treatment for attention-deficit/hyperactivity disorder (ADHD) symptoms. Unfortunately, continuity of medication treatment is poor, as children often discontinue or periodically stop and re-start medicine,[3-7] which leads to the re-emergence of ADHD symptoms.[8,9] The most commonly cited reason for medication discontinuity is side effects.[10] Because many side effects can be mitigated through dose adjustments or medication switching, close follow-up of patients to address side effects should promote medication continuity. Indeed, ADHD clinical practice guidelines encourage physicians to titrate ADHD medication and to closely monitor treatment response to maximize benefit and minimize side effects.[11-13] Although the frequency of titration[4] and of monitoring[14-17] have been described in community-based settings, it is unknown whether either is associated with medication continuity.

Our objective was to describe the relationships between ADHD care practices and medication supply and continuity during the first year of treatment among children newly treated for ADHD. We hypothesized that after prescribing medication, the less time that elapsed until the physician had contact with the family, titrated medication, or assessed treatment response by collecting a behavioral rating scale would be associated with better continuity of medication treatment.

METHOD

Participants and Setting

We recruited practices from August 2010 through December 2012 to participate in a study focusing on improving the quality of community-based ADHD care. The data presented here reflect ADHD care at baseline (i.e., before intervention). A recruitment mailing was sent out to 128 practices in central and northern Ohio that served primarily children, had at least 2 pediatricians, and did not have access to an on-site mental health professional. We selected the first 50 practices that responded and met our inclusion criteria to participate. The

remaining practices either did not respond, responded late, chose not to participate because they refer out all patients for ADHD care, or declined because they were already involved in other research or quality improvement initiatives. We recently published data from these practices on variation in physician ADHD assessment practices and monitoring behaviors (e.g., collection of rating scales).[17] This article takes the next step by describing variation in titration practices, medication supply and continuity, and the relationship between titration/monitoring practices and child medication supply/continuity.

Chart Reviews

We reviewed charts to assess pediatricians' ADHD care practices and their patients' medication supply and continuity. To select patient charts, we retrieved billing records with an ADHD diagnosis code during the past year. Coders randomly selected 10 patients per practitioner by selecting every nth patient from the list where n = (number of patients on the billing query) / 10. Since these chart reviews required a review of retrospective patient charts, a waiver of consent was granted from the Nationwide Children's and Cincinnati Children's Medical Centers' institutional review boards on the condition that no identifying or demographic information from the patient charts would be recorded.

Using a standardized chart audit form, we extracted the following information from each patient chart for any ADHD care between 2002 (the year after the initial American Academy of Pediatrics ADHD treatment guideline[12] was released) and the date of the chart review (August 2010 through December 2012): information on prescriptions written (i.e., date, medication, dosage, amount dispensed); dates of all ADHD-related treatment visits and phone or e-mail correspondence; and dates of collection for all parent- and teacher-completed ADHD rating scales after medication initiation. A random 10% sample of charts was audited by 2 research assistants each blinded to the other's audit. Interrater reliability was high for the number of days covered with medicine (intraclass correlation coefficient [ICC] = 0.96), presence of a medication change ($\kappa = 0.89$), and time to contact (ICC = 0.86).

Measurement of Physician and Practice Characteristics

Pediatricians reported their demographic characteristics and the percentage of their patients whose primary payer was Medicaid. They also reported whether their practice was affiliated with an academic medical center, had an electronic medical record (EMR), and was located in an urban, suburban, or rural setting.

Healthcare Provider Sample

The 50 participating practices included 188 healthcare providers (184 pediatricians and 4 nurse practitioners). The mean age of the health care providers was 43.5 years (SD = 9.5 years). The average number of years since health care providers had finished their residency training program was 12.9 years (SD = 9.1 years). The majority of health care providers were white (n = 158, 86%) and female (n = 117, 64%). Pediatricians varied in the reported proportions of Medicaid patients in their panels (range = 0%–99%; mean = 45%, SD = 31%). Approximately 25% of pediatricians (n = 39) reported an affiliation with an academic medical center. In all, 69% of practices (37/50) had an EMR at the time of the chart audit.

Of the pediatricians, 53 pediatricians (28%) reported being located in urban settings, 103 as suburban (55%), and 17 as rural (9%).

Patient Sample

Across the 188 providers, 1,514 patient charts were reviewed. Of those, we identified 1,352 children who were newly treated for ADHD with prescriptions written that were sufficient to cover at least 30 days with medication. Of those, 699 had at least 1 year elapse from the date of the first prescription to the date of the chart review.

Quality of Care Measures

We calculated “times to events”—the number of days from when the patient was initially prescribed medication until the relevant event—as indices of recommended ADHD care behaviors. Titration events of interest included medication adjustments (i.e., dosage change, medication switch, addition/removal of a medicine). Monitoring events of interest included parent–physician contact (i.e., visit, phone call, or e-mail to discuss the child's response to ADHD treatment, excluding parent contacts with office staff solely to request a refill) and the collection of a behavior rating scale from a parent or teacher. We also tallied the number of events that each child experienced in the first year of treatment. For parent–physician contacts, we also examined whether children had the event of interest in the first month after starting medicine, because having a visit in the first month of treatment is an established quality metric that is routinely tracked and reported by the National Committee for Quality Assurance.[18]

For children prescribed stimulant medication, the daily dosage for the final prescription written was calculated in methylphenidate dosage-equivalent units by converting daily dosages of all nonmethylphenidate stimulant medications using the following conversions (mixed salt amphetamines dose or dexmethylphenidate dose × 2; lisdexamfetamine × 0.8).

Outcome Measures

Based on prescriptions written, we calculated medication supply, as defined by the number of days covered with ADHD medication during the first year of treatment, and medication continuity, as defined by the time from starting medicine to the first 30-day gap in medication supply.

Statistical Analyses

Patients were nested within pediatricians, and pediatricians were nested within practices. Our description of the ADHD care quality and medication supply in the first year of treatment focuses on the 699 participants who had a full year elapse from starting medicine to the date of the chart review. This was necessary to ensure that all participants had an equal opportunity to experience the event of interest. We computed all descriptive estimates by modeling the multilevel nature of the data. For the medication titration events and outcome measures, we used multilevel models to estimate the percentage of variation attributable to patients, pediatricians, and practices, and statistically tested whether these estimates differed from 0.

For children who had at least 1 year elapse from starting medication to the date of the chart audit, we used multilevel modeling to test whether predictor variables (i.e., time to first medication adjustment, number of medication adjustments, presence of a contact in the first month, time to first contact, and number of contacts) were associated with number of days covered with medicine. We used SAS Proc Mixed to model the continuous variables (e.g., time to contact) using Kenward-Roger degrees of freedom for fixed effect parameter estimate tests.[19] We used Mplus version 7.11 (Muthen and Muthen, Los Angeles, CA) to model the binary variables (i.e., presence or absence of medication adjustment).

We included the full 1,352 patients who started medication in analyses that involved the outcome of time to first 30-day gap in medication. Cox proportional hazards regression models with clustering of patients under pediatricians and of pediatricians under practices and using robust standard errors were estimated to assess the association between presence of follow-up in the first month of treatment and the days to the first 30-day gap (function coxme in R version 3.01). To examine the influence of summer vacation on these relationships, we conducted sensitivity analyses with and without participants with a first 30-day gap occurring during the summer. For some patients who started medication, less than 1 year elapsed before the chart review (n = 653). If these patients did not experience a 30-day gap, the time to the event was calculated as the time from prescribing until the time of the chart review, and the observation was right-censored in the analyses.

RESULTS

Medication Starts

For the vast majority of children (87%), the initial medication regimen was an extended-release stimulant medication alone. Few children were started on an immediate-release stimulant medication alone (6%), extended release nonstimulant medication alone (5%), or more than 1 category of ADHD medications (2%).

Quality of Care

Among the 699 children who had a full year elapse between medication initiation and the chart review, 27% had no medication adjustments after initial dosing. Among the 73% of children who had a medication adjustment, the initial adjustment was as follows: 63% had a dosage change alone, 29% had a medication switch alone, 6% had a medication added or removed, and 2% had some combination of these changes. Of the children who had a medication adjustment in the first year, the average time to first medication adjustment was 91 days (standard error [SE] = 8.2). Children had an average of 2.8 (SE = 0.10) medication adjustments (i.e., either a dosage change, medication switch, or adding/removing a medication) in the first year of treatment. Very little variation related to medication adjustments was accounted for at the physician- or practice-levels (Table 1). Among those taking a stimulant medication (n = 660), the final dosage was a mean of 24.9 (SE = 0.65) methylphenidate-equivalent milligrams.

In all, 45% of the children (SE = 0.02%) had a parent–physician contact in the first month after starting medication. Contact included a visit in the first month for 28% (SE = 0.03%)

of the sample. Children averaged 5.9 contacts (SE = 0.19 contacts), including 4.5 visits (SE = 0.2 visits), in the first year of treatment. The time to first contact was 65.7 days (SE = 3.6 days). The time to the first visit was 88.5 days (SE = 5.4 days).

Few children had parent- or teacher-completed ADHD rating scales collected to monitor response to treatment (12% [SE = 0.03%] and 8% [SE = 0.02%], respectively). Therefore, we excluded rating scale completion from subsequent analyses examining associations with medication supply and continuity.

Refill Practices

Of the 4,791 prescriptions written, only 14.8% of prescriptions were written to dispense more than a 30-day supply. Two prescriptions were provided for the same medicine and dosage on the same date on only 0.9% of instances. There were no instances in which 3 prescriptions were provided on the same date to cover the next 3 months.

Medication Supply

Among the 699 children who initiated medication and had at least 1 year elapse from the date of the first prescription to the date of the chart review, the number of days covered with medicine in the first year of treatment was a mean of 217 days (SE = 5.9 days; median = 221 days) (Figure 1). This equates to approximately 60% (217/365) of days in the first year. Variation in days covered existed at the practice level (8%, $p = .01$) and patient level (87%, $p < .0001$) (Table 1).

Medication Continuity

Among the 1,352 children with prescriptions written that were sufficient to cover at least 30 days with medication, the time to the first 30-day gap in medication supply was a mean of 110 days (SE = 2.4 days). Figure 2 shows the survival distribution of days treated before the first 30-day gap in medication supply. For example, the proportion of patients in this sample who completed the first year of treatment without experiencing a 30 day gap was 0.15. For those with a gap, little variation was explained at the physician or practice level (Table 1). Of those with a 30-day gap (n = 1,048), 29% (n = 308) had their first gap during a summer month (i.e., May, June, or July).

Relationship Between Quality of Care and Number of Days Covered With Medicine

Children with a medication adjustment in the first year of treatment had significantly more days covered with medication than those who did not (mean 235 days [SE = 3.9 days] versus 172 days [SE = 7.9 days], $p < .0001$). Among those who had an adjustment in the first year, time to first medicine adjustment ($r = -0.18$, $p < .0001$) was significantly associated with number of days covered with medicine. Less time elapsing before the care event was associated with more days covered with medication. Similarly, the number of medicine adjustments in the first year ($p < .0001$) was significantly associated with number of days covered with medicine such that, for every unit increase in medication adjustments, there were 13.2 (SE = 1.6) more days covered with medicine. Among children taking stimulant medications, the final dosage in methylphenidate-equivalent milligrams ($p < .0001$) was

related to number of days covered with medicine such that for every unit increase in milligrams, there were 1.4 (SE = 0.3) more days covered with medicine.

Children with a parent–physician contact in the first month after starting treatment had 22.2 (SE = 7.4) more days covered with medication ($p < .01$) over the first year of treatment. Similarly, children with a contact in the first year of treatment had significantly more days covered with medication than those who did not (mean = 223 days [SE = 3.7 days] versus 132 days [SE = 19.1], $p < .0001$). Among those who had a contact in the first year, time to first contact ($r = -0.26$, $p < .0001$) was significantly associated with number of days covered with medicine, such that fewer days to contact related to more days covered. Number of contacts in the first year ($p < .0001$) was significantly associated with number of days covered with medicine such that for every unit increase in contacts there were 10.1 (SE = 1.4) more days covered with medicine. Of note, the pattern of results between our contact metrics (i.e., presence of contact in first month, time to first contact, and total number of contacts in the first year) and the number of days covered with medicine were similar when we limited contacts to include only visits.

Relationship Between Quality of Care and Time to First 30-Day Gap in Medicine

Among the 1,352 children with prescriptions written sufficient to cover at least 30 days with medication, presence of a contact (i.e., visit or call) in the first month was associated with a longer time to first 30-day gap in medication supply in Cox proportional hazard models (hazard ratio = 0.67 [SE = 0.04], $p < .0001$). Similarly, presence of a visit in the first month of treatment was associated with a significantly longer time to first 30-day gap in medication supply (hazard ratio = 0.77 [SE = 0.06], $p < .001$). To examine the influence of summer vacation on these relationships, we conducted sensitivity analyses with and without participants with a first 30-day gap occurring during the summer. The pattern of findings described above did not change when excluding participants whose first 30-day gap occurred during the summer (n = 308).

DISCUSSION

In this large community-based sample of children with ADHD, medication continuity was variable, with children having a medication supply sufficient to cover about 60% of days in the first year of treatment. The vast majority of children had a 30-day gap in medication supply in the first year of treatment, with half experiencing such a gap in the first 110 days.

These problems in continuity did not reflect a lack of engagement by pediatricians: Nearly three-fourths of children had a medication adjustment in the first year of treatment, with the first adjustment usually being a dosage change. However, the timing of clinician engagement seemed to be important. The average time to the first medication adjustment was over 3 months. After starting medication, physicians' first contact with parents occurred in the first month of treatment for fewer than half of children, with the average time to first contact being over 2 months. Early titration and early contact were related to greater medication supply and continuity of treatment. Unfortunately, instrument-based monitoring was too rare to evaluate for its association with medication use.

Our analyses are the first to suggest that aspects of ADHD care delivered by physicians—specifically, early contact with parent after starting medication, and early medication adjustment—are associated with medication supply and continuity. This is welcome news, as medication continuity is poor among children with ADHD. Children in our study and previous studies[3-7] often discontinue or periodically stop and re-start medicine. Our estimates of medication continuity are higher than past reports, with approximately 60% of days covered compared to approximately 40% of days covered among children in a health maintenance organization (HMO) in 1997 to 1999[4] and approximately 33% of days covered among children enrolled in California Medicaid in 2000 to 2003.[3] One plausible explanation for this difference is a shift over the past decade from prescribing immediate-release to extended-release formulations. Only 30% of children enrolled in California Medicaid in 2000 to 2003 were started on an extended-release stimulant, compared to 87% in our sample. Indeed, past studies have documented greater medication continuity among children prescribed an extended-release compared to an immediate-release formulation.[3,20,21] Alternatively, we relied on chart audit of written prescriptions without verification of whether the prescription was actually filled, which could artificially increase our estimates of medication continuity. It is also possible that our sample of study volunteers enrolling in a randomized trial of quality improvement methods may have represented better practice than usual care.

There are still glaring deficiencies in the quality of ADHD care delivered by physicians, namely having close contact with parents and adjusting medication, both in our sample and nationally. ADHD guidelines recommend contact with the family during titration[11,13] with a face-to-face follow-up visit within[11,22] or soon after[13] the first month of treatment. Nationally, less than 40% of children receive a follow-up visit in the first 30 days after starting medication.[18] Less than 50% had any contact (e.g. visit or phone call) in the first month after starting medication, and the average time to first contact was more than 2 months. ADHD guidelines also suggest that titration of stimulants can be rapid with adjustments as often as every week,[11,13] but the average time to first medication adjustment in our study was more than 3 months. Our estimate is very similar to that documented in a commercial HMO setting,[4] suggesting that the need to improve titration practices may be pervasive. Titration is recognized as a key behavior to optimize dosage,[11,13,15,22] but no adequate quality metrics or algorithms exist for ADHD medication titration practices.[18]

Little variation related to medication adjustments was accounted for at the physician or practice level; far more variation was driven by families. This suggests that current ADHD systems of care in pediatric settings are inadequate to engage families in the process of titration. Pediatricians may need to take on additional responsibility for patient tracking (e.g., using patient registries to track contacts, appointments, and rating scale collection), and explore innovative technologies to prompt and facilitate patient and family engagement.[23] Increased incentives (e.g., pay-for-performance) or system-level interventions at the community or health plan may be necessary to promote adoption of these expensive and demanding initiatives.

In contrast, more variation in the number of days covered with medicine was explained at the practice level. The state of Ohio allows prescribers to provide a 3-month supply (e.g., 90

pills by mail-order pharmacy or 3 prescriptions dated 1 month apart all given at the same visit). We infrequently identified these practices in our data. It is possible that unmeasured variables (e.g., practice processes related to refill and/or preauthorization requests) might account for some of this variation.

This study's findings must be interpreted in light of study limitations. First, to protect human participants, our chart review methodology did not include collection of personal patient data, such as age, gender, insurance status, ADHD severity, and comorbid conditions, from patient charts. Hence, the association between patient-level data and medication prescribing practices could not be estimated. This is noteworthy, as past studies have documented relationships between these variables and child medication continuity.[24] It also is possible that chart reviews underestimated the amount of care provided if ADHD care was not adequately documented in the patient chart. We were unable to determine from chart reviews whether medication gaps were planned by parents and/or physicians to assess continued need for medication or to take a “medication holiday,” but the pattern of results did not change when excluding those children whose first 30-day gap occurred during the summer. Our examination of final dosage in methylphenidate-equivalent milligrams is imperfect, because conversion rates for lisdexamfetamine are not exact and may not be linear (i.e., we used a conversion rate of 0.8, but the literature supports a range of 0.6–0.9).[25]

In addition, all of the participating practices volunteered to participate in a quality improvement intervention focusing on improving ADHD care, and thus may differ from typical practices. Our sample was limited both geographically (i.e., central and northern Ohio) and according to specific practice characteristics (i.e., excluding practices with only 1 physician and/or access to an on-site mental health professional). Therefore, it is unclear whether our results characterize practices outside the study region or practice types not included in this study (e.g., solo practices). Still, if this represents best practice among volunteers interested in improving quality of ADHD care, we have miles to go before achieving best practice for our children and families.

Early titration and early contact were associated with greater supply and continuity of medication treatment in children newly treated for ADHD in pediatric primary care practices. However, early titration and contact did not occur routinely in this sample, even though these practices are recommended in ADHD best practice guidelines.[11-13] It remains to be determined whether interventions that improve the quality of titration and monitoring practices for children with ADHD would also improve medication continuity. &

Acknowledgments

This research was supported by grant R01MH083665 from the National Institute of Mental Health (NIMH) and grant UL1TR000077 from the National Center for Advancing Translational Sciences of the National Institutes of Health (NIH). Drs. Epstein and Brinkman were supported by grants K24MH064478 and K23MH083027 from NIMH, respectively. The funders played no role in study design or conduct; data collection, management, analysis, or interpretation; preparation, review, or approval of the manuscript; or decision to submit the manuscript for publication. The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH.

Drs. Peugh and Gardner served as the statistical experts for this research.

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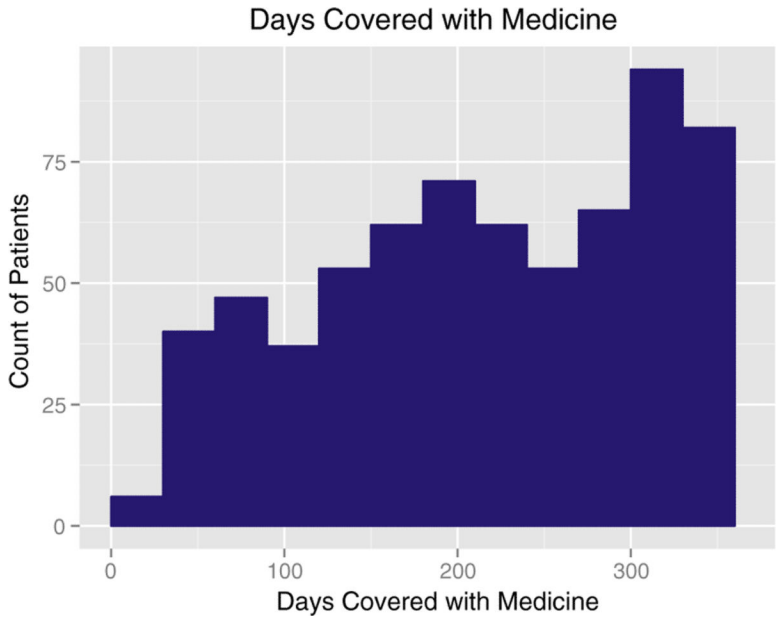

FIGURE 1.
Number of days covered with medicine in the first year of treatment.

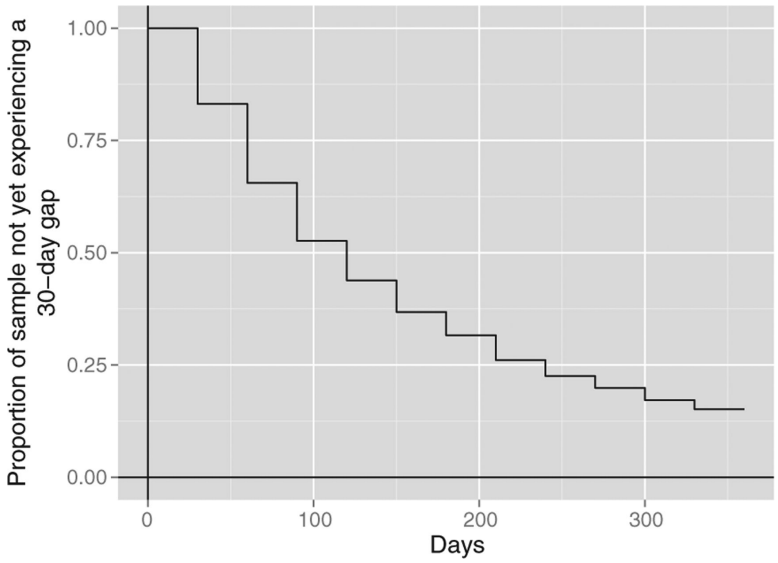

FIGURE 2.
Survival distribution of days treated before first 30-day gap in medication supply.

TABLE 1

Descriptive Statistics and Percentage of Variance for Attention-Deficit/Hyperactivity Disorder (ADHD) Medication Adjustments, Medication Supply, and Medication Continuity

	Mean	SE	Practice-Related Variability (%)	Pediatrician-Related Variability (%)	Patient-Related Variability (%)	n
ADHD Medication Adjustments						
Percentage who had medication adjustment in first year	73%	0.02	0	0%	100%**	699
Number of medication adjustments in first year	2.8	0.10	0.9%	6.8%	92.3%**	507
For those with first medication adjustment, time to first adjustment after starting medication (days)	91.1	8.1	0.1%	0.4%	99.5%**	507
Final dosage (methylphenidate equivalent milligrams)	24.9	0.65	3.9%*	0.9%	95.2%**	660
Medication Supply						
Number of days covered with medication in first year	217.7	5.9	8.4%*	4.9%	86.7%**	699
Medication Continuity						
For those with a gap, time to first 30-day gap in medication supply (days)	110	2.4	3.2%	2.6%	94.1%**	1048

Note:

* $p < .05$

** $p < .001$.