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Effects of Training on Use of Stimulant Diversion Prevention Strategies by Pediatric Primary Care Providers: Results from a Cluster-Randomized Trial

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Abstract

Pediatric primary care is a promising setting for reducing diversion of stimulant medications for ADHD. We tested if training pediatric primary care providers (PCPs) increased use of diversion prevention strategies with adolescents with ADHD. The study was a cluster-randomized trial in 7 pediatric primary care practices. Participants were pediatric PCPs ($N=76$) at participating practices. Practices were randomized to a 1-h training in stimulant diversion prevention or treatment-as-usual. At baseline, 6 months, 12 months, and 18 months, PCPs rated how often they used four categories of strategies: patient/family education, medication management/monitoring, assessment of mental health symptoms/functioning, and assessment of risky behaviors. They completed measures of attitudes, implementation climate, knowledge/skill, and resource constraints. Generalized Estimating Equations estimated differences in outcomes by condition. Mediation analyses tested if changes in knowledge/skill mediated training effects on strategy use. PCPs in the intervention condition reported significantly greater use of patient/family education strategies at all follow-up time points. There were no differences between conditions in medication management, assessment of mental health symptoms/functioning, or assessment of risky behaviors. At 6 months, PCPs in the intervention condition reported more positive attitudes toward diversion prevention, stronger implementation climate, greater knowledge/skill, and less resource constraints. Differences in knowledge/skill persisted at 12 months and 18 months. Brief training in stimulant diversion had substantial and enduring effects on PCPs' self-reported knowledge/skill and use of patient/family education strategies to prevent diversion. Training had modest effects on attitudes, implementation climate, and resource constraints and did not change use of strategies related to medication management and assessment of mental health symptoms/functioning and risky behaviors. Changes in knowledge/skill accounted for 49% of the total effect of training on use of patient/family education strategies.

Trial registration This trial is registered on ClinicalTrials.gov (NCT03080259). Posted March 15, 2017.

Keywords Stimulant diversion · Stimulant misuse · Pediatric primary care · Implementation · Clinical trial

Introduction

Nonmedical use of stimulant medications intended for treatment of ADHD is a significant problem (Faraone et al., 2020; McCabe & West, 2013; McCabe et al., 2014; Wilens et al., 2008). Family and friends are the most common source of stimulants for nonmedical use, and stimulants are considered relatively easy to obtain (Benson et al., 2015; Faraone et al., 2020; McCabe & Boyd, 2005). Reducing diversion (i.e., sharing, selling, and/or trading) of prescribed stimulant medications can reduce their availability for nonmedical use.

Diversion and risk for diversion increase during adolescence and peak in young adulthood (Faraone et al., 2020;

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Lasopa et al., 2015; McCabe et al., 2004; Molina et al., 2021). Intervening in adolescence may reduce diversion risk and prevent diversion by adolescents with ADHD. Because adolescents with ADHD are most often treated in pediatric primary care, pediatric primary care providers (PCPs) are well-positioned for diversion prevention efforts (Anderson et al., 2015; Garfield et al., 2012; Matson et al., 2021). Strategies to prevent diversion include educating patients and their families about negative consequences of diversion and ways to respond to diversion requests, managing medication supply to reduce the availability of excess pills, and assessing related risk factors (e.g., mental health symptoms, peers, risky behavior) (Molina et al., 2020). Use of these strategies by pediatric PCPs has the potential to prevent misuse and diversion by adolescents prescribed stimulant medications (Matson et al., 2021; Molina et al., 2020).

Encouragingly, providers, including PCPs, believe diversion prevention is important (Colaneri et al., 2017; Loskutova et al., 2020; McGuier et al., 2021). Many providers, however, feel unprepared to address diversion and infrequently use diversion prevention strategies, especially those most directly related to diversion (Colaneri et al., 2017; Loskutova et al., 2020; McGuier et al., 2021). The theory of planned behavior (Ajzen, 1991; Armitage & Conner, 2001; Godin et al., 2008) proposes that behavior is driven by attitudes, subjective norms, and perceived behavioral control, suggesting that these are critical domains to address to increase providers' use of diversion prevention strategies. Previous research on medical providers' efforts to prevent diversion has identified barriers and facilitators (i.e., determinants) of behavior consistent with this theory, including attitudes, knowledge, skill, confidence, time constraints, and reimbursement concerns (Colaneri et al., 2017, 2018, 2020; Horwitz et al., 2015; Loskutova et al., 2020; Matson et al., 2021; Meadows et al., 2011; Van Hook et al., 2007). Training providers in diversion prevention strategies may reduce barriers and increase strategy use.

Our research team recently completed a randomized clinical trial of strategies to prevent diversion by adolescents with ADHD treated in pediatric primary care (NCT03080259) (Molina et al., 2021, 2022). In a previous publication, we used baseline data from pediatric PCPs enrolled in the trial to test associations between attitudes (i.e., need for and the effectiveness of diversion prevention in primary care), subjective norms (i.e., implementation climate), and perceived behavioral control (i.e., knowledge/skill, resource constraints) and use of diversion prevention strategies (McGuier et al., 2021). Before the start of the clinical trial, PCPs reported positive attitudes about diversion prevention, room for improvement in implementation climate and knowledge/skill, and low concerns about resource constraints. Knowledge/skill was most strongly and consistently associated with strategy use prior to training, suggesting it is a potential mechanism of change and target for interventions (McGuier et al., 2021).

Current Study

The current study is a secondary analysis of data from a cluster-randomized clinical trial of stimulant diversion prevention strategies in pediatric primary care (Molina et al., 2021, 2022). The trial enrolled adolescents and their parents as well as PCPs in participating practices to test the effectiveness of the intervention in changing attitudes, norms, and behaviors in both adolescents and PCPs (Molina et al., 2021). Intervention effects on primary adolescent patient outcomes are reported by Molina and colleagues (2022). This paper reports intervention effects on provider use of diversion prevention strategies over 18 months after training and discusses implications for improving PCPs' diversion prevention behaviors.

The first aim of this paper was to test the effect of training on how often PCPs used four categories of diversion prevention strategies: patient/family education, medication management and monitoring, assessment of mental health symptoms/functioning, and assessment of risky behaviors. We hypothesized that providers in the intervention condition would use all categories of strategies more often than providers in treatment-as-usual (TAU).

The second aim of this paper was to test training effects on determinants of strategy use, specifically attitudes about the need for and the effectiveness of diversion prevention in primary care, implementation climate, knowledge/skill, and resource constraints. We hypothesized that providers in the intervention condition would report more positive attitudes regarding diversion prevention, stronger implementation climate, greater knowledge/skill, and less resource constraints than providers in TAU. Our final aim was to test if changes in determinants mediated training effects. We hypothesized that changes in knowledge/skill would mediate training effects on strategy use.

Methods

Participants and Practices

Participants were 76 PCPs from seven pediatric practices in southwestern Pennsylvania. Practices belonged to a large healthcare system and were members of a university-hosted practice-based research network (UL1 TR001857). All providers at each practice were invited to participate in the study, and all except one consented (99% participation). Most PCPs identified as non-Hispanic white (92%) and as women (71%); McGuier and colleagues (2021) provide additional details about provider characteristics

at baseline. There were no significant demographic differences between PCPs in the intervention and TAU conditions at baseline. Over 90% of PCPs provided data at each wave (see Fig. 1).

Procedures

Practices were randomized to receive training in stimulant diversion prevention or continue TAU (Molina et al., 2022). Prior to randomization, practices were matched on practice characteristics, including size, number of patients with ADHD, insurance coverage of patient population, and number of medical and behavioral health providers. Two small practices were yoked for randomization. The three matched pairs were provided to an independent methodologist (DB) who conducted randomization using random number generation in SAS 9.4. Practices were informed of randomization status after completion of baseline data collection. The trial was conducted from 2016 to 2019.

Participants completed assessments at baseline (prior to randomization), 6 months, 12 months, and 18 months. At each time point, participants received an individual email invitation to complete an online survey in Qualtrics. All participants provided informed consent. The study was approved by the University of Pittsburgh Institutional Review Board.

Intervention (Stimulant Diversion Prevention Training)

Each practice in the intervention condition received a 1-h on-site workshop on stimulant diversion prevention strategies led by the principal investigator (BSGM) and clinical coordinator (HLK). Workshops were attended by a total of 38 prescribing providers and 58 additional staff (77%

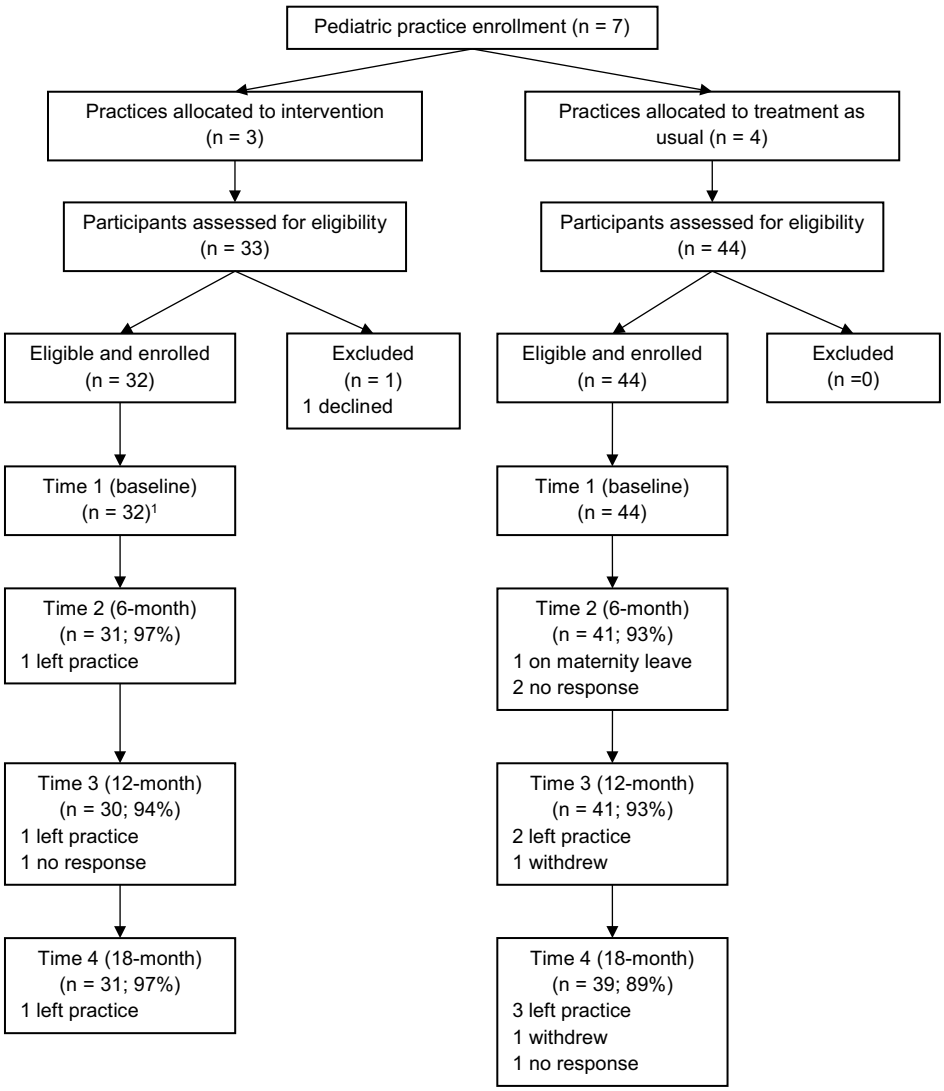

Fig. 1 CONSORT flow diagram for primary care provider participants

Superscript 1 indicates one participant completed the baseline survey after participating in training and with instructions to report her attitudes and behaviors prior to training. Analyses with and without this participant found the same pattern of findings. We report results for the full sample

in-person; 23% remote). Training focused on (1) providing educational counseling to patients and caregivers, (2) monitoring medication utilization and supply, and (3) assessing patient risk for diversion. The training included didactic components, video demonstrations, and guided discussions about how to implement prevention strategies within the practice. Providers received continuing education credits. Practices received patient handouts, posters for exam rooms, and provider handouts and resource binders (see Molina and colleagues (2022) for more details).

Measures

Diversion Prevention Strategy Use

Use of diversion prevention strategies was assessed with 35 items describing behaviors presumed to be directly (e.g., discussing diversion specifically) or indirectly (e.g., assessing risky behaviors) related to diversion prevention. Items measured four domains targeted by the diversion prevention training: (1) patient and family education (13 items; e.g., remind patient their medication is only to be used by them), (2) medication management and monitoring (9 items; e.g., ask how many pills remaining at home), (3) assessment of mental health symptoms and functioning (7 items; e.g., ask about other mental health symptoms), and (4) assessment of risky behaviors (6 items; e.g., ask about alcohol use). Participants rated how often they engaged in each behavior with their adolescent patients with ADHD during the last 6 months on a 4-point scale (1 "Not at all," 2 "Once," 3 "More than once," 4 "Most or all of the time"). All scales had good internal consistency at baseline ($\alpha = 0.83$–0.91) (McGuier et al., 2021).

Provider-Reported Determinants

Attitudes toward diversion prevention (i.e., perceived effectiveness, perceived need), implementation climate (i.e., perceptions that strategy use is expected, supported, and rewarded), knowledge/skill in diversion prevention, and resource constraints (e.g., time, reimbursement) were assessed with items adapted from the Provider Practices Regarding Tobacco Survey and tailored to reference diversion prevention (Amemori et al., 2011; Ostroff et al., 2014; Park et al., 2001). Participants rated their agreement with each item on a 7-point Likert scale from 1 "Strongly Disagree" to 7 "Strongly Agree."

Statistical Analyses

We conducted an a priori power analysis to estimate the number of providers needed to detect a significant effect, finding that 58 providers were needed to achieve 80% power to detect a medium treatment effect with alpha of 0.05. Our sample of 76 providers exceeds this estimate, indicating that the study was sufficiently powered.

We used Generalized Estimating Equations (GEE) in SPSS 27.0 (Armonk, NY) to estimate differences in outcomes between PCPs in intervention and TAU practices while accounting for repeated measurements of participants over time (i.e., correlation of within-subject data). Following an intent-to-treat approach, all participants were included in analyses. We compared models with different correlation structures; an exchangeable correlation structure was the best fit across outcomes and was used for all models (range of working correlations: 0.30–0.69). All GEE models were linear (identity link) models assuming conditional normality for outcomes. Outcomes at 6, 12, and 18 months were treated as repeatedly measured dependent variables. We used orthogonal contrasts to capture practice differences (Cohen et al., 2003). The first contrast represented the overall intervention effect, and the remaining contrasts accounted for any other between-practice differences and residual dependency within practices. Each model included the baseline measure for that outcome, contrast codes, time as a categorical within-subjects variable, and interactions between time and intervention condition. Any demographic characteristics associated with the outcome at baseline were also included as covariates. Inclusion of baseline measures as covariates increased power by removing extraneous error and adjusting for any pre-existing differences between groups. Contrasts were used to identify specific time points when conditions were significantly different.

We conducted path analyses with non-parametric bootstrapping (1000 draws) in M*plus* 8.4 (Los Angeles, CA) to test for evidence of mediation (i.e., significant indirect effects). Our primary question was if changes in knowledge/skill mediated training effects on strategy use, specifically use of patient/family education strategies. We also explored mediation by other determinants (i.e., perceived effectiveness, perceived need, implementation climate, resource constraints). We chose to include the first three time points (0, 6, and 12 months) in our mediation analyses because we expected that most change in determinants would occur immediately after training. Accordingly, each model tested a pathway from intervention condition to the determinant at 6 months to strategy use at 12 months (e.g., intervention to knowledge/skill at 6 months to patient/family education strategies at 12 months). All models included contrasts accounting for nesting within practices, any demographic variables associated with the determinant at baseline, baseline scores of the determinant, and baseline use of education strategies. This approach allowed examination of change from baseline in mediators and outcomes as a function of intervention condition.

Results

Table 1 shows unadjusted means by condition, unadjusted effect sizes (Cohen's *d*), and results from GEE models at each time point. Supplemental File 1 provides full results of GEE models. There were no significant differences between conditions in any outcome at baseline. For our first aim, we tested the effect of training on how often PCPs used different categories of diversion prevention strategies. PCPs in the intervention condition reported significantly more use of patient/family education strategies than PCPs in TAU at all follow-up time points, and group differences were moderate-to-large in size. There were no differences between conditions in how frequently PCPs used strategies related to medication management, assessment of mental health symptoms/functioning, or assessment of risky behaviors. Exploratory analyses of individual education strategies found significant improvements in almost all individual strategies over time (Table 2).

For our second aim, we tested training effects on determinants of strategy use. At the first follow-up, 6 months after training, all determinants were significantly different between conditions. Consistent with hypotheses, providers in the intervention condition reported significantly more positive attitudes about the effectiveness of and need for diversion prevention, stronger implementation climate, greater knowledge/skill, and less resource constraints than providers in TAU. At 12-month follow-up, providers in the intervention condition continued to report more positive attitudes about the effectiveness of diversion prevention, stronger implementation climate, and greater knowledge/skill than those in TAU. At 18-month follow-up, providers in the intervention condition reported significantly greater knowledge/skill and less resource constraints than those in TAU. Differences between conditions in attitudes about effectiveness and resource constraints at specific time points should be interpreted cautiously, as the overall time by condition interaction was not significant for these outcomes ($p = 0.08$ and $p = 0.12$, respectively; this interaction was significant for all other outcomes).

Lastly, our mediation analyses tested indirect effects of training on use of patient/family education strategies at 12 months through changes in each determinant (i.e., attitudes, implementation climate, knowledge/skill, resource constraints) at 6 months. We found a significant indirect effect for knowledge/skill (standardized estimate = 0.15; 95% CI 0.02–0.30). The intervention effect on use of patient/family education strategies at 12 months was mediated by changes in knowledge/skill at 6 months. Changes in knowledge/skill accounted for 49% of the total effect of training on use of patient/family education strategies. No other determinants had significant indirect effects.

Discussion

Pediatric PCPs are well-positioned to prevent stimulant diversion by adolescents with ADHD treated with stimulant medications (Matson et al., 2021). We used data from a cluster-randomized clinical trial to test the effects of training in stimulant diversion prevention on PCPs' use of stimulant diversion strategies. We also tested training effects on determinants of strategy use (i.e., attitudes, implementation climate, knowledge/skill, resource constraints) and if changes in determinants mediated the effect of the training on strategy use.

We found that a brief (1-h) workshop on stimulant diversion prevention resulted in significant changes in PCPs' self-reported use of patient/family education strategies that persisted for 18 months after training. Prior to training, PCPs reported infrequent use of patient/family education strategies (McGuier et al., 2021), with no differences between PCPs in the intervention and TAU conditions. The medium-to-large effects found at each follow-up time point indicate that the training was successful in increasing use of these strategies most directly relevant to diversion. We did not find significant differences in use of other categories of diversion prevention strategies, including medication management strategies, assessing symptoms/functioning, and assessing risky behaviors. Lack of differences in assessment of symptoms/functioning and assessment of risky behavior may reflect ceiling effects given their frequent use at baseline (McGuier et al., 2021). These strategies are consistent with published practice guidelines for pediatric ADHD (Wolraich et al., 2019), and PCPs are likely to have access to other training and continuing education to support these behaviors. They may be less important to target in stimulant diversion prevention training. The lack of change in medication management strategies, however, is surprising and may reflect PCPs' greater comfort with educating and empowering patients to resist or protect against diversion than acting as an external monitor. Although medication management strategies were relatively infrequent at baseline, they were more frequent than patient/family education strategies, resulting in less room for change (McGuier et al., 2021). It is also possible that PCPs may require more specific or in-depth training on monitoring medication use and supply to change their medication management behaviors.

Compared to PCPs in TAU, PCPs in the intervention condition reported significantly more positive attitudes (i.e., perceived effectiveness of and need for diversion prevention), more favorable implementation climate, greater knowledge/skill, and less resource constraints 6 months after training. Differences in attitudes about the effectiveness of diversion prevention, implementation climate, knowledge/skill, and resource constraints remained evident in at least

Table 1 Descriptive statistics by condition and time and results of GEE analyses

	Time 1 (baseline)		Time 2 (6 months)		Time 3 (12 months)		Time 4 (18 months)		Results of GEE analyses		
	TAU *M* (SD)	SDP *M* (SD)	TAU *M* (SD)	SDP *M* (SD)	TAU *M* (SD)	SDP *M* (SD)	TAU *M* (SD)	SDP *M* (SD)	Time 2 *B* (SE)	Time 3 *B* (SE)	Time 4 *B* (SE)
			Cohen's *d*		Cohen's *d*		Cohen's *d*		95% CI	95% CI	95% CI
Use of diversion prevention strategies											
Patient/family education	1.73 (0.71)	1.52 (0.55)	2.05 (0.79)	2.74 (0.82)	2.21 (0.86)	2.70 (0.86)	2.35 (0.81)	2.70 (0.88)	**.79 (.15)***	**.61 (.17)***	**.49 (.17)***
									.50–1.09	**.28–.94**	**.15–.83**
			d = .86		*d* = .57		*d* = .41				
Medication management	2.47 (0.58)	2.24 (0.63)	2.56 (0.42)	2.46 (0.65)	2.55 (0.51)	2.57 (0.70)	2.74 (0.46)	2.58 (0.68)	−.05 (.11)	.08 (.13)	−.06 (.13)
									−.27–17	−.17–.34	−.32–20
			d = .18		*d* = .03		*d* = .28				
Assessment of symptoms and functioning	3.73 (0.32)	3.62 (0.55)	3.79 (0.24)	3.71 (0.54)	3.81 (0.26)	3.73 (0.54)	3.83 (0.21)	3.75 (0.34)	−.07 (.11)	−.07 (.12)	−.04 (.06)
									−.30–.15	−.30–.16	−.16–.07
			d = .19		*d* = .19		*d* = .28				
Assessment of risky behavior	3.21 (0.83)	3.16 (0.75)	3.25 (0.66)	3.24 (0.79)	3.28 (0.66)	3.30 (0.70)	3.31 (0.72)	3.25 (0.74)	−.07 (.15)	−.03 (.16)	−.06 (.15)
									−.37–.24	−.34–.29	−.36–.24
			d = .01		*d* = .03		*d* = .08				
Determinants											
Attitudes: perceived effectiveness	5.41 (0.83)	5.55 (1.03)	5.66 (0.85)	6.11 (0.75)	5.70 (0.86)	6.10 (0.75)	5.61 (0.95)	5.97 (1.25)	**.40 (.17)***	**.39 (.18)***	.38 (.22)
									.06–.74	**.04–.73**	−.05–.81
			d = .56		*d* = .62		*d* = .32				
Attitudes: perceived need	6.27 (0.58)	6.19 (0.92)	6.25 (0.69)	6.47 (0.83)	6.20 (0.68)	6.31 (0.73)	6.21 (0.67)	6.23 (1.08)	**.29 (.10)***	.12 (.13)	.17 (.13)
									.09–.49	−.14–.38	−.08–.41
			d = .29		*d* = .16		*d* = .02				
Implementation climate	4.09 (0.89)	4.29 (0.76)	4.13 (0.88)	4.73 (0.86)	4.14 (0.91)	4.73 (0.83)	4.25 (0.84)	4.53 (0.89)	**.48 (.18)***	**.42 (.15)***	.16 (.16)
									.13–.83	**.12–.72**	−.15–.47
			d = .69		*d* = .68		*d* = .32				
Knowledge/skill	3.95 (1.32)	3.56 (1.31)	4.24 (1.30)	5.13 (0.94)	4.69 (1.15)	5.03 (0.93)	4.66 (1.33)	5.34 (1.04)	**1.10 (.20)***	**.52 (.23)***	**.94 (.23)***
									.72–1.49	**.07–.97**	**.48–1.40**
			d = .78		*d* = .33		*d* = .57				
Resource constraints	4.07 (0.97)	3.80 (0.73)	4.16 (0.93)	3.57 (1.12)	4.03 (0.85)	3.70 (1.09)	4.23 (1.08)	3.66 (0.99)	**−.48 (.24)***	−.24 (.20)	**−.43 (.21)***
									−.96– −.01	−.64–.16	**−.84– −.01**
			d = .57		*d* = .34		*d* = .55				

Significant results from GEE analyses are bolded

GEE Generalized Estimating Equations, *SDP* stimulant diversion prevention training condition, *TAU* treatment-as-usual condition, *CI* confidence interval

*$p < .05$

Table 2 Patient/family education strategies: descriptive statistics by condition and time and results of exploratory GEE analyses

	Time 1 (baseline)		Time 2		Time 3		Time 4		Results of GEE analyses		
	TAU	SDP	TAU	SDP	TAU	SDP	TAU	SDP	Time 2	Time 3	Time 4
	M (SD)	*M* (SD)	*M* (SD)	*M* (SD)	*M* (SD)	*M* (SD)	*M* (SD)	*M* (SD)	*B* (SE) 95% CI	*B* (SE) 95% CI	*B* (SE) 95% CI
Individual patient/family education strategies											
Remind that meds should only be used by patient	2.59 (1.09)	2.03 (1.06)	2.88 (1.03)	3.32 (.83)	3.20 (.90)	3.43 (.86)	3.23 (.81)	3.29 (.90)	**.56 (.18)*** **.20–.91**	**.44 (.19)*** **.07–.81**	.22 (.19) −.15–.58
Explain that patient will not have enough meds when needed	1.70 (1.05)	1.50 (.88)	1.98 (1.23)	2.97 (1.08)	2.29 (1.19)	2.73 (1.17)	2.61 (1.04)	2.97 (1.08)	**1.05 (.20)*** **.67−1.44**	**.57 (.22)*** **.13−1.00**	**.48 (.23)*** **.03−.94**
Explain that patient is likely to be approached to divert	1.68 (.96)	1.47 (.84)	2.17 (1.12)	2.87 (.99)	2.34 (1.15)	3.00 (.91)	2.15 (1.11)	2.90 (1.01)	**.72 (.20)*** **.33–1.12**	**.79 (.21)*** **.38–1.21**	**.86 (.22)*** **.44–1.29**
Discuss what to say if someone asks for pills	1.48 (.90)	1.28 (.63)	1.76 (1.02)	2.77 (1.09)	1.95 (1.12)	2.80 (1.03)	2.05 (1.15)	2.94 (.93)	**1.09 (.20)*** **.69–1.49**	**1.03 (.20)*** **.63–1.43**	**1.06 (.20)*** **.66–1.46**
Explain that if word of diversion gets out others will ask	1.25 (.72)	1.28 (.68)	1.73 (1.00)	2.52 (1.00)	1.73 (1.07)	2.60 (1.03)	2.03 (1.18)	2.68 (1.14)	**.83 (.21)*** **.43–1.24**	**.83 (.25)*** **.34–1.33**	**.66 (.26)*** **.16–1.17**
Explain that diversion can negatively affect reputation	1.39 (.87)	1.28 (.68)	1.63 (.99)	2.35 (1.20)	1.68 (1.13)	2.30 (1.29)	2.08 (1.18)	2.35 (1.20)	**.80 (.22)*** **.38–1.22**	**.67 (.26)*** **.16–1.18**	.35 (.26) −.17–.87
Explain that diversion can get patient in trouble	1.75 (1.10)	1.59 (.91)	2.20 (1.12)	3.06 (.93)	2.34 (1.24)	3.00 (1.02)	2.51 (1.10)	2.84 (1.04)	**.91 (.21)*** **.50–1.33**	**.72 (.24)*** **.26–1.19**	.37 (.23) −.08–.83
Discuss keeping diagnosis and treatment private	1.93 (1.04)	1.81 (1.09)	2.32 (1.21)	3.00 (1.06)	2.34 (1.26)	2.97 (1.10)	2.69 (1.08)	3.06 (1.09)	**.73 (.25)*** **.24–1.21**	**.65 (.26)*** **.13–1.16**	.43 (.24) −.04–.91
Discuss safe storage	2.18 (1.13)	1.78 (1.01)	2.44 (1.10)	2.97 (1.02)	2.68 (1.01)	3.07 (1.14)	2.87 (1.00)	2.81 (1.08)	**.58 (.21)*** **.17–.99**	.35 (.23) −.11–.80	−.01 (.23) −.45–.43
Explain that meds may not help friends	1.32 (.80)	1.22 (.61)	1.66 (1.04)	2.45 (1.15)	1.93 (1.10)	2.20 (1.24)	1.92 (1.09)	2.29 (1.19)	**.85 (.22)*** **.41–1.28**	.34 (.24) −.13 to .82	.46 (.25) −.03–.96
Explain that meds may be dangerous for friends	1.59 (1.00)	1.19 (.64)	1.85 (1.04)	2.84 (1.04)	2.20 (1.10)	2.80 (1.12)	2.31 (1.13)	2.68 (1.05)	**1.09 (.22)*** **.66–1.52**	**.60 (.24)*** **.14–1.07**	**.55 (.24)*** **.08–1.02**
Discuss using meds with alcohol/drugs	2.32 (1.25)	2.09 (1.12)	2.73 (1.12)	2.74 (1.06)	2.66 (1.20)	2.80 (1.12)	2.72 (1.07)	2.65 (1.14)	.07 (.22) −.35–.50	.20 (.23) −.25–.64	.12 (.21) −.30–.54
Discuss increased monitoring by schools	1.30 (.76)	1.19 (.54)	1.20 (.61)	1.74 (1.00)	1.34 (.79)	1.63 (1.07)	1.33 (.74)	1.71 (1.16)	**.56 (.19)*** **.18–.93**	.29 (.20) −.11–.69	.40 (.23) −.06–.85

Significant results from GEE analyses are bolded

GEE Generalized Estimating Equations, *SDP* stimulant diversion prevention training condition, *TAU* treatment-as-usual condition, *CI* confidence interval

*$p < .05$

one follow-up time point. Changes in knowledge/skill were evident through 18-month follow-up. Encouragingly, even though attitudes were very positive and resource constraints low prior to the trial (McGuier et al., 2021), both attitudes and resource constraints still showed significant change after training.

In mediation analyses, knowledge/skill had a significant indirect effect on strategy use. This finding is consistent with prior analyses of baseline data showing that knowledge/skill had strong and consistent associations with use of all categories of diversion prevention strategies prior to the start of the trial (McGuier et al., 2021). Although there were improvements in other determinants (i.e., attitudes, implementation climate, resource constraints) for PCPs in the intervention condition, we did not find evidence that changes in these determinants led to changes in strategy use. These findings suggest that increasing PCPs' knowledge and skill regarding diversion prevention is critical to increasing use of diversion prevention strategies in pediatric primary care.

Limitations

This study was conducted in multiple pediatric primary care practices, increasing its generalizability; however, all practices were part of the same health system and research-practice network. Although the findings reported here rely on PCP self-report, they are consistent with reports from the adolescent patients enrolled in the trial. Adolescent patients in intervention practices reported that providers used more diversion prevention strategies than PCPs in TAU practices (Molina et al., 2022). The correspondence of PCP and adolescent reports suggests that our findings reflect real changes in PCPs' behaviors during provider-patient interactions.

The stimulant diversion prevention strategies tested in this trial show some benefit in reducing risk for diversion within a sample of adolescents with ADHD treated in pediatric primary care (Molina et al., 2022). Ongoing longitudinal follow-up will provide additional opportunities to evaluate their effectiveness as these adolescents move into young adulthood, a period of increased risk for diversion.

Conclusions

Overall, we found that a brief workshop in stimulant diversion prevention increased the frequency with which pediatric PCPs educated their patients about stimulant diversion. The training also resulted in improvements in PCPs' attitudes, perceived norms, and knowledge/skill regarding diversion prevention. Increases in use of education strategies after training were mediated by increases in knowledge/skill. This brief training can be rapidly and easily scaled up, making it a promising approach for widespread dissemination of stimulant prevention strategies. Training pediatric PCPs in diversion prevention strategies, particularly patient/family education strategies, is a promising approach for reducing stimulant diversion by adolescents with ADHD.

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Declarations

Ethics Approval The study was performed in accordance with ethical standards of the institution and the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. All study procedures and materials were approved by the University of Pittsburgh Institutional Review Board.

Consent to Participate All participants provided informed consent.

Conflict of Interest Dr. Geetha Subramaniam is an employee of the National Institute on Drug Abuse (NIDA), which is the funding agency for the study. She was substantially involved in DA040213, consistent with her role as Scientific Officer; she had no substantial involvement in the other cited grants. The remaining authors declare no conflicts of interest.

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