

# Increasing Recognition and Diagnosis of Adolescent Depression: Project RedDE: A Cluster Randomized Trial

Michael L. Rinke, MD, PhD\*; David G. Bundy, MD, MPH†; Ruth E.K. Stein, MD\*; Heather C. O'Donnell, MD, MS‡; Moonseong Heo, PhD§; Shilpa Sangvai, MD, MPH¶; Harris Lilienfeld, MD||; Hardeep Singh, MD, MPH\*\*

## ABSTRACT

**Background:** Adolescent depression causes appreciable morbidity and is underdiagnosed in primary care. This study investigated whether a quality improvement collaborative (QIC) increases the frequency of adolescent depression diagnoses, thus reducing missed diagnoses. **Methods:** During a cluster-randomized clinical trial, a national cohort of primary care pediatric practices worked in different orders based on randomization to improve performance on each of three different diagnoses; one was increasing adolescent depression diagnoses. While improving their first diagnosis during an 8-month action period, practices collected control data for a different diagnosis. In two subsequent 8-month periods, practices worked to improve two additional diagnoses and continued to provide data on the ability to sustain and maintain improvements. The QIC intervention included day-long video conferences, transparent data sharing, analysis of failures, QI coaching, and tools to help improve diagnostic performance, including the Patient Health Questionnaire-9 Modified. The primary outcome was the measured frequency of depression diagnoses in adolescent health supervision visits compared via generalized mixed-effects regression models. **Results:** Forty-three practices were randomized with 31 in the final analysis. We included 3,394 patient visits in the control and 4,114 in the intervention phases. The adjusted percentage of patients with depression diagnoses increased from 6.6% in the control to 10.5% in intervention phase (Risk Difference (RD) 3.9%; 95% CI 2.4%, 5.3%). Practices sustained these increases while working on different diagnoses during the second (RD -0.4%; 95% CI -2.3, 1.4%), and third action periods (RD -0.1%; 95% CI -2.7%, 2.4%). **Conclusions:** A QIC intervention can sustainably increase adolescent depression diagnoses. (*Pediatr Qual Saf* 2019;4:e217; doi: 10.1097/pq9.000000000000217; Published online September 30, 2019).

## INTRODUCTION

One in 8 adolescents had at least 1 major depressive episode in the prior year, and up to 20% of adolescents experience a major depressive episode.<sup>1-7</sup> Over 28% of adolescents report depressive symptoms every day for 2 or more weeks, and 7.4%–7.8% of adolescents attempt suicide annually.<sup>8,9</sup> Depressed adolescents experience damaging effects on academics and relationships

and are at increased risk for substance use, social impairment, and depression later in life.<sup>3,4</sup> The US Preventive Services Task Force and the American Academy of Pediatrics (AAPs) recommend screening adolescents for depression.<sup>10-13</sup> Improving rates of timely adolescent depression diagnosis is crucial to prevent life-altering comorbidities.

Depressed adolescents are often seen in the ambulatory setting,<sup>14,15</sup> but provider



From the \*Department of Pediatrics, The Children's Hospital at Montefiore and the Albert Einstein College of Medicine, Bronx, N.Y.; †Department of Pediatrics, Medical University of South Carolina, Charleston, S.C.; ‡Children's Hospital Boston, Boston, Mass.; §Department of Public Health Sciences, and School of Mathematical Sciences, Clemson University, Clemson, S.C.; ¶Department of Pediatrics, Dayton Children's Hospital, Boonshoft School of Medicine, Wright State University, Dayton, Ohio; ||Delaware Valley Pediatric Associates, Lawrence, N.J.; and \*\*Center for Innovations in Quality, Effectiveness and Safety, Michael E. DeBakey Veterans Affairs Medical Center, Department of Medicine, Baylor College of Medicine, Houston, Tex.

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\*Corresponding author. Address: Michael L. Rinke, MD, PhD, Department of Pediatrics, The Children's Hospital at Montefiore and the Albert Einstein College of Medicine, 3411 Wayne Avenue, Room 801, Bronx, NY 10467. PH: 718-741-2524; Fax: 718-920-4351 Email: mrinke@montefiore.org

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recognition of depression is low,<sup>16–18</sup> potentially due to lack of provider knowledge and time during visits.<sup>19–21</sup> Also, adolescents may have symptoms of irritability rather than sadness and rarely present to physicians with a mood complaint, making their diagnosis harder.<sup>22,23</sup> Although treatment of adolescent depression can reduce symptoms, morbidity, and mortality,<sup>24,25</sup> few adolescents receive treatment.<sup>22</sup> Recognition of adolescent depression and follow-up are important, and reducing missed diagnoses of adolescent depression is a priority among pediatricians.<sup>26</sup> By focusing on improved diagnostic accuracy, providers can reduce morbidity and mortality caused by adolescent depression.

This study's objective was to determine whether a quality improvement (QI) collaborative (QIC) intervention could increase the frequency of recognition and diagnosis of adolescent depression and sustain rates over 16 months while clinicians concurrently worked to improve other diagnoses. The primary intervention, a QIC, is an organized, multifaceted collaborative approach to QI with (1) a specific topic for improvement with large practice variation; (2) clinical and QI experts sharing best practices; (3) multidisciplinary teams from multiple sites willing to improve; (4) a model for improvement with measurable targets, data feedback, and small tests of change; and (5) a series of structured activities to advance improvement, exchange ideas, and share experiences.<sup>10,27–32</sup> The intervention was tested via a prospective, stepped-wedge cluster randomized trial in a national group of pediatric primary care clinics.

## METHODS

### *Study Design*

As described previously,<sup>33,34</sup> Project RedDE (Reducing Diagnostic Errors in Pediatric Primary Care) aimed to improve diagnostic performance in primary care pediatrics, in collaboration with the AAP's Quality Improvement Innovation Networks (QuIIN). QuIIN aims to "improve the quality and value of care and outcomes for children and families" via QI networks. Increasing diagnoses of adolescent depression was 1 of 3 QIC topics. A group of experts developed interventions and measures and directed the QIC.

### *Randomization*

Thirty-four "wave 1" pediatric practices were recruited in March 2015 and randomized via computer random number generator in a nonblinded fashion, to 1 of 3 clusters. We performed multivariate matching before randomization<sup>35</sup> based on university affiliation, self-reported prior work to improve performance on these diagnoses, and total annual visits per practitioner equivalents. Nine practices dropped out after randomization but before submitting data due to inability to collect necessary baseline data. Twenty-four of the remaining 25 practices submitted complete data for the project; 1 practice dropped

out after 8 months due to loss of their lead physician. This practice's data were included as they submitted control and intervention data, but not long-term follow-up data. To increase sample size, we recruited and randomized 9 additional practices in December 2015 (wave 2). Of these, 2 practices dropped out due to data collection issues before the intervention, and 2 other practices from a single care network merged into 1 "team" to boost their sample size (Fig. 1). The 6 wave 2 practices participated alongside the wave 1 teams. Forty-three total practices were randomized, and we included 31 in the final analysis.

Each of the 3 clusters intervened on the same diagnoses, but in a different order (Fig. 2). Each cluster was assigned to collect retrospective baseline data (February 2015–June 2015) on 1 of 3 diagnoses: missed diagnosis of elevated blood pressure, delayed diagnosis of abnormal laboratory values, or increasing the recognition and diagnosis of adolescent depression. Clusters collected 1 month of prospective baseline data (September 2015) to ensure comparability between retrospective and prospective data collection, and in October of 2015, began to work to improve the first assigned diagnosis through May 2016. Concurrently, each cluster collected control data on a second diagnosis. In a prospective, stepped-wedge fashion, after 8 months (June 2016), each cluster then began to work to improve a second diagnosis, sustain the improvement on their first diagnosis, and act as a control group for the third diagnosis. In February 2017, each cluster began to work to improve the third diagnosis, sustain improvement on their second diagnosis, and maintain improvement on their first diagnosis with reduced feedback and attention on that diagnosis from the QIC (Fig. 2). As wave 2 practices entered the collaborative after the first action period, these practices intervened on only 2 of the 3 diagnoses.

Each cluster had a "control phase" when they collected data on adolescent depression frequency before attempting to increase its identification and all but 1 wave 2 group had an "intervention phase" when they actively worked to increase adolescent depression diagnosis frequency. Two clusters had a "sustain phase" when they actively worked to improve performance on an additional diagnosis and sustain improvement on adolescent depression frequency; 1 cluster had a "maintenance phase" when they actively worked to improve performance on 2 other diagnoses and maintain improvement on adolescent depression frequency.

### *Intervention*

Each practice identified a 3-person QI team consisting of at least a physician, a nurse, and another professional. Teams participated in a 2-day interactive video learning session during which they learned and practiced QI methodology and diagnosis-specific content related to the first targeted diagnosis. They then received rapid, transparent data feedback with benchmarking, participated in monthly, hour-long video conferences, and completed

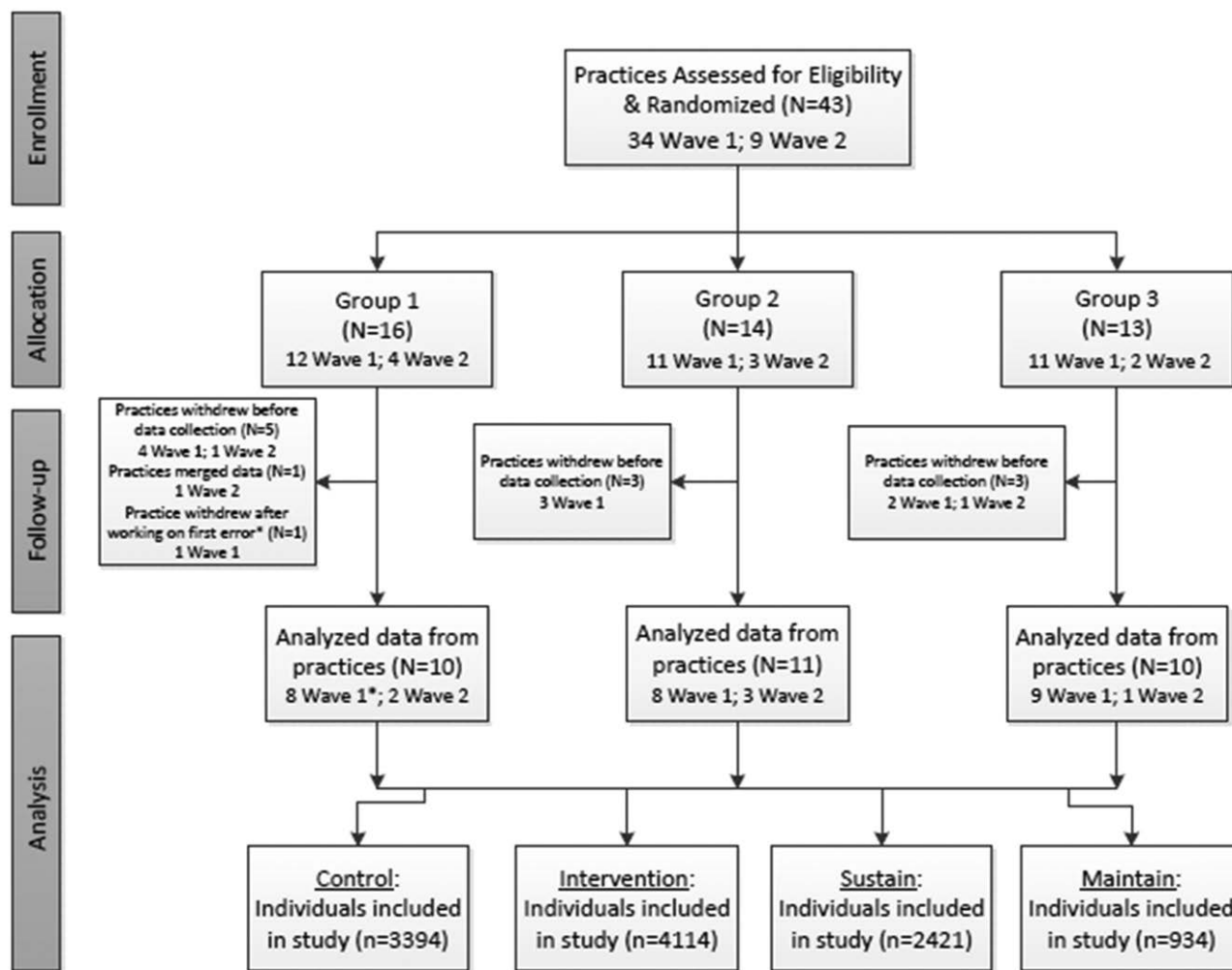


Fig. 1. Modified consort flow diagram for cluster randomized stepped-wedge trial. \*One practice in group 1 withdrew after the first phase of the project. Their data were included in the primary analysis.

monthly mini root cause analyses. Mini root cause analyses examined 15 standardized patient and system factors that could have led to a patient with depression not being recognized or diagnosed.<sup>36,37</sup> Additional day-long video learning sessions were conducted every 8 months as practices transitioned to working on a new diagnosis (Fig. 2). Although clusters were working on their second diagnosis, monthly video conferences provided transparent data feedback from both their first and second diagnoses; when working on their third diagnosis, monthly video conferences presented data from their second and third diagnoses, and data from their first diagnosis were only presented quarterly. We provided each practice a QI coach, and each cluster had an interactive email listserv and cluster-specific website with resources.

During learning sessions, clusters about to intervene on adolescent depression were taught about this condition, its importance, and the utility of screening; how to use the Pediatric Health Questionnaire 9-Modified (PHQ-9M);<sup>12</sup> how to assess and diagnose adolescents who screened

positive; and how to begin treatment or create referrals depression diagnosis to mental health practitioners. The PHQ-9M is a screening tool to identify patients who need depression diagnosis evaluation. The PHQ-9M consists of 9 questions about depression symptom frequency in the prior 2 weeks, 1 question about symptoms interfering with daily tasks, 1 question about depressed feelings in the past year, and 1 question each about suicidal thoughts and attempts. The Resource for Advancing Children’s Health (REACH) Institute’s Patient-centered Mental Health in Pediatric Primary Care Program’s training materials were used with permission.<sup>38</sup> Teams were taught how to use the Columbia Depression Scale and Global Assessment Scale. These tools, including the PHQ-9M and Guidelines for Adolescent Depression in Primary Care (GLAD-PC), were chosen as they are AAP endorsed.<sup>12</sup>

Teams received adolescent depression-related tools via a “change package” which was modeled on the REACH Institute’s materials and the GLAD-PC.<sup>12,38</sup> Steps in

Group	February 2015-June 2015 & September 2015	Sept. 2015	Action Period I: October 2015-May 2016	June 2016	Action Period II: June 2016-January 2017	Feb. 2017	Action Period III: February 2017-September 2017
<b>Wave 1</b>							
<b>Group 1</b>	Control Phase	Virtual Learning Session 1	Intervention Phase	Virtual Learning Session 2	Sustain Phase <sup>b</sup>	Virtual Learning Session 3	Maintenance Phase
<b>Group 2</b>	<sup>a</sup>		Control Phase		Intervention Phase		Sustain Phase
<b>Group 3</b>	<sup>a</sup>		<sup>a</sup>		Control Phase		Intervention Phase
<b>Wave 2<sup>c</sup></b>			<b>November 2015-March 2016</b>				
<b>Group 1</b>			<sup>a</sup>		<sup>a</sup>		Control Phase
<b>Group 2</b>			Control Phase		Intervention Phase		Sustain Phase
<b>Group 3</b>			<sup>a</sup>		Control Phase		Intervention Phase

**Fig. 2.** Project RedDE timeline for adolescent depression. <sup>a</sup>Practices were involved in Project RedDE during this time but working exclusively on the 2 nondepression errors. Practices in groups 2 and 3 had already worked to reduce 1 or 2 other DEs before beginning to work on depression errors. <sup>b</sup>During the sustain and maintenance phases, practices began working to reduce a second and third DE, respectively. <sup>c</sup>Wave 2 practices integrated alongside wave 1 practices, intervening first on wave 1’s second DE. These practices never intervened on a third DE. DEs indicates diagnostic errors.

adolescent depression diagnosis and care had accompanying tools: screening, recognizing abnormal screens, diagnosing depression, discussing with families, screening for suicidality, referring to mental health and/or providing treatment, and communicating with mental health providers. Finally, information about coding and billing was shared. Resources were maintained on the Project RedDE website. All QIC resources were made available to the public following the project’s conclusion.<sup>39</sup>

**Outcome Measures**

Pragmatic outcome measures were employed that took into account (1) a prevalent and harmful underlying condition with preventable morbidities; (2) interest from pediatricians;<sup>26</sup> (3) the key steps involved in diagnosis; and (4) feasibility of data collection by busy clinicians. Adolescent depression clearly fits this description as patients diagnosed with and treated for depression have reduced risk for suicidality, self-esteem, behavior problems, and functional problems.<sup>40,41</sup> In addition, pediatricians reported interest in improving depression diagnostic performance,<sup>26</sup> and diagnoses are present upon chart review.<sup>12</sup> Predata collection webinars, slides, and written definitions emphasized measurement concepts; email listservs and the research team provided clarifications. A refresher data collection webinar was held half-way through the project, but direct data validation was beyond the scope of this study.

Although depressive symptoms (eg, poor school performance, interrupted sleep patterns, and increased disruptive behaviors) without appropriate provider identification or referral were considered as the primary outcome, pilot data suggested the number of times a patient has documented signs and symptoms of depression but is not referred to or already receiving mental health treatment is rare, and this methodology likely underidentifies

adolescent depression.<sup>17</sup> Thus, we used a proxy primary outcome measure for poor adolescent depression diagnostic performance: the frequency of adolescent depression recognition and diagnosis, which increases as missed diagnoses decrease. Given prior literature,<sup>16-18</sup> it is reasonable to assume an underdiagnosis of adolescent depression. Practices identified the percent of adolescents who carried diagnoses of depression, dysthymia, or subsyndromal depression in visit notes, problem lists or billing records (International Classification of Diseases-9/10 codes 296.2, 296.3, 311, 311.0, 300.4, 309.0, 309.1, 309.4; F32.0-5, F32.9, F33.0-4, F33.8-9, F34.1, F43.21, F43.25, F06.3X). These were not patients who only screened positive on a PHQ-9M screen, but those who were ultimately given, at that visit or within 30 days of the visit, a diagnosis of depression. Subsyndromal depression was defined as “a depressive state having two or more symptoms of depression of the same quality as in major depression (MD), excluding depressed mood and anhedonia.”<sup>42</sup> We included patients if they were 11–23 years old and attending a health supervision visit. Eleven years old was chosen because the AAP recommended screening at this age.<sup>13</sup> Charts were checked 30 days after the visit.

The secondary outcome measure was whether a provider documented depression concerns or the exclusion of concerns at every adolescent health supervision visit, either with formal screening tools or clinical judgment. This measure examines if clinicians take advantage of health-care maintenance visits to recognize whether a patient does or does not have depression as suggested by the US Preventive Services Task Force and the AAP.<sup>11-13</sup> In addition, practices tracked a process measure: the percent of eligible patients who received the PHQ-9M screen. Teams were required to report this process measure during the intervention phase until at least 90% of eligible patients received the screen for 2 consecutive months. The primary

and secondary outcome data were collected for the length of the project.

In the initial retrospective phase, practices examined the first 10 patients who met inclusion criteria for the primary and secondary outcomes monthly. During the action periods, practices examined the first 17 patients monthly who met inclusion criteria, based on predetermined power analyses. If practices had fewer eligible patients in a given month, they entered all available data. For each patient, practices recorded deidentified data, including age, sex, and insurance status, in a secure online portal. Insurance status was included as a potential confounder because it is an easily collectible, partial marker of socioeconomic status, which is associated with ambulatory errors and adolescent depression.<sup>43,44</sup> Practices were provided a paper data abstraction tool, but anecdotally many practices entered data directly into the portal.

### Statistical Analysis

Using patients as the unit of analysis, we compared the primary outcome of mean number of adolescent patients diagnosed with depression per 100 adolescent patients seen for health supervision visits across all practices' intervention and control phases. The outcomes are presented as model-based estimated risk differences (RDs) comparing intervention versus control phases. Generalized mixed-effects regression models with the identity link, adjusted for age, sex, insurance status, and wave, were applied with month-specific and practice-specific intercepts considered random. We only included patients with complete demographic data. Our power analysis was revised based on group 1 baseline data.<sup>33</sup> The minimally detectable RD effect sizes with >80% power at a 2-sided significance level equal to 0.05 with correlations of outcomes across months within practices equal to 0.05 and across charts within periods equal to 0.5 were identified as at least 5.1%.

Similar models examined (1) the secondary outcome and (2) any differences in the intervention and sustain phases and sustain and maintenance phases (Fig. 2). The latter analyses investigated whether practices could sustain improvements while working to improve a second diagnosis and/or maintain improvements while working to improve 2 additional diagnoses with attention diverted from adolescent depression. Process measure data were compared between collaborative groups using Kaplan-Meier analysis and log-rank tests. We additionally examined aggregated primary and secondary outcomes using statistical process control p charts, with Nelson rules<sup>45</sup> signifying changes. The intervention's initiation was adjusted so each group began the intervention on "month 1." Small multiple p charts identified trends across groups and variation between clinics.

Intervention versus control patient demographics were compared with chi-square tests. All data analyses were performed using SAS v9.4. The institutional review boards of the AAP and the Albert Einstein College of Medicine

approved this study. Clinical trial registration number is for Project RedDE is NCT02798354 (clinicaltrials.gov).

## RESULTS

Thirty-one practices were included in the primary outcome analysis (Table 1), all of which used an electronic health record. Data on 3,394 patient visits were entered for the control phase and 4,114 for the intervention phase. We excluded 295 patients from the final model due to missing insurance data. There were younger and more nonprivately insured patients in the intervention phase (Table 2).

The adjusted percentage of patients with depression, dysthymia, or subsyndromal depression in the control phase was 6.6%, compared with 10.5% in intervention phase (RD 3.9%; 95% CI 2.4%, 5.3%,  $P < 0.0001$ ). Practices sustained and maintained these improvements (Table 3): the mean percentage of patients with depression was not different comparing the intervention with the sustain phase (RD -0.4%; 95% CI -2.3, 1.4%,  $P = 0.642$ ) nor the sustain phase to the maintenance phase (RD -0.1%; 95% CI -2.7%, 2.4%,  $P = 0.911$ ).

The secondary outcome, identifying when a provider pursued an evaluation for adolescent depression, also improved during the control versus intervention phases (RD 26.6%; 95% CI 22.4%, 30.7%,  $P < 0.0001$ ). Improvement continued during the intervention versus sustain phase (RD 18.6%; 95% CI 14%, 23.2%,  $P < 0.0001$ ) and sustain versus maintenance phases (RD 7.4%; 95% CI 2.3%, 12.6%,  $P = 0.005$ ).

Figure 3 demonstrates a significant shift began with the first intervention month for the primary outcome and with the second intervention month for the secondary outcome. Variation is observed in the small multiple p charts (See figure, Supplemental Digital Content, available at <http://links.lww.com/PQ9/A137>) between and within groups, with some clinics still not at 10% depression incidence by the conclusion of the intervention and some at 10% in the baseline period. There is continued variation within clinics as the expected number of patients with depression for any given clinic per month was 1.7 patients: some clinics have months with zero diagnoses and months with 4 to 5 diagnoses.

There were no differences in the Kaplan-Meier analysis comparing the time to 2 months with 90% or more patients screened with the PHQ-9M across the 3 clusters (log-rank test  $P = 0.534$ ). Fifty percent of practices reached this threshold at 5 months, and 70% reached at the end of the intervention phase.

## DISCUSSION

In a cluster randomized, stepped-wedge trial involving a national cohort of pediatric practices, a QIC successfully increased the percent of adolescents who carried diagnoses of depression from 6.6% to 10.5% and sustained this improvement over 16 months. This change was also

Table 1. Demographics of Included Practices at Baseline: N (%)

Characteristics	Group 1	Group 2	Group 3	All
No. practices	10	11	10	31
University affiliation	6 (60)	7 (64)	5 (50)	18 (58)
Previously worked "a lot" on 1 of the 3 errors of interest: percent yes	5 (50)	5 (45)	5 (50)	15 (48)
Total annual visits per full-time physician or physician extender equivalents: mean (SD)	4,549 (2,875)	3,172 (1,274)	3,399 (1,671)	3,689 (2,057)
Patient demographics percentage: mean (SD)				
White, non-Hispanic/Latino	38 (21)	43 (22)	28 (10)	37 (19)
Hispanic/Latino origin	17 (9)	20 (20)	31 (18)	22 (17)
Black/African American	30 (24)	32 (19)	31 (22)	31 (21)
Asian	3 (3)	3 (3)	5 (4)	4 (3)
Native Hawaiian/other Pacific Islander	0.1 (0.3)	–	1 (3)	0.4 (2)
American Indian/Alaska native	0.3 (0.5)	–	0.5 (1)	0.3 (1)
Other	12 (13)*	2 (5)	4 (6)	6 (9)
Team's QI skill and knowledge at project enrollment: %				
Very knowledgeable	1 (10)	–	1 (10)	2 (7)
Knowledgeable	7 (70)	6 (55)	5 (50)	18 (58)
Somewhat knowledgeable	1 (10)	5 (45)	4 (40)	10 (32)
Not knowledgeable	1 (10)	–	–	1 (3)

\*Two practices in this group had a large Somali population.

Table 2. Demographics of Included Adolescent Patients in Primary Analysis

	Control	Intervention	Total	P
Demographics				
No. adolescents included	3,394	4,114	7,508	
Age (11–13 y)	45.6%	48.4%	47.1%	0.013
Female	49.4%	50.9%	50.2%	0.189
Private insurance*	29.8%	26.4%	28.0%	0.002

\*Two hundred ninety-five (3.9%) patients had missing insurance data and were excluded from primary analyses.

Table 3. Primary and Secondary Outcome Results

Outcome	Comparison	Total N	Model-based Percentages	RD (95% CI)	P
Primary outcome					
Adolescent patients with a documented depression, dysthymia, or subsyndromal depression diagnosis at health supervision visit	Intervention versus control Sustain versus intervention Maintenance versus sustain	7,508 6,265 3,194	10.5% versus 6.6% 10.1% versus 10.5% 10.2% versus 10.3%	3.9% (2.4%, 5.3%) –0.4% (–2.3%, 1.4%) –0.1 (–2.7%, 2.4%)	<0.0001 0.642 0.911
Secondary outcomes					
Documentation of concerns for depression or exclusion of depression by provider at health supervision visit	Intervention versus control Sustain versus intervention Maintenance versus sustain	7,508 6,265 3,194	76.0% versus 49.5% 92.9% versus 74.3% 94.1% versus 86.7%	26.6% (22.4%, 30.7%) 18.6% (14.0%, 23.2%) 7.4% (2.3%, 12.6%)	<0.0001 <0.0001 0.005

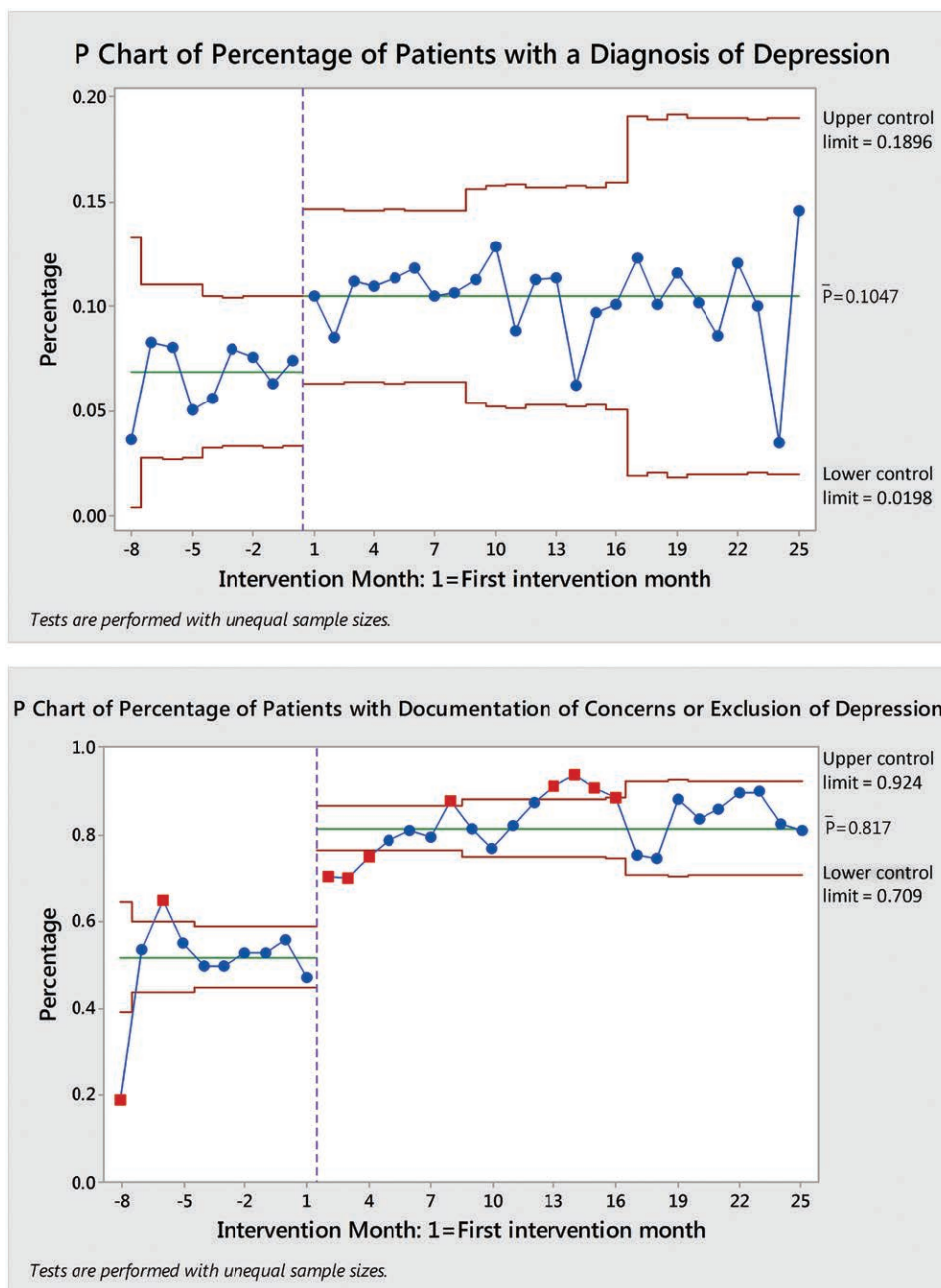
Fitted by generalized mixed-effects model with potential clustering effects of practices and months taken into account; adjusted for age, sex, insurance, and wave.

evident in statistical process control analyses. Practices were able to screen more systematically with an appropriate tool and also improved providers pursuing a diagnosis of depression at health supervision visits, a key step in recognizing a depressed adolescent. This type of diagnostic performance improvement strategy can potentially be applied across other mental health conditions.

Missed opportunities to diagnose depression occur in approximately 60% of adolescents,<sup>33</sup> and such high-frequency errors are a priority for pediatricians.<sup>26</sup> Our data support prior studies suggesting underdiagnosis of adolescent depression is common in pediatrics<sup>16–18</sup> and illustrates a methodology to reduce these misdiagnoses through collaboration, data benchmarking, QI coaching, and focusing on failures. Systematizing office practices to ensure screening with the PHQ-9M may improve diagnosis rates, as this process measure increased with depression diagnoses. Although measuring time to treatment

and symptom relief was beyond the scope of this project, many practices anecdotally reported increased confidence in managing mild to moderately depressed adolescents, increased communication and collaboration with mental health practitioners, and improved outcomes for patients they otherwise would not have suspected of having depression. Given the sustainability of improvements when practices were focused on other diagnoses, we hypothesize that the change seen can be replicated in practices without an extensive QIC infrastructure, because improvements were consistent when the QIC was not focused on depression diagnosis. Further work is needed to understand why some clinics improved immediately and some clinics did not see appreciable improvement across the intervention phase (See figure, Supplemental Digital Content, available at <http://links.lww.com/PQ9/A137>).

Practices anecdotally identified separating adolescents from their adult caregivers as a challenge in depression



**Fig. 3.** p charts of primary and secondary outcomes UCL, upper control limit; LCL, lower control limit.

screening. Although considered best practice, participants reported that separating patients and their caregivers was less commonly used and less commonly accepted for younger adolescents. One practice stated, “We never would have screened or even considered depression in a 12 year-old, and we found two 12-year-old patients last week with depression, one of whom was suicidal.” Solutions to privacy concerns included administering the PHQ-9M while caregivers were completing insurance forms, or when patients privately had vitals, hearing tests, vision tests, or anthropometric measurements. Many practices reduced inefficiencies and risk of error by developing previsit screening protocols to identify patients

who would need the PHQ-9M. Others screened all adolescent patients for depression at every visit, thus making the process more standardized. Anecdotally, practices that reported screening at all adolescent visits did not report detrimental impacts on patient flow. In addition, many practices notified caregivers in advance that this type of screening, and for alcohol, tobacco, illicit drugs, and sexual activity, would occur during health supervision visits. Future work on improving detection and diagnosis for similarly sensitive conditions should consider the importance of integrating privacy interventions.

Limitations of this study include the concern that practices enrolled in a QIC are unlikely to be representative of

all pediatric practices. Further, 11 of the 43 practices randomized withdrew before study implementation due to data collection burden. All of these practices withdrew before attempting to change their clinic processes and behaviors, making it unclear if easier data collection would have reduced this attrition rate. The study does not have information on practices that dropped out either for an intention to treat analysis or to compare demographics as these practices did not submit any data. It is possible that practices with more resources or abilities to collect needed data, may be less likely to resemble other general pediatric practices, although we believe this to be less likely as our cohort included great diversity with single practitioner private practices and large academic practices with many residents and attending. In addition, because the research team performed no direct site visits, there was potential variability in the application of data definitions across practices. However, the research team was available to answer questions during all data collection phases, hosted review sessions, and shared tips frequently on the listserv. To facilitate pragmatic data collection, the adolescent depression primary outcome measure assumes an underdiagnosis of adolescent depression, which is probable in light of current literature.<sup>16–18</sup> The research study is unable to confirm the true incidence of adolescent depression in these practices, only that its diagnosis increased significantly and the percent of providers addressing adolescent depression at health supervision visits significantly increased. It is possible that even more adolescents during the intervention had diagnosable depression; this may be true as only 70% of practices were consistently screening 90% of patients with the PHQ-9M at the end of the intervention phase. It is worth noting that the frequency of adolescents diagnosed with depression in these clinics at the end of the project was around 10%, which is comparable with the frequency in large US depression studies.<sup>7</sup> We are unable to comment on which piece of the QIC intervention was most important for the increase in adolescent depression recognition and diagnosis. Finally, practices were asked to evaluate the first 17 patients' charts that met inclusion criteria from each month. Although this is not a randomized assignment for chart review, it does reduce the potential for biased chart sampling as it is a systematic sample of patients.

## CONCLUSIONS

A national group of pediatric practices increased diagnoses of adolescent depression and sustained that improvement over 16 months. Future research should focus on spreading this effort to all pediatric primary care clinics, on the outcomes of patients following these diagnoses, and whether this model can apply to other adolescent and adult mental health diagnoses in primary care.

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## DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

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