

Evidence-Based Algorithm to Prevent the Misdiagnosis of Attention-Deficit Hyperactivity

Disorder in Preschoolers

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Abstract

There is an increased risk of misdiagnosis of Attention Deficit Hyperactivity Disorder (ADHD) in preschoolers due to the lack of validated diagnostic tools and provider knowledge of normal behavior and development. The goal of this project was to standardize the diagnostic process by adopting an evidence-based ADHD algorithm protocol for preschoolers (3-5 years). In an urban military pediatric clinic, five pediatric care clinicians were provided with an educational ADHD algorithm. Pre/posttest surveys were used to assess provider knowledge and perceptions of care. Chart audits determined preschooler ADHD diagnosis prevalence pre- and post-implementation of the algorithm. The rate of ADHD diagnosis in preschoolers reduced significantly from 78.6% pre-audit to 22.6% post-audit. In addition, providers improved their accuracy in diagnosing alternative disorders and behaviors that mimic the symptomology of ADHD ($Z=-2.0$, $p=0.046$). The rate of misdiagnosis of ADHD in preschoolers decreased because of the use of an evidence-based ADHD algorithm.

Keywords: ADHD, misdiagnosis, preschoolers, evidence-based practice, standardized diagnostic tools, pediatric care

Evidence-Based Algorithm to Prevent the Misdiagnosis of Attention-Deficit Hyperactivity Disorder in Preschoolers

The American Academy of Pediatrics (AAP) has identified Attention Deficit Hyperactivity Disorder (ADHD) as one of the most frequently diagnosed health conditions among school-age children. Notably, the AAP has estimated that 5% of American children have received an ADHD diagnosis (AAP, 2011). On the other hand, the Center for Disease Control (CDC) has reported that 11% of American children aged between four and seven years have been diagnosed with ADHD (Bruchmuller, Margraf, & Schneider, 2012; Elder, 2010). In addition, Visser et al. (2014) have reported that the percentage of children receiving an ADHD diagnosis from a healthcare provider increased by 42% from 2003-2004 to 2011-2012. The increasing cases of ADHD diagnosis has brought to the forefront pertinent concerns regarding the misdiagnosis of ADHD in children, especially preschoolers. As such, it is imperative to develop and standardize the criteria for diagnosing ADHD in preschoolers to reduce the risk of misdiagnosis and overtreatment.

ADHD symptomology elicits a broad differential diagnoses (including autism, learning disabilities, depression, anxiety disorder, conduct disorders, and sleep disorders), which make it difficult to make a correct diagnosis in preschoolers (Feldman & Reiff, 2014; Mahone & Schneider, 2012; Merikangas et al., 2010). Evidence from multiple studies has shown that the misdiagnosis of ADHD is distorting the prevalence rates among preschoolers (Arnett, MacDonald, & Pennington, 2013; Coghill & Seth, 2015). Clinicians normally assess ADHD using either clinician-rated behavioral observations or self-report questionnaires completed by parents and teachers. These diagnostic approaches are not only subjective but are also susceptible to the influences of personal intuitions, preferences, and cultural norms (Elder, 2010; Ford-Jones,

2015). Thus, the vagueness of the various Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM V) diagnostic criteria, coupled with the subjectivity of the most common evaluation tools increases the risk of misdiagnosis in preschoolers (Wolraich et al., 2011). These issues point to the need for the development of a standardized protocol for diagnosing ADHD in preschoolers.

Search Strategy

The clinical (PICOT) question that guided the literature search strategy was as follows: “In children aged 3-5 years, does the use of a preschool-specific evidence-based algorithm compared to the current clinical guidelines affect the rate of misdiagnosis and the prescription of stimulants?” An exhaustive search of four electronic databases was conducted through PubMed Central (PMC), Ovid MEDLINE, Cochrane, and EBSCO. Predetermined MeSH terms and Boolean connectors were used to locate peer-reviewed articles. The key search terms included *ADHD, preschoolers, diagnoses, misdiagnoses, evidence-based practice, and symptoms*. The inclusion criteria included peer-reviewed research articles published in English between 2010 and 2015. The journal articles were also required to have explored the diagnosis and treatment of ADHD in preschoolers and children. The search yielded 56 journal articles from the four databases. Only ten of these articles met the eligibility criteria, and were included in the review and synthesis of evidence (Arnett et al., 2013, Bruchmuller et al., 2012; Chankalal & Daily, 2012; Coghill & Seth, 2015; Elder, 2010; Evans et al., 2010; Feldman & Reiff, 2014; Ford-Jones, 2015; French, 2015, Hamed, Aaron, Kauer, & Stevens, 2015; Mahone & Schneider, 2012; Visser et al., 2014; Wolraich et al., 2011).

The review and synthesis of evidence has underscored two fundamental issues. First, misdiagnosis of ADHD is more prevalent in preschoolers compared to their older counterparts.

Factors that contribute to this situation include unstandardized psychometric assessment in preschoolers and inconsistent parent reports (Coghill & Seth, 2015; Mahone & Schneider, 2012; Wolraich et al., 2011). For instance, the diagnosis of ADHD in school age children and adolescents requires assessment from two settings (home and school environment) to support the diagnosis. However, French (2015) has found that only parents provide information from these assessment tools because most preschoolers are not yet enrolled in school. Second, most symptoms of ADHD are salient in preschoolers, making it challenging to identify preschoolers who will develop persistent ADHD and those whose symptoms will wane with increasing developmental skill attainment (Chankalal & Daily, 2014; Evans, Morrill, & Parente, 2010; Visser et al., 2014). The increasing cases of misdiagnosis and overtreatment of ADHD call for the development of a standardized protocol for diagnosing ADHD in preschoolers.

Purpose Statement

The purpose of this Doctor of Nursing Practice (DNP) project was to standardize the diagnosis of ADHD among preschoolers using an evidence-based ADHD algorithm. The achievement of this objective was necessary to reduce cases of misdiagnosis, which subsequently increase the overtreatment of ADHD symptomology in preschoolers. The implementation of this project supported an ongoing utilization of an evidence-based standardized ADHD screening tool detailing current national recommendations for the diagnosis and treatment of ADHD symptoms in preschoolers at a pediatric clinic in Southwestern United States. Guided by the evidence, this process will not only standardize the diagnostic process but also enhance the validity of the final ADHD diagnosis in preschoolers.

Evidence-Based Practice Model

The Iowa Model of Evidence Based Practice guided the implementation process. This model constitutes seven steps: the selection of appropriate topic, forming a team, retrieval of evidence, grading the evidence, developing an EBP standard, implementing the EBP, and evaluation (Doody & Doody, 2011). Each of these phases provided crucial information and guidelines that facilitated a seamless flow of successive implementation processes. The cyclic nature of this model made it easier to transition from one phase of implementation to the next. This model was useful in creating the urgency for change by highlighting the limitations of the current guidelines regarding ADHD diagnosis in preschoolers. Most significantly, this model facilitated broader engagement of all stakeholders in planning (decision-making), implementation, and evaluation processes, which was critical to reducing the risk of resistance to change.

Conceptual/Theoretical Framework

The Roger's Diffusion of Innovation theory was used to facilitate the seamless implementation of the proposed changes (Dearing, 2009). According to Dearing (2009), this model consists of five phases of planned change: awareness, interest, evaluation, trial, and adoption. The first phase entailed getting a buy-in from all the stakeholders by providing the rationale and significance of instituting the proposed changes. Second, all stakeholders participated actively in the decision-making processes. Third, a multidisciplinary team was constituted to review the applicability of the algorithm in the pediatric setting through a pilot initiative that involved two pediatricians and two pediatric nurse practitioners. Fourth, the intervention was rolled-out in the pediatric unit by integrating the evidence-based algorithm in

clinical practice. Finally, routine monitoring and evaluation was conducted to assess performance and outcomes against specific benchmarks.

Method

The Institutional Review Board of Arizona State University reviewed and approved the proposed project.

Participants and Setting

The project was implemented at a primary pediatric clinic, which is a military facility located in the Southwestern United States with a population of 8,500 beneficiaries. The clinic has seven pediatricians, four pediatric nurse practitioners (PNPs), four administrative technicians, fourteen medical technicians, four pediatric nurses, physician assistant (PA) students, and PNP students. Secondly, the project included a purposive sample of five pediatric healthcare providers who encountered children with ADHD symptomology in their pediatric practices. These healthcare providers included four pediatricians and one pediatric nurse practitioner. The co-investigator met individually with each clinician providing them with an introductory letter and explanation of the proposed project.

Intervention/Design and Implementation Process

The evidence-based ADHD algorithm consists of several steps for reviewing and eliminating possible diagnoses associated with ADHD-related symptoms. At the core of this protocol is a detailed medical history, which helps eliminate various symptomologies that could mimic ADHD in preschoolers. The first step entails a review of family history for psychiatric, behavioral or neurodevelopmental disorders, including a review of annual exam findings (past year) and newborn screening, specifically phenylketonuria (PKU) and hypothyroidism. Subsequent steps address the following issues respectively: routine hearing and vision screening;

sleep apnea; parental assessment; assessment of the home environment; review of growth/development milestones; and final assessment.

The evidence-based ADHD algorithm uses the following diagnostic tools: Pediatric Symptom Checklist (PSC) developed by Jellinek et al. (1988); Ages and Stages Questionnaire (ASD) developed by Squires et al. (2009); Denver scales (Frankenburg, 1992); Modified Checklist for Autism in Toddlers (M-CHAT) developed by Robins, Fein, Barton, and Green (2001); the Vanderbilt Form (Brown et al., 2001); and the DSM-V criteria (American Psychiatric Association, 2013). Finally, the algorithm recommends that children with a positive ADHD diagnosis be referred for behavior therapy before considering pharmacological interventions.

The algorithm implementation process was as follows: first, the co-investigator met with each of the selected healthcare providers for approximately 30 minutes to discuss the background and objectives of the project. The individual meetings allowed the care providers to ask questions and seek clarification on any component of the algorithm. The second step entailed the administration of the pre-survey to identify gaps in healthcare providers' knowledge and facilitate the development of an educational intervention. The third step involved a ten-minute follow-up meeting with each healthcare provider following the completion and submission of the pretest survey. The aim of the follow-up meeting was to address emerging questions and concerns regarding the new protocol, as well as its application in clinical practice.

The fourth step was the actual implementation, whereby copies of the pocket size laminated ADHD algorithm was placed in a predetermined standardized location in each exam room where the care providers could easily access them. The providers were required to use the new ADHD algorithm when assessing children (age 3-5 years) who presented to the clinic with

parental behavioral concerns or ADHD-related symptoms (i.e., inattentiveness, impulsiveness, and hyperactivity).

The final step of implementation of the algorithm into this pediatric clinic encompassed monitoring and evaluation of the project. The co-investigator made at least one clinic visit per week to monitor progress, motivate healthcare providers, and address any emerging questions/concerns. Evaluation data was collected eight weeks after implementation using two instruments: posttest surveys and chart audits. The posttest survey was used to determine the extent to which the educational intervention had improved care providers' knowledge and perceptions regarding the integration of evidence in ADHD diagnosis among preschoolers. Second, an initial chart audit was conducted to determine the number of preschoolers (age 3-5 years) who received an ADHD diagnosis based on predetermined ICD-10 codes, which were made by the healthcare providers. A second electronic chart audit was conducted two months post implementation.

Outcomes Measured and Instruments

The evaluation process focused on determining the outcomes of the project based on findings from both the electronic chart audit and pre/post surveys. Electronic medical record audits and pre/post-surveys were the main instruments used to measure the outcomes of the project. The first outcome evaluated ADHD diagnosis before and after the implementation of the evidence-based ADHD algorithm. Chart audits were used to measure this outcome. The pre-implementation audit was conducted three days before algorithm implementation while the second one was performed eight weeks after implementation. A feedback system was embedded in the chart audits to measure the level of adherence to the guidelines outlined in the evidence-based ADHD algorithm. The second outcome was providers' knowledge and attitudes regarding

the evidence-based ADHD algorithm, which was measured by comparing pre-survey findings to those generated from the post-survey. The Principal Investigator developed the survey using experts in the field.

Validity and Reliability of Instruments

The primary data collection instruments were retrospective chart audits and pre/posttest survey. Chart audits are useful in gathering objective data about the performance of healthcare providers. Content validity of the chart audits was maintained by selecting criteria that would identify valid indicators within the patients' records. The co-investigator and data analytic team developed criteria that was used as a checklist when conducting the chart audits. The first criterion was ADHD diagnosis among preschoolers (age 3-5 years) based on sixteen predetermined ICD-10 diagnostic codes. The second criterion was an eligibility criterion for the predetermined ICD-10 codes data capture. The eligibility criterion included children aged between three and five years who presented to the pediatric clinic with chief complaints of ADHD-related symptoms (i.e., hyperactivity, inattentiveness, and impulsiveness, behavioral concerns).

Two approaches were used to increase the validity and reliability of the pre/posttest surveys. First, the author and the author's mentor reviewed the questions to determine the degree to which the instrument would fully assess healthcare providers' knowledge and perceptions. This process focused primarily on the clarity, readability, and comprehensiveness of the selected question. The draft survey had twelve questions, which were reduced to eight after reviewing them for readability, clarity, and comprehensiveness. Second, the author pretested the questions on a random sample of two healthcare providers. The purpose of pretesting was to assess the

appropriateness of the selected questions. Pretesting results improved the wording of questions and improved levels of understanding.

Data Collection and Analysis

Data was collected using electronic chart audits and pre- and post-test surveys. The EMR chart audit was completed to determine the number of preschoolers diagnosed with ADHD pre- and post-implementation. The first audit was conducted prior to implementation of the algorithm and the second audit was completed after the project was implemented. The pre-test survey was administered to the participants prior to the individual educational session regarding the use of the ADHD algorithm and a post survey was administered two months post implementation of the algorithm. Within five days of administration, participants were required to return both surveys in a sealed envelope utilizing a four digit number identification of their choice. The surveys were placed in an anonymous location to protect the identity of the participants. Additionally, the surveys neither requested nor contained any identifiable provider data or demographics. Quantitative data from both the survey and audits was entered in an MS Spreadsheet for cleaning, validation, and verification. The data was then transferred to SPSS® (version 22) for analysis. Descriptive statistics were presented as percentages. The Wilcoxon signed-rank test and Z-scores were used to measure changes in scores between pre and post implementation.

Results

Quantitative Findings

The rate of ADHD diagnosis reduced significantly from 78.6% pre-audit to 22.6% post-audit. The five healthcare providers that participated in the project examined 241 preschool patients during the pre-implementation period. Of these, 28 had ADHD-related symptoms, and 22 of them were diagnosed with ADHD. Four (18%) were three-year-olds; five (23%) were four-

year-olds, and 13 (59%) were five-year-olds. Comparatively, the healthcare providers evaluated 247 preschool patients during the post-audit period. Thirty-one of them had ADHD-related symptoms, and seven were diagnosed with ADHD. Of the seven, two (29%) were four-year-olds and five (71%) were five-year-olds. No three-year old patients diagnosed with ADHD during the post audit whereas the number of four-and five-year-olds who were diagnosed with ADHD decreased substantially, 60% and 61.54%, respectively. Table 1 illustrates comparative descriptive statistics between pre-audit and post-audit findings. Another project outcome was providers' knowledge and attitudes toward the evidence-based ADHD algorithm. The providers completed an eight-item pre-test and post-test survey to assess their knowledge and attitude regarding the diagnosis of ADHD in preschoolers. The findings of both the Wilcoxon signed-rank test and the Z-test scores revealed perfect agreement in three items (1, 6, and 7), statistically insignificant changes in four items (2, 3, 4, and 8), and statistically significant changes in one item (item five). Tables 2 and 3 detail item descriptions and a summary of the results of the Wilcoxon signed-ranks test and the Z-scores for the eight items of the pre-and-post survey.

Four of the knowledge and attitude survey items reflected changes in the level of agreement of the participant providers, but did not reach statistical significance. This finding was expected due the small sample size (i.e., five providers participated in the surveys). Despite this limitation, the observed changes demonstrated clinical significance. For instance, detailed medical examination and a thorough patient and family history are central to attaining an ADHD diagnosis. These aspects of patient assessment had the highest level of agreement among all providers prior to the introduction of the algorithm. However, two of the providers showed a lower level of agreement after eight weeks post-implementation ($Z = -1.424, p = 0.157$).

Statistically significant changes were observed in item five ($Z=-2.000$, $p=0.046$), which queried the healthcare providers about the use of ASQ, Denver, MCHAT and other validated tools to rule out other disorders. The five providers strongly agreed that ruling out other disorders that mimic ADHD enhances the accuracy of diagnosis through the evaluation of social, emotional and developmental milestones and age-appropriate growth. The healthcare providers were using ASQ, Denver, MCHAT and other validated tools to diagnose ADHD in preschoolers. After the implementation of the ADHD algorithm, providers could rule out disorders that mimic ADHD in pre-school children. A significant change was observed in the accuracy of ADHD diagnosis facilitated by the algorithm ($Z = -2.000$, $p = 0.046$).

Qualitative Findings

The second outcome measured the extent to which the evidence-based ADHD algorithm supported the incorporation of the research evidence into arriving at an ADHD diagnosis. Four themes emerged from the qualitative analysis of findings from the post-survey. Healthcare providers indicated that the evidence-based ADHD algorithm helped them to optimize clinical examination time during the diagnostic process. Second, the care providers were increasingly using the new ADHD protocol in preschoolers because it was more feasible and practical than they perceived before. Third, the healthcare providers indicated that the evidence-based ADHD algorithm clarified considerations in ADHD diagnosis among preschoolers, as well as the use of behavioral therapy and completion of previous ADHD diagnostics.

Finally, the evidence-based algorithm simplified the diagnostic process (especially for novice providers) because it integrated research evidence for addressing differential diagnoses. These qualitative findings are a clear indication that the evidence-based algorithm improved the incorporation of evidence-based care in clinical practice. One care provider noted that the new

algorithm “Clarified considerations in ADHD diagnosis among preschoolers; use of behavioral therapy and completion of previous ADHD diagnostics”. Another healthcare provider reported that the evidence-based ADHD algorithm was “More helpful than earlier perceived”.

Discussion

The purpose of this project was to standardize the diagnosis of ADHD among preschoolers using an evidence-based ADHD algorithm. The findings have shown that the evidence-based ADHD algorithm significantly reduced the number of preschoolers (age 3-5 years) that were diagnosed with ADHD post-implementation of the practice change. Notably, no three-year-old child was diagnosed with ADHD post-audit compared to 18% during the pre-audit period. Importantly, this algorithm standardized the diagnostic process by incorporating evidence into clinical practice. Findings from multiple studies have underscored the importance of standardizing tools for diagnosing ADHD in preschoolers (Arnett et al., 2013, Feldman & Reiff, 2014; Ford-Jones, 2015; French, 2015, Wolraich et al., 2011). Previous research has shown that the use of DSM-V diagnostic criteria alone can be problematic because most presenting symptoms among 3-5-year-olds are typical rather than ADHD-related (Feldman & Reiff, 2014; Hamed et al., 2015). According to Elder (2010), the diagnostic process should follow a systematic approach rather than reliance on broad classifications.

Another issue that emerged from the analytical results is the importance of healthcare providers considering broad differential diagnoses when diagnosing ADHD in preschoolers. In particular, the Wilcoxon signed-ranks test and the Z-scores revealed statistically significant results regarding the use of age appropriate growth and developmental milestones assessment tools. All of the providers strongly agreed that ruling out other disorders that mimic ADHD are instrumental in the accuracy of ADHD diagnosis. Findings from other studies have also

underscored the need of considering the etiologies of ADHD to make the correct diagnosis in preschoolers (Coghill & Seth, 2015; Feldman & Reiff, 2014; French, 2015, Visser et al., 2014). Notably, Hamed et al. (2015) have found that ADHD has a broad differential diagnoses in preschoolers considering that inattentiveness, impulsiveness, and hyperactivity are common in preschoolers. Similarly, Arnett et al. (2013) have noted that the absence of a standard diagnostic/assessment tool for preschoolers hinders correct diagnosis because of the underlying etiologies.

Strengths and Limitations

Findings from this project should be interpreted with caution because the purposive sample included five healthcare providers. A small and unrepresentative sample will affect the generalizability of these findings. Second, the project was implemented at a single pediatric care clinic, which also affects the generalizability of the findings. Third, the data collection methods (especially the newly created survey) may decrease the validity of the findings. Despite these limitations, these findings support the need of adopting a standardized protocol for diagnosing ADHD in preschoolers. These findings incorporate best evidence concerning the diagnosis of ADHD in preschool age children into a transformative practice change in a pediatric clinical setting.

Implications for Future Practice

These findings have a number of implications for future practice. Pediatric care clinics should consider the increasing incidence of ADHD diagnosis in preschoolers as an indication of the need for a quality improvement (QI) initiative (Hamed et al. 2015). It is necessary to monitor practice change initiatives to improve the accuracy of ADHD diagnosis in preschoolers on a continual basis to increase the ongoing integration of the best available evidence in clinical

practice. Stakeholder engagement is central to successful implementation of change initiatives (Engvall et al., 2014). This goal can be achieved by incorporating change management models in the implementation process. The IOWA model is one of widely used frameworks that promote broader engagement of stakeholders in planning and decision-making processes. The project also incorporated the Roger's Diffusion of Innovation Theory to facilitate the seamless implementation of the proposed changes. This theory supported the adoption of a collaborative approach to the planning, implementation, and evaluation processes.

The Iowa Model and the Roger's Diffusion of Innovation Theory emphasized greater stakeholder engagement in the decision-making processes. Thus, both models facilitated the adoption of an advanced practice nurse (APN) driven protocol. This protocol empowered APNs to assume an active role in planning and decision-making processes. According to Engvall et al. (2014), nurse-driven protocols inform the decision-making of advanced practice nurses and empower them to integrate evidence in clinical practice. Importantly, this project demonstrates that an advanced practice nurse-driven protocol encouraged healthcare providers to become change champions. Change champions are necessary to oversee the successful implementation of change. Change is a complex and protracted process in clinical practice, especially in military practice considering the top-down (autocratic) approach to decision-making. The identification of change champions minimized the risk of resistance to change and ensured that the project maintained its focus.

The greatest lesson learned from this project is the importance of involving all stakeholders in the design, implementation, and evaluation of clinical improvement projects. The second lesson is the need for baseline assessment, which entails a review of the existing clinical practices and protocols to identify their strengths and limitations. Baseline information also

identifies facilitators and barriers to effective implementation of change. Thus, these lessons would be valuable when engaging the next group of healthcare providers. First, the providers would participate actively in formulating SMART goals to ensure buy-in and ownership of the project. Second, information from baseline assessment would be critical in redesigning and improving the existing clinical practices and guidelines.

Conclusion

The increasing incidence of ADHD misdiagnosis among children (particularly preschoolers) brings to question the clinical effectiveness of current diagnostic procedures and tools. The elemental concern is that misdiagnosis increases oversubscription of medications, which exposes preschool children to the risk of increased adverse health outcomes and may delay correct diagnoses of other developmental or health issues. The current diagnostic guidelines and protocols are not applicable to preschoolers because they require subjective assessments from two settings (school/daycare center and home). Most preschoolers are excluded from utilizing these diagnostic criteria because they are too young to enroll in school. It was important to develop a standardized ADHD protocol that specifically targeted preschoolers between three and five years of age. The current project achieved this goal by designing and implementing an evidence-based ADHD algorithm to standardize the diagnostic process in one outpatient military pediatric clinic. The implementation of the new protocol was critical to address ADHD misdiagnosis in preschoolers.

Findings from previous research and this project have shown that standardized protocols reduce the likelihood of misdiagnosis of ADHD in preschoolers. In particular, the evidence-based ADHD algorithm for preschoolers provided a systematic approach to diagnosis by considering differential diagnoses of ADHD symptomology in preschoolers. ADHD has

emerged as one of the most diagnosed conditions in children. This project has generated valuable lessons that will support the incorporation of this new algorithm in other military pediatric settings. Standardized processes enhance the integration of evidence in clinical practice, which improves the quality and safety of care.

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Appendix

Table 1. *Comparative Patient Statistics for the Pre- and Post-Implementation Period*

	Pre-Audit Period	Post-Audit Period	Difference ^b (% Change)
Total of preschool age patients ^a	241	247	- 6 (2.43%)
Total of preschool aged children with behavioral and school issues	28	31	3 (9.68%)
Those with ADHD diagnosis ^c	22	7	-15 (31.82%)
Three-year-olds	4 (18%)	0 (0%)	4 (100.00%)
Four-year-olds	5 (23%)	2 (29%)	3 (60.00%)
Five-year-olds	13 (59%)	5 (71%)	8 (61.54%)

^a Those attended to by anyone of the five providers who participated in the study

^b Difference is computed by subtracting the relevant statistics from the pre-audit period. A negative difference indicates that the recorded frequency is lower in the pre-audit period. % Change is computed based on the larger frequency regardless of the period.

^c The percentage shown in the frequency of the preschool aged patients below were computed from the total frequency of those diagnosed with ADHD.

Table 2. *Wilcoxon Signed Ranks Test: ADHD Algorithm Pre-and-Post Implementation Survey*

Survey Items	Negative Ranks	Positive Ranks	Mean Ranks *	Sum of Ranks *	Ties
1. ADHD-related symptoms in preschoolers has broad differentials that can influence the diagnosis process in preschoolers (Pre1) vs. A number of differential diagnoses should be considered when evaluating preschoolers for ADHD-related symptoms (Post1).	0	0	0.00	0.00	5
			0.00	0.00	
2. A detailed medical examination and history determines the underlying cause of the ADHD-related symptoms in preschoolers	2	0	1.50	3.00	3
			0.00	0.00	
3. Providers should review a preschool age child’s family history when diagnosing ADHD (Pre3) vs. The review of a preschool-aged child’s family history identifies the presence of psychiatric, behavioral, and neurodevelopmental disorders (Post3)	2	0	1.50	3.00	3
			0.00	0.00	
4. Reviewing newborn screening results are instrumental in the diagnosis of ADHD among preschoolers (Pre4) vs. Providers should confirm the results of the child’s newborn screen to determine the presence of phenylketonuria and hypothyroidism (Post4).	0	2	0.00	0.00	3
			1.50	3.00	
5. Completing ASQ, Denver, MCHAT and other validated tools can rule out disorders that mimic ADHD in preschool-aged children. (Pre5) vs. Attainment of age appropriate growth and developmental milestones can rule out disorders that mimic ADHD in preschool-aged children (Post5).	0	4	0.00	0.00	1
			2.50	10.00	
6. Providers should evaluate children for sleep disorders (particularly sleep apnea) during the diagnostic process when a child presents with ADHD-related symptoms (Pre6) vs. Sleep disorders (sleep apnea) impair daytime functioning, which may manifest as ADHD-related symptoms (Post6).	0	0	0.00	0.00	5
			0.00	0.00	
7. An assessment of a child’s home structure provides valuable insights during the diagnostic process when a child presents with ADHD-related symptoms (Pre7) vs. Home	0	0	0.00	0.00	5
			0.00	0.00	

structures influence children’s behavior patterns (sleep, diet, exercise, and discipline(Post7).					
8. Effective diagnosis of ADHD in the preschool aged child requires input from a multidisciplinary team (Pre8) vs. Multidisciplinary teams are necessary to provide holistic and comprehensive assessment of the preschool age child who presents with ADHD-like symptoms (Post8).	2	1	2.25	4.50	2
			1.50	1.50	

*The mean ranks and the sum of ranks of the negative ranks are indicated above, whereas those for the positive ranks are indicated below.

Table 3. *Wilcoxon Signed Ranks Test Statistics*

Survey Items**	Z-scores	Asymptotic Sig. (2-tailed) [or p-value]	Statistical Interpretation
1. Pre1 vs. Post1	0.000	1.000	Perfect agreement. No change in pre-and-post implementation responses.
2. Pre2 vs. Post2	-1.424	0.157	Changes observed, but not statistically significant.
3. Pre3 vs. Post3	-1.414	0.157	Changes observed, but not statistically significant.
4. Pre4 vs. Post4	-1.342	0.180	Changes observed, but not statistically significant.
5. Pre5 vs. Post5	-2.000	0.046***	Significant change observed
6. Pre6 vs. Post6	0.000	1.000	Perfect agreement. No change in pre-and-post implementation responses.
7. Pre7 vs. Post7	0.000	1.000	Perfect agreement. No change in pre-and-post implementation responses.
8. Pre8 vs. Post8	-0.816	0.414	Changes observed, but not statistically significant.

** The survey items are shown in their complete form in the first column of Table 1. Only their short labels are displayed in this table to save space.

*** Statistically significant at the 0.05 level.