NEBA

(Neuropsychiatric EEG-Based ADHD Assessment Aid)

neba
H E A L T H

Robert Pollard
Chairman of Board

Howard Merry, JD
President

Steven M. Snyder, PhD
Vice President of R&D

Contact:
(706)736-5864
hmerry@nebahealth.net

About neba
H E A L T H

- Georgia headquartered

- > 85% owned by Georgians

- Research facility in Boulder, Colorado

- ISO 13485 medical device manufacturer

- Worked with FDA to create special controls for new device category (brainwave-based biomarkers)

- First to develop an FDA-cleared, brainwave-based biomarker for aiding ADHD assessment (NEBA)

Overview

We are requesting :

* NEBA coverage by Georgia Department of Community Health (DCH)

* Access to DCH expertise and partnership opportunities for ongoing cost savings research

Overview

In support of our requests, we will address:

- Clinical Utility
  - NEBA offers unique and powerful information to support a clinician's ADHD evaluation.

- Research Evidence
  - NEBA helps to reduce misdiagnoses.

- Cost Savings
  - Reducing misdiagnoses improves healthcare and reduces cost.

Clinical Utility

FDA cleared NEBA to help clinicians answer:

Are these symptoms caused by ADHD,

**or are they better explained by another condition?**

Clinical Utility

"The NEBA System along with other clinical information may help health care providers more accurately determine if ADHD is the cause of a behavioral problem."

 — FDA, Center for Device and Radiological Health

Clinical Utility

To use NEBA:

1)   Clinicians conduct their regular ADHD evaluation.

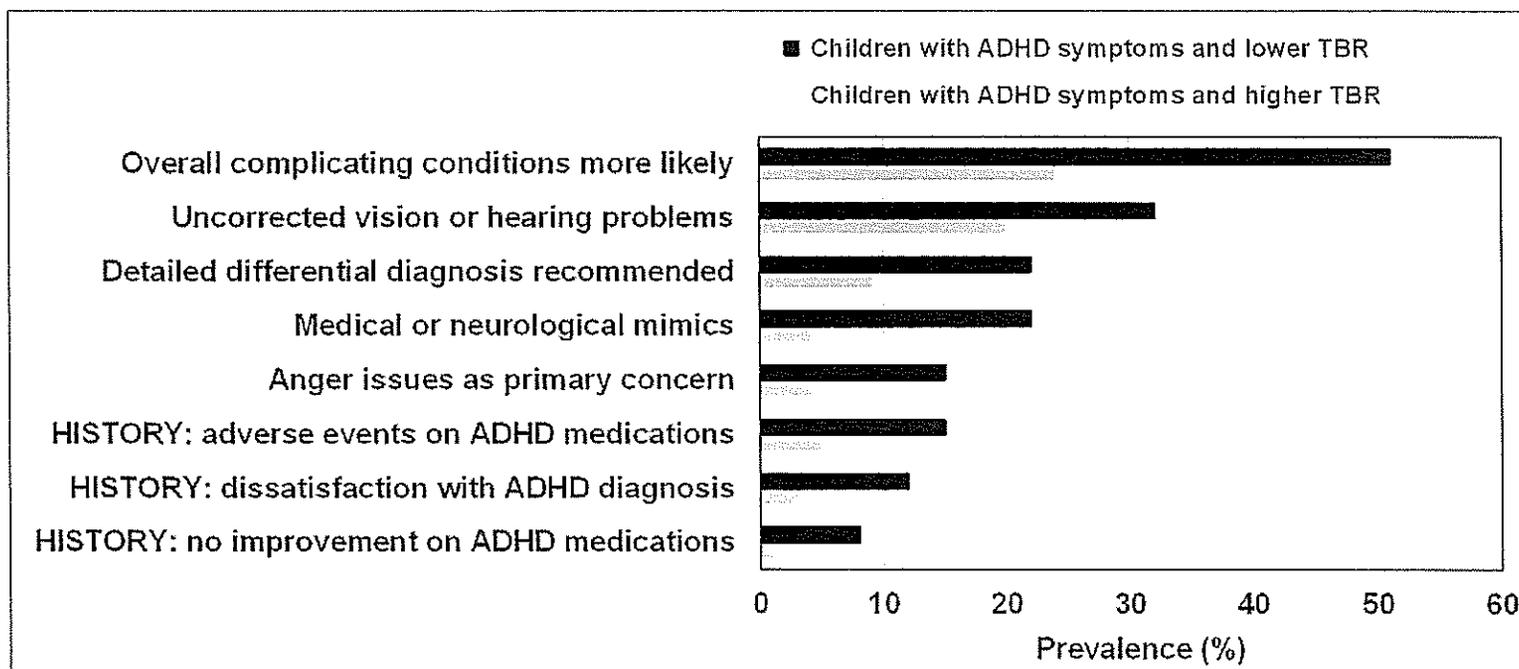2)   Clinicians collect EEG in a simple, 20-minute procedure.
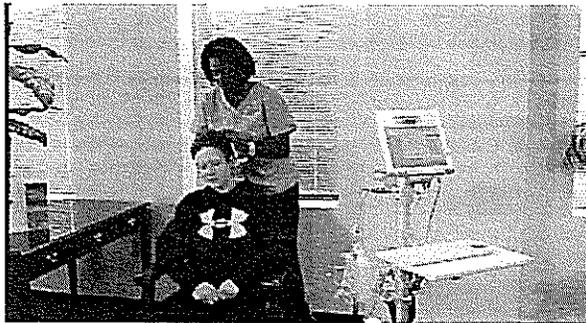
3)   NEBA analyzes EEG to determine theta/beta ratio (TBR).

4)   NEBA applies TBR to provide additional information to the clinician's ADHD evaluation.

How can TBR provide additional info?

Research Evidence[1-3]

Children with ADHD symptoms <u>and</u> lower TBR
are more likely to have other conditions that *could impact an ADHD evaluation.*

■ Children with ADHD symptoms and lower TBR
Children with ADHD symptoms and higher TBR

Overall complicating conditions more likely
Uncorrected vision or hearing problems
Detailed differential diagnosis recommended
Medical or neurological mimics
Anger issues as primary concern
HISTORY: adverse events on ADHD medications
HISTORY: dissatisfaction with ADHD diagnosis
HISTORY: no improvement on ADHD medications

0   10   20   30   40   50   60

Prevalence (%)

Clinical Utility

NEBA provides recommendations directly related to these outcomes.

1) Children with ADHD symptoms <u>and lower TBR</u>
   are *more likely* to have complicating conditions.

   ➤ NEBA recommends considering other conditions before proceeding.

2) Children with ADHD symptoms <u>and higher TBR</u>
   are *less likely* to have complicating conditions.

   ➤ NEBA provides confirmatory support for ADHD.

*What is the diagnostic accuracy?*

Research Evidence[1-3]

1) NEBA recommends considering other conditions before proceeding.

   ➢ NEGATIVE PREDICTIVE VALUE: 85%

2) NEBA provides confirmatory support for ADHD.

   ➢ POSITIVE PREDICTIVE VALUE: 92%

✕ _FDA study design:_ _Investigators conducted a prospective, triple-blinded, 13-site, clinical cohort study. Comprehensive clinical evaluation data were obtained from 275 children and adolescents presenting with attentional and behavioral concerns. A qualified clinician at each site performed differential diagnosis. EEG was collected by separate teams. The reference standard was consensus diagnosis by an independent, multidisciplinary team (psychiatrist, psychologist, and neurodevelopmental pediatrician), which is well-suited to determine if ADHD symptoms are due to another condition._

Research Evidence[1-3]

A scatter-plot further shows that NEBA can accurately separate patients into subgroups with helpful information.
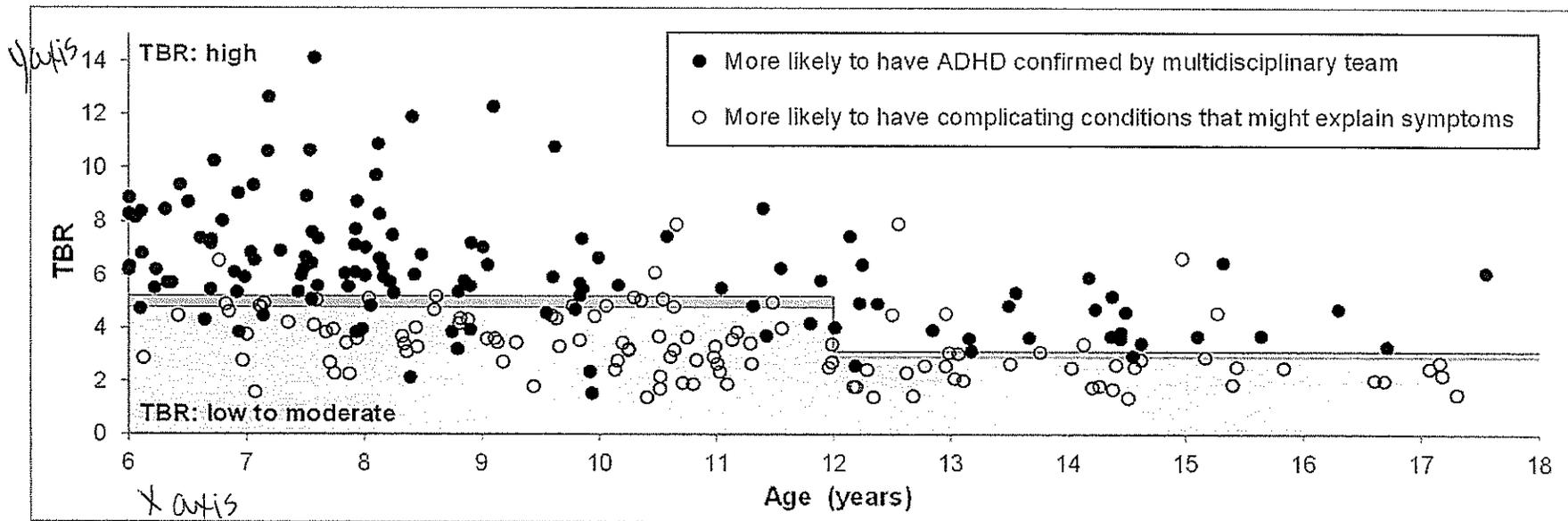
Clinical Utility

In summary:

• NEBA accurately provides confirmatory support for ADHD presence.

• NEBA accurately identifies children who have ADHD symptoms that may be better explained by another condition.

This additional information helps the clinician to determine whether symptoms are due to ADHD or another condition.

Can this help to improve a clinician's accuracy?

Research Evidence[1-3]

TABLE 1. With a multidisciplinary team as the reference standard, analysis shows that a clinician integrating NEBA would improve accuracy from 61% to 88%.

	Clinician	n	Clinician + NEBA	n
Specificity, % (95% CI)	36 (29-44)	145	94 (89-97)	145
Sensitivity, % (95% CI)	89 (83-93)	130	82 (74-87)	130
Positive Predictive Value*, % (95% CI)	56 (49-62)	209	92 (86-96)	115
Negative Predictive Value*, % (95% CI)	79 (67-87)	66	85 (79-90)	160
Overall Accuracy, % (95% CI)	61 (55-67)	275	88 (84-91)	275

How does this help to reduce overdiagnosis?

Research Evidence[1-3]

1) Traditional ADHD evaluation can lead to overdiagnosis in 34% of children with attentional and behavioral concerns.

2) Addition of NEBA can reduce overdiagnosis from 34% to 3%.

FDA study results:

- *Of 209 patients meeting ADHD criteria per a site clinician's judgment, 93 were found by a separate, independent multidisciplinary team to be less likely to meet criterion E (requirement that symptoms are not better explained by another condition), implying possible overdiagnosis by clinicians in 34% of the total clinical sample (93/275).*

- *Of those 93, 91% were also identified by NEBA, showing a relatively lower TBR (85/93), supporting the potential to reduce overdiagnosis from 34% to 3% of the total clinical sample (8/275).*
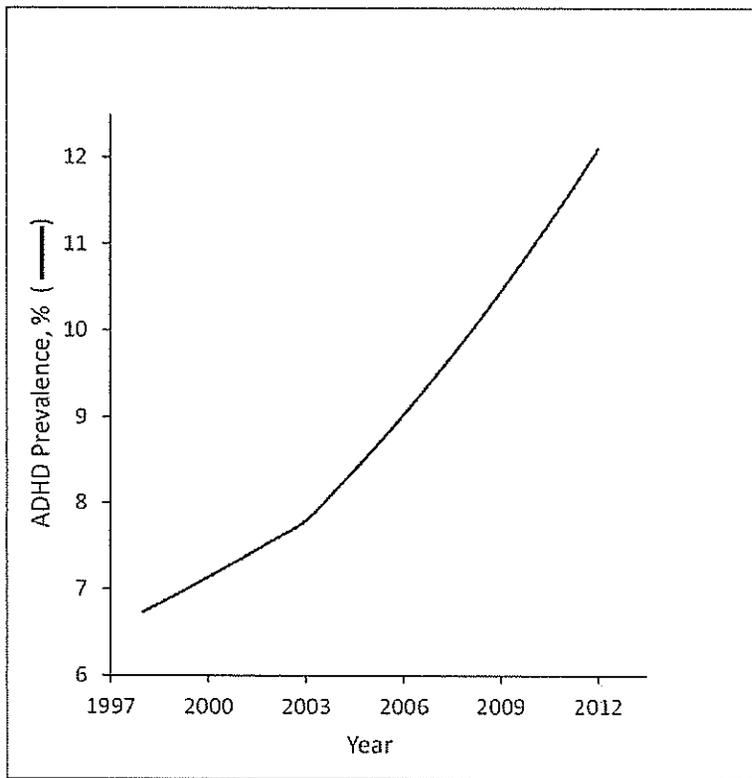
How does NEBA apply to the big picture?

The Big Picture

ADHD prevalence has been rapidly increasing.

Research Evidence
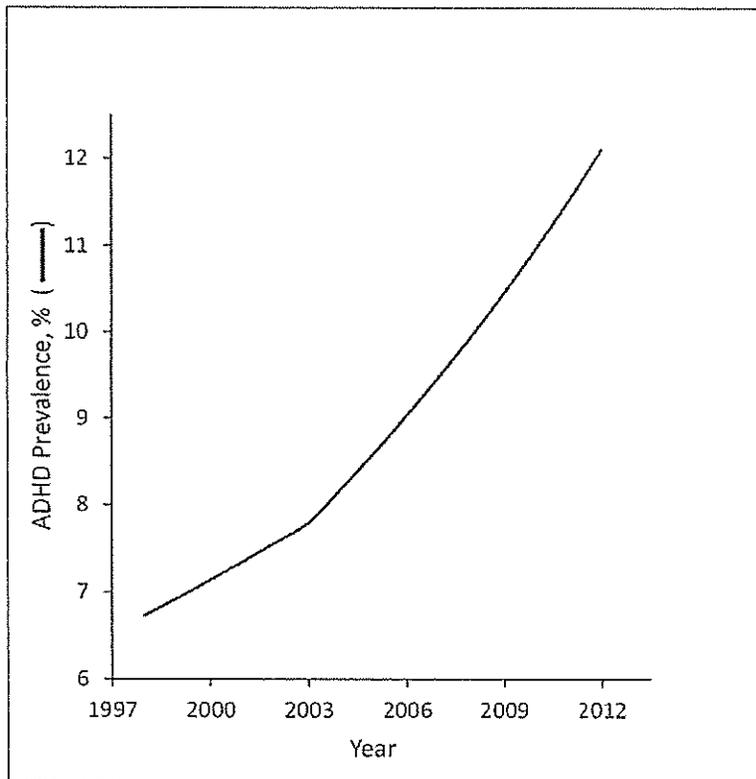
ADHD prevalence has been rapidly increasing.

Prevalence results are from CDC-reported values,
with extrapolation per CDC-reported rates.

- *Visser, et al. J Am Acad Child Adolesc Psychiatry. 53: 34-46 e2. 2014*
- *CDC. Attention-Deficit / Hyperactivity Disorder (ADHD) Data & Statistics. http://www.cdc.gov/ncbddd/adhd/data.html, 2014.*
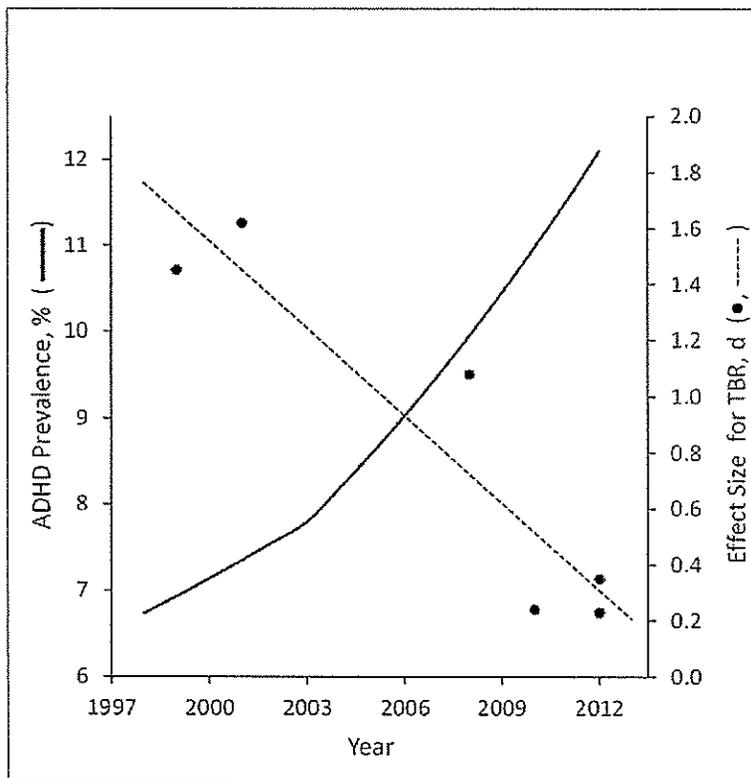
Research Evidence

ADHD prevalence has been rapidly increasing.

If the prevalence increase is partly due to clinical overdiagnosis, then we would expect to see a decrease in the effect size for a biomarker (TBR) associated with ADHD. (*in different studies over time*)

Research Evidence[1-3]
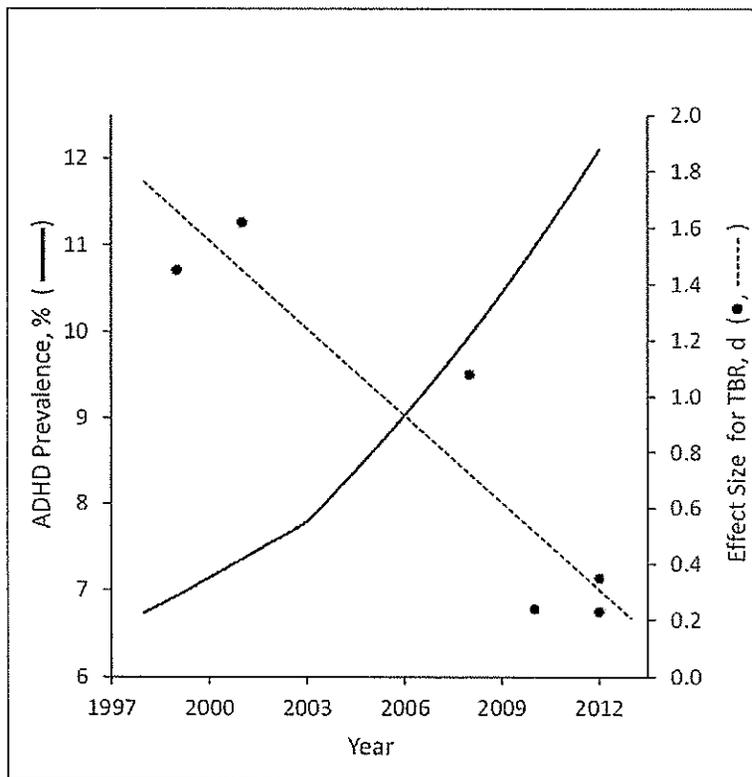
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A decrease in effect size is seen, supporting that there is clinical overdiagnosis.

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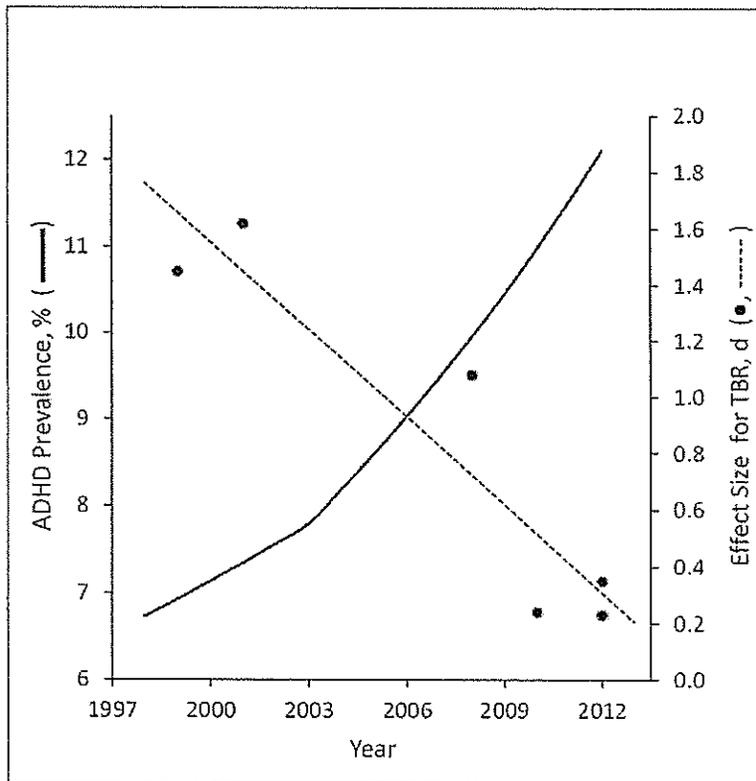
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The decrease in effect size strongly correlates with the increase in ADHD prevalence. ($R^2 = 0.89$)

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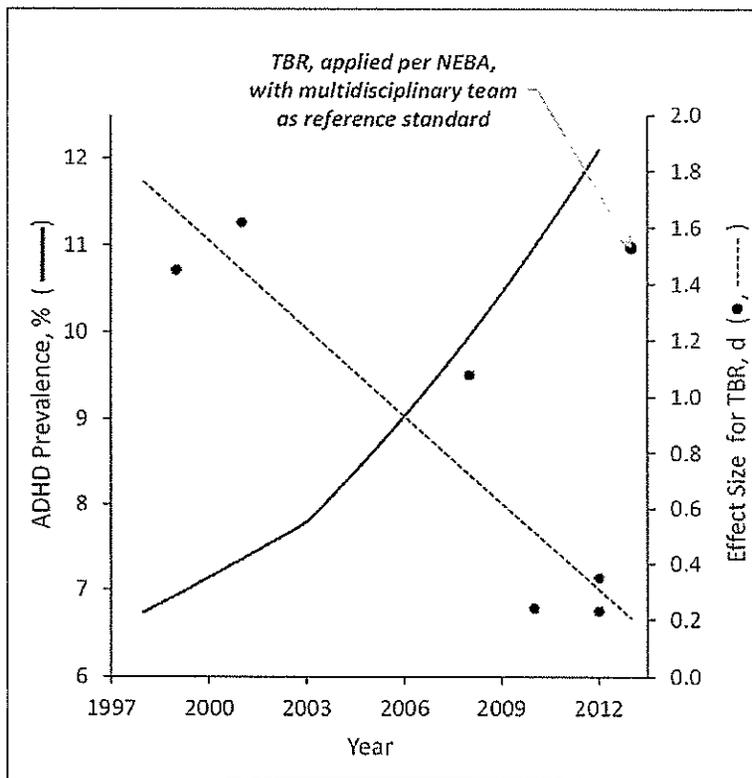The decrease in effect size strongly correlates with the increase in ADHD prevalence. ($R^2 = 0.89$)

If the prevalence increase is partly due to overdiagnosis, then we would expect to see that a stronger reference standard (multidisciplinary team) would improve TBR effect size.

A multidisciplinary team is well-suited to address overdiagnosis.

NEBA also integrates TBR in a manner that addresses overdiagnosis.

Research Evidence[1-3]

ADHD prevalence has been rapidly increasing.

TBR, applied per NEBA,
with multidisciplinary team
as reference standard

ADHD Prevalence, % (——)

Effect Size for TBR, d (•, ----)

Year

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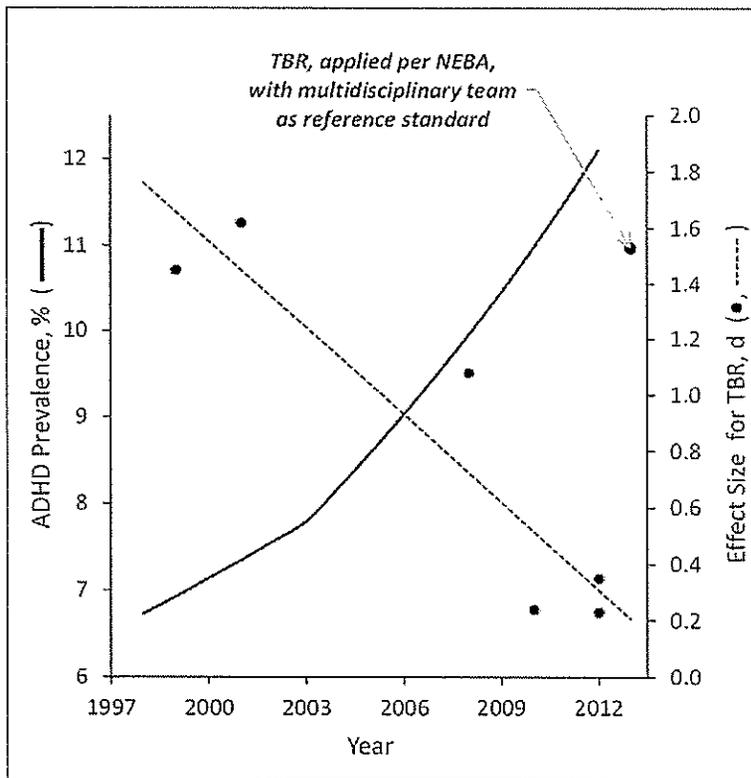
A multidisciplinary team is well-suited to address overdiagnosis.

NEBA also integrates TBR in a manner that addresses overdiagnosis.

A return to a stronger effect size is seen, supporting further that there is clinical overdiagnosis.

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>
> NEBA also integrates TBR in a manner that addresses overdiagnosis.

A return to a stronger effect size is seen, supporting further that there is clinical overdiagnosis.

The implication is that overdiagnosis can be addressed by:

1) **A multidisciplinary team, or**

2) **NEBA integration of TBR.**

Research Evidence

Key References

1) Snyder, SM, et al. Integration of an EEG biomarker with a clinician's ADHD evaluation. *Brain and Behavior.* 5(4), April 2015.

2) Snyder, SM. Systems and methods to identify a subgroup of ADHD at higher risk for complicating conditions. US Patent 8,509,884, August 13, 2013.

3) FDA. De novo classification request for neuropsychiatric EEG-based assessment aid for ADHD (NEBA) system. K112711, July 15, 2013.

Cost Savings

Reducing misdiagnoses improves healthcare and reduces cost.

Cost savings

NEBA won:

- National Institute of Health / Health and Human Services
  Qualifying Therapeutic Discovery Project Grant
  PA-11-133, October 29, 2010.

  ➤ One basis of the award was NEBA's potential to reduce excess costs
  associated with ADHD overdiagnosis.

Cost Savings

There is much evidence that ADHD is overdiagnosed.

- We have shown:
    - The CDC-reported rapid increase in ADHD prevalence may be partly due to clinical overdiagnosis.[1]
    - ADHD may be overdiagnosed in as many as 34% of cases.[1]

- Others have shown that ADHD is overdiagnosed in:
    - 38% of depression cases[2]
    - 29% of bipolar disorder cases[2]
    - 14% of anxiety cases[3]

- Others have also shown that ADHD misdiagnosis can be due to:
    - a child being relatively young for his/her school grade
        - which could account for 20% of ADHD cases[4,5]

[1]Snyder, et al. 2015
[2]Chilakamarri, et al., 2011
[3]Bruchmuller, et al., 2012
[4]Elder, 2010
[5]Morrow et al., 2012

Cost Savings

Therefore, our cost savings premise is based on reducing overdiagnosis.

- Overdiagnosis results in excess costs, due to:
  - Payment for ADHD treatment and management when ADHD is not present.

- NEBA can reduce overdiagnosis and thereby reduce costs.
  - NEBA can reduce costs by accurately identifying children who have ADHD symptoms that may be better explained by another condition.
  - NEBA may help to significantly reduce ADHD costs in Georgia.

What costs reported by DCH may be reduced by NEBA?

Cost Savings

Table 2. According to values reported by DCH, costs for a member with an ADHD diagnosis are significantly greater.

Member has ADHD diagnosis?	Number of members[1]	Total costs	Per annum member costs
yes	73,269	$156,425,900[2]	$2,135
no	818,936	$434,892,120	$531
		Extra costs for a member with an ADHD diagnosis =	**$1604**

[1]Georgia DCH, "ADHD Diagnosed Medicaid Children 4-18 Cost Comparison CY 2009 – 2011".

[2]We presume "total costs" include "ADHD costs", "ADHD costs (other)" and medication costs.

Cost Savings

Table 3. If an ADHD misdiagnosis is identified, there would be numerous cost savings.

Cost savings	Costs (per annum)
1) Reduction of ADHD direct costs	$440[1]
2) Reduction of ADHD medication costs	$450[1,2]
3) Reduction of ADHD related costs (other)	$714[3]
Total reduction of costs for a member with ADHD misdiagnosis =	**$1604**

[1]Georgia DCH, FOI request July 2013. Direct costs are $32,257, 857. Prescription rates and annual cost estimates of top 5 medications provided by DCH: Concerta, Adderall XR, Focalin XR, Vyvanse, Generics (MPH/Amphetamine).

[2].Vestal, Christine, "Medicaid ADHD Treatment Under Scrutiny", Stateline – The Pew Charitable Trusts, October 8, 2014, http://www.pewtrusts.org/en/research-and-analysis/blogs/stateline/2014/10/08/medicaid-adhd-treatment-under-scrutiny.

[3]ADHD related costs (other) includes = ADHD member cost over baseline less direct costs, less medication costs.

Cost Savings

Georgia Department of Community Health
Office of Planning and Fiscal Analysis

Georgia Medicaid
ADHD Diagnosed Medicaid Children Ages 4-18 Cost Comparison CY2009-2011

Table 4. Considering that the rate of ADHD overdiagnosis may range from 14-38%[1-5], a proportional reduction in total ADHD costs would be significant.

ADHD Costs	Costs of 73,269 members with an ADHD diagnosis
1) ADHD Costs (not including medication)[7]	$32,257,857
2) ADHD Costs other (including medication)[8]	$124,168,043
Total ADHD Costs[6,8]	**$156,425,900**

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[1]Chilakamarri et al. Misdiagnosis of bipolar disorder in children and adolescents: a comparison with ADHD and MDD. Ann Clin Psychiatry. 23: 25-9. 2011.

[2]Bruchmuller et al. Is ADHD diagnosed in accord with diagnostic criteria? Overdiagnosis and influence of client gender on diagnosis. J Consult Clin Psychol . 80: 128-38. 2012.

[3]Elder. The importance of relative standards in ADHD diagnoses: evidence based on exact birth dates. J Health Econ. 29: 641-56. 2010.

[4]Morrow, et al. Influence of relative age on diagnosis and treatment of attention-deficit/hyperactivity disorder in children. CMAJ. 184: 755-62. 2012.

[5]Snyder, et al. Integration of an EEG biomarker with a clinician's ADHD evaluation. Brain and Behavior. 5(4). 2015

[6]Georgia DCH, "ADHD Diagnosed Medicaid Children 4-18 Cost Comparison CY 2009 – 2011".

[7]"ADHD Costs" do not include expenses related to ADHD medication. DCH Notes to FOI request, July 2013.

[8] We presume "Total ADHD Costs" include medication costs.

Cost Savings

In closing, we showed that NEBA can accurately identify children who have ADHD symptoms that may be better explained by another condition.

NEBA can reduce costs and improve healthcare by reducing ADHD misdiagnosis, which would lead to:

- Elimination of unnecessary ADHD medication from treatment plans.

- Elimination of unnecessary psychiatric services.

- Improvement of quality of life by helping clinicians to determine the correct care for children.