How the
American Academy of Pediatrics

reached the conclusion that
EEG Biofeedback, (aka Neurofeedback) is a Level 1 Evidence-Based Practice for Attention and Hyperactivity,
and other recent evidence of the efficacy of Neurofeedback for ADHD

CONTENTS

1 Executive Summary

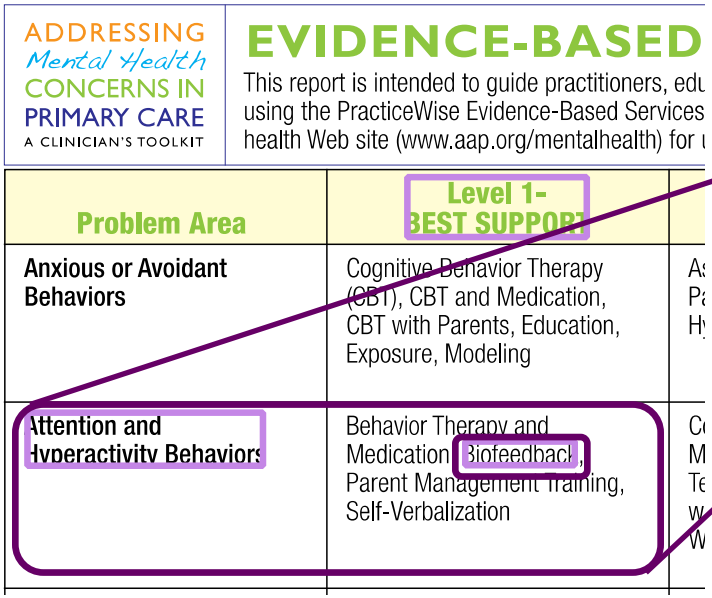
In October 2012 the American Academy of Pediatrics report on Evidence-based Child and Adolescent Pyschosocial Interventions concluded that for the Attention and Hyperactivity behavioural problems, Biofeedback was a “Level 1 Best Support’ intervention, the highest level of support.

This document includes the studies that directly led to this conclusion and also includes some additional studies, and summaries of these studies, that may be useful to health professionals, other professionals, parents and adolescents in assessing Neurofeedback as an option.

This paper was collated by BrainTrainUK.

2 AAP Report on Evidence-Based Psychosocial Interventions – October 2012

The AAP Report is reproduced below, with the Level 1 Support for Biofeedback highlighted and enlarged. The original report can be obtained here - http://pediatrics.aappublications.org/content/125/Supplement_3/S128.full.pdf+html.



ADDRESSING Mental Health CONCERNS IN PRIMARY CARE
A CLINICIAN'S TOOLKIT

EVIDENCE-BASED

This report is intended to guide practitioners, edu
using the PracticeWise Evidence-Based Services
health Web site (www.aap.org/mentalhealth) for

Problem Area	Level 1– BEST SUPPORT	
Anxious or Avoidant Behaviors	Cognitive Behavior Therapy (CBT), CBT and Medication, CBT with Parents, Education, Exposure, Modeling	As Pa Hy
Attention and Hyperactivity Behaviors	Behavior Therapy and Medication, Biofeedback, Parent Management Training, Self-Verbalization	Co M Te w W

ADDRESSING Mental Health CONCERNS IN PRIMARY CARE
A CLINICIAN'S TOOLKIT

EVIDENCE-BASED CHILD AND ADOLESCENT PSYCHOSOCIAL INTERVENTIONS

This report is intended to guide practitioners, educators, youth, and families in developing appropriate plans using psychosocial interventions. It was created for the period November 2012–April 2013 using the PracticeWise Evidence-Based Services (PWEBS) Database, available at www.practicewise.com. If this is not the most current version, please check the American Academy of Pediatrics mental health Web site (www.aap.org/mentalhealth) for updates.

Problem Area	Level 1– BEST SUPPORT	Level 2– GOOD SUPPORT	Level 3– MODERATE SUPPORT	Level 4– MINIMAL SUPPORT	Level 5– NO SUPPORT
Anxious or Avoidant Behaviors	Cognitive Behavior Therapy (CBT), CBT and Medication, CBT with Parents, Education, Exposure, Modeling	Assertiveness Training, Attention, CBT for Child and Parent, Cultural Storytelling, Family Psychoeducation, Hypnosis, Relaxation, Stress Inoculation	Contingency Management, Group Therapy	Biofeedback, CBT with Parents Only, Play Therapy, Psychodynamic Therapy, Rational Emotive Therapy	Assessment/Monitoring, Attachment Therapy, Client Centered Therapy, Eye Movement Desensitization and Reprocessing (EMDR), Peer Pairing, Psychoeducation, Relationship Counseling, Teacher Psychoeducation
Attention and Hyperactivity Behaviors	Behavior Therapy and Medication, Biofeedback, Parent Management Training, Self-Verbalization	Contingency Management, Education, Parent Management Training (with Problem Solving, or with Teacher Psychoeducation), Physical Exercise (with or without Relaxation), Social Skills and Medication, Working Memory Training	Biofeedback and Medication	Parent Management Training and Social Skills, Relaxation, Self-Verbalization and Contingency Management, Social Skills	Attention Training, Client Centered Therapy, CBT, CBT and Anger Control, CBT and Medication, Family Therapy, Parent Coping/Stress Management, Parent Management Training and Self-Verbalization, Problem Solving, Psychoeducation, Self-Control Training, Self-Verbalization and Medication, Skill Development
Autism Spectrum Disorders	Intensive Behavior Therapy, Intensive Communication Training	Parent Management Training, Peer Pairing, Physical/Social/Occupational Therapy	None	Cognitive Behavior Therapy, Massage, Social Skills	Auditory Integration Training, Biofeedback, Eclectic Therapy, Hyperbaric Treatment, Modeling, Structured Listening
Delinquency and Disruptive Behavior	Anger Control, Assertiveness Training, CBT, Multisystemic Therapy, Parent Management Training, Parent Management Training and Problem Solving, Social Skills	Communication Skills, Contingency Management, Functional Family Therapy, Parent Management Training and CBT, Parent Management Training and Classroom Management, Problem Solving, Rational Emotive Therapy, Relaxation, Therapeutic Foster Care, Transactional Analysis	Client Centered Therapy, Family Therapy, Moral Reasoning Training, Outreach Counseling, Peer Pairing, Self-Control Training	CBT and Teacher Training; Parent Management Training, Classroom Contingency Management, and CBT; Parent Management Training and Self-Verbalization; Physical Exercise; Stress Inoculation	Behavioral Family Therapy, Catharsis, CBT and Anger Control, CBT with Parents, Collaborative Problem Solving, Education, Exposure, Family Empowerment, Family Systems Therapy, Group Therapy (!!), Imagery Training, Parent Management Training and Peer Support, Play Therapy, Psychodynamic Therapy, Self-Verbalization, Skill Development, Wraparound
Depressive or Withdrawn Behaviors	CBT, CBT and Medication, CBT with Parents, Family Therapy	Client Centered Therapy, Cognitive Behavioral Psychoeducation, Expressive Writing/Journaling/Diary, Interpersonal Therapy, Relaxation	None	Problem Solving, Self-Control Training, Self-Modeling	Life Skills, Play Therapy, Psychodynamic Therapy, Psychoeducation, Social Skills
Eating Disorders	None	CBT, Family Therapy, Family Systems Therapy	None	None	Client Centered Therapy, Education, Goal Setting
Elimination Disorders	Behavior Alert; Behavior Alert and Behavioral Training; Behavioral Training; Behavioral Training, Dietary Care, and Medical Care (with or without Biofeedback)	Behavioral Training and Dietary Care; Behavioral Training, Hypnosis, and Dietary Care; CBT	Behavior Alert and Medication	None	Assessment/Monitoring, Assessment/Monitoring and Medication, Behavioral Training and Medical Care, Biofeedback, Contingency Management, Dietary Care, Dietary Care and Medical Care, Hypnosis, Medical Care, Psychoeducation
Mania	None	Cognitive Behavioral Psychoeducation	None	None	Family-Focused Therapy, Psychoeducation
Substance Use	CBT, Community Reinforcement, Family Therapy	Assertive Continuing Care, CBT and Medication, CBT with Parents, Contingency Management, Family Systems Therapy, Functional Family Therapy, Goal Setting/Monitoring, Motivational Interviewing/Engagement (with and without CBT), Multidimensional Family Therapy, Purdue Brief Family Therapy	Drug Court, Drug Court with Multisystemic Therapy and Contingency Management	Goal Setting	Behavioral Family Therapy, CBT and Functional Family Therapy, Client Centered Therapy, Drug Court and Multisystemic Therapy, Education, Family Court, Group Therapy (!), Motivational Interviewing/Engagement with CBT and Family Therapy, Multisystemic Therapy, Parent Psychoeducation, Problem Solving, Project CARE (!), Psychoeducation
Suicidality	None	Attachment Therapy, Counselors Care, Counselors Care and Support Training, Multisystemic Therapy, Social Support Team	None	None	Accelerated Hospitalization, Counselors Care and and Anger Management
Traumatic Stress	CBT, CBT with Parents	Exposure	None	EMDR, Play Therapy, Psychodrama	Client Centered Therapy, CBT and Medication, CBT with Parents Only, Interpersonal Therapy, Psychodynamic Therapy, Psychoeducation, Relaxation

Note: Level 5 refers to treatments whose tests were unsupportive or inconclusive. The symbol (!!) indicates that at least one study found negative effects on the main outcome measure. The risk of using treatments so designated should be weighed against potential benefits. This report updates and replaces the "Blue Menu" originally distributed by the Hawaii Department of Health, Child and Adolescent Mental Health Division, Evidence-Based Services Committee from 2002–2009.

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3 AAP Evidence Base and Methodology

The AAP uses the PracticeWise Evidence-Based Services (PWEBS) Database as a source. The PWEBS Database methodology is described below:-

3.1 Background

The AAP Report on Evidence Based Child and Adolescent Psychosocial Interventions is created twice each year and posted on the AAP Web page (www.aap.org/mentalhealth/), using data from the PracticeWise Evidence Based Services Database. The table is based on an ongoing review of randomized clinical psychosocial and combined treatment trials for children and adolescents with mental health needs. The contents of the table represent the treatments that best fit a patient's characteristics, based on the primary problem (rows) and the strength of evidence behind the treatments (columns). Thus, when seeking an intervention with the best empirical support for an adolescent with depression, one might select from among cognitive behavior therapy (CBT) either alone or with medication, CBT with parents included, or family therapy. Each clinical trial must have been published in a peer- reviewed scientific journal, and each study is coded by 2 independent raters, whose discrepancies are reviewed and resolved by a third expert judge. Prior to report development, the data are then subject to extensive quality analyses to identify and eliminate remaining errors, inconsistencies, or formatting problems.

3.2 Strength of Evidence Definitions

The strength of evidence classification utilizes a 5- level system that was originally adapted from the American Psychological Association Division 12 Task Force on the Promotion and Dissemination of Psychological Procedures (1995). These definitions can be seen in Table 1. Higher strength of evidence is an indicator of the reliability of the findings behind the treatment, not an index of the expected size of the effect. In other words, stronger evidence levels in this report typically reflects that a treatment approach has a larger number of studies behind it than those at a lower level, not that the level 1 treatments would necessarily have a larger effect than the level 2 treatments.

Level 1: Best Support

I. At least 2 randomized trials demonstrating efficacy in one or more of the following ways:
a. Superior to pill placebo, psychological placebo, or another treatment.
b. Equivalent to all other groups representing at least one Level 1 or Level 2 treatment in a study with adequate statistical power (30 participants per group on average) and that showed significant pre- post change in the index group as well as the group(s) being tied. Ties of treatments that have previously qualified only through ties are ineligible.

II. Experiments must be conducted with treatment manuals.

III. Effects must have been demonstrated by at least 2 different investigator teams.

Level 2: Good Support

I. Two experiments showing the treatment is (statistically significantly) superior to a waiting- list or no- treatment control group. *Manuals, specification of sample, and independent investigators are not required.* OR

II. One between group design experiment with clear specification of group, use of manuals, and demonstrating efficacy by either:
a. Superior to pill placebo, psychological placebo, or another treatment.
b. Equivalent to an established treatment (see qualifying tie definition above).

Level 3: Moderate Support
One between group design experiment with clear specification of group and treatment approach and demonstrating efficacy by either:

a. Superior to pill placebo, psychological placebo, or another treatment.
b. Equivalent to an already established treatment in experiments with adequate statistical power (30 participants per group on average).

Level 4: Minimal Support
One experiment showing the treatment is (statistically significantly) superior to a waiting- list or no- treatment control group. *Manuals, specification of sample, and independent investigators are not required*.

Level 5: No Support
The treatment has been tested in at least 1 study, but has failed to meet criteria for levels 1 through 4.

3.3 Treatment Definitions

The report uses a broad level of analysis for defining treatments, such that interventions sharing a majority of components with similar clinical strategies and theoretical underpinnings are considered to belong to a single treatment approach. For example, rather than list each cognitive behavior therapy protocol for depression on its own, the report handles these as a single group, which collectively has achieved a particular level of scientific support. This approach focuses more on “generic” as opposed to “brand name” treatment modalities, and it also is designed to reduce the more than 500 distinct treatments that would otherwise be represented on this report to a more practical level of analysis.

3.4 Problem Definition

The presenting problems represented in the table rows are coded using a checklist of 25 different problem areas (eg, anxious or avoidant behaviors, eating disorders, substance use). The problem area refers to the condition that a treatment explicitly targeted and for which clinical outcomes were measured. These problem areas are inclusive of diagnostic conditions (eg, all randomized trials targeting separation anxiety disorder are considered collectively within the Anxious or Avoidant Behaviors row), but also include the much larger number of research trials that tested treatments but did not diagnosis as a study entry criterion. For example, many studies use elevated scores on behavior or emotion checklists or problems such as arrests or suicide attempts to define participants. Mental health diagnoses are therefore nested under these broader categories.

4 AAP Studies used to Reach Conclusions

2 forms of biofeedback were assessed:

1. Electroencephalographic (EEG) Biofeedback; and
2. Electromyographic (EMG) Biofeedback (feedback on skeleton muscle electrical activity).

The studies relating to EEG Biofeedback (aka Neurofeedback) are included in this document.

The 3 studies of Neurofeedback are :-

Gevensleben, H., Holl, B., Albrecht, B., Vogel, C., Schlamp, D., et al. (2009). Is neurofeedback an efficacious treatment for ADHD?: A randomized controlled clinical trial. *Journal of Child Psychology and Psychiatry*, 50, 780–789

Levesque, J., Beauregard, M., & Mensour, B. (2006). Effect of neurofeedback training on the neural substrates of selective attention in children with attention deficit/hyperactivity disorder: A functional magnetic resonance imaging study. *Neuroscience Letters*, 394, 216–221.

Beauregard, M., & Levesque, J. (2006). Functional magnetic resonance imaging investigation of the effects of neurofeedback training on neural bases of selective attention and response inhibition in children with attention-deficit/hyperactivity disorder. *Applied Psychophysiology and Biofeedback*, 31, 3–20

5 Summary of AAP Studies and other recent studies

The following table collates some key points regarding the used by AAP and other recent studies, together with hyperlinks to the original papers, and includes:-

- a meta-study of an aggregated sample of 1,194;
- a very recent (2012) study published in BMC Psychiatry;
- studies showing that NF seemed to make changes at the biological level (measured with EEG normalization), and lasted for 2 years after the end of training;
- a further long-term study of the effects of NF.

The Summary of Findings column is included to translate the findings into relative layman's speak for communication with those not used to assessing scientific research papers.

Publication	Date	Research Reference	Summary of Research	Summary of Findings
The Journal of Child Psychology and Psychiatry	2009	Gevensleben, H., Holl, B., Albrecht, B., Vogel, C., Schlamp, D., et al. (2009). Is neurofeedback an efficacious treatment for ADHD?: A randomized controlled clinical trial. *Journal of Child Psychology and Psychiatry*, 50, 780–789	102 children aged 8 to 12 with an ADHD diagnosis were randomly assigned into two groups – one group did a course of 36 sessions of neurofeedback, the other did 36 sessions of a computerised attention skills training game 'Skillies' (control group). Outcomes were measured by comparing pre and post-training assessments using several established behavioural rating scales completed by parents and teachers.	Improvements in the neurofeedback group were superior to the control group. The ratings indicated that "neurofeedback effects are substantial and of practical importance. Our results confirm findings of previous neurofeedback studies even under strict control conditions." The researchers concluded the result "indicates clinical efficacy of neuorofeedback in children with ADHD".
Neuroscience Letters	2006	Levesque, J., Beauregard, M., & Mensour, B. (2006). Effect of neurofeedback training on the neural substrates of selective attention in children with attention deficit/hyperactivity disorder: A functional magnetic resonance imaging study. *Neuroscience Letters*, 394, 216–221.	20 children with ADHD were randomly assigned into two groups – one group did neurofeedback and one group didn't (control group). Outcomes were assessed using functional MRI (fMRI) scans before and after training whilst the child performed a 'Counting Stroop' test (a test that involves counting the number of words on the screen, e.g. if two two two two was displayed, the correct answer would be 'four').	Before the training, both groups showed abnormal functioning, with no activity in the area of the brain associated with selective attention (the ACC or anterior cingulate cortex) during the test. After receiving the training, the neurofeedback group showed "significant activation" of the ACC, together with a "significantly greater" score on the test. The control group showed no change in either respect. The researchers concluded the results "suggest that in ADHD children, neurofeedback therapy has the capacity to normalize the functioning of the ACC, the key neural substrate of selective attention".

Publication	Date	Research Reference	Summary of Research	Summary of Findings
			The scans were studied to assess activation of the anterior cingulate cortex (ACC), the part of the brain associated with selective attention, selection of an appropriate response, and the suppression of inappropriate responses.	
Applied Psychophysiology and Biofeedback	2006	Beauregard, M., & Levesque, J. (2006). Functional magnetic resonance imaging investigation of the effects of neurofeedback training on neural bases of selective attention and response inhibition in children with attention-deficit/hyperactivity disorder. *Applied Psychophysiology and Biofeedback*, 31, 3–20	The same two groups described in the above study were also subject to a test of reaction time and impulsivity whilst subject to the fMRI scan (Experiment 2). The scans were studied to access activation of areas of the brain associated with response inhibition (ACC, dorsolateral prefrontal cortex, orbitofrontal cortex, ventrolateral prefrontal cortex, striatum),	Before the training, neither group showed any significant activity in the areas of the brain observed. After the training, the neurofeedback group showed improvements in the reaction/impulsivity test, the results indicating a “significant decrease of inattention and hyperactivity” and “marked improvement in attention and behavioural inhibition”. After the training, the neurofeedback group also showed significant activity in areas of the brain that had shown no detectable activity prior to the training, specifically in areas associated with response inhibition (right ventrolateral prefrontal cortex), decision formation and monitoring (right anterior cingulate cortex), motor inhibition of inappropriate behaviours (left caudate nucleus), motor planning, initiation and timing (left thalamus), and selective attention, selection of an appropriate response, and the suppression of inappropriate behavioral responses (left substantia nigra). In the test the neurofeedback group also showed a “significant decrease of inattention and hyperactivity” and “marked improvement in attention and behavioural inhibition”. The control group showed no change in either respect. The researchers concluded the results “suggest that neurofeedback therapy has the capacity to functionally normalize the brain systems mediating selective attention and response inhibition in ADHD children”.
Clinical EEG and Neuroscience	2009	Arns, M., de Ridder, S., Strehl, U., Breteler, M., & Coenen, A. (2009). Efficacy of neurofeedback treatment in ADHD: the effects on inattention, impulsivity and hyperactivity: a meta-analysis. *Clinical EEG and neuroscience*, *40*(3), 180-189.	This is a meta-analysis (study of studies) that assesses the evidence of 15 previous studies of neurofeedback treatment for ADHD which together involved 1,194 participants. The studies were analysed to assess to what extent it can be concluded that neurofeedback is an effective treatment for ADHD symptoms.	The authors concluded “the clinical effects of neurofeedback in the treatment of ADHD can be regarded as clinically meaningful.” “We conclude that neurofeedback treatment for ADHD can be considered ‘Efficacious and Specific’ (level 5) with a high ES for inattention and impulsivity and a medium ES for hyperactivity.”

Publication	Date	Research Reference	Summary of Research	Summary of Findings
Scientific American	2004	Rothenberger, A. & Banaschewski,T. (2007), Informing the ADHD Debate, *Scientific American Special Edition*, Jun2007 Special Edition-Child Dev, Vol. 17 Issue 2, p36-41	This article describes in relative layman's terms the latest (2004) research on what causes ADHD, the genetic and environmental influences, medication concerns and alternatives to medication.	In an inset titled 'Latest Leap', the authors describe neurofeedback as "the newest treatment alternative that therapists are exploring to combat ADHD", and describe how after multiple sessions of training "Attention, concentration, impulsivity and mild forms of hyperactivity frequently improve. A child's feelings of self-esteem also improve …".
BMC Psychiatry	2012	Duric NS, Assmus J, Gundersen DI, Elegen IB. (2012). Neurofeedback for the treatment of children and adolescents with ADHD: A randomized and controlled clinical trial using parental reports. *BMC Psychiatry*, 12:107	130 ADHD children aged 6-18 were randomly assigned into 3 groups – one received neurofeedback, one received medication (methylphenidate), one received both neurofeedback and medication.	As assessed by parental reports, neurofeedback was as effective as medication in improving symptoms. Neurofeedback demonstrated more than twice the improvement of the other groups in Attention, though this was not significant. The researchers concluded "NF produced a significant improvement in the core symptoms of ADHD, which was equivalent to the effects produced by MPH, based on parental reports. This supports the use of NF as an alternative therapy for children and adolescents with ADHD."
Applied Psychophysiology and Biofeedback	2002	Monastra, V.J., Monastra, D.M. & George, S. (2002) *The effects of stimulant therapy, EEG biofeedback, and parenting style on the primary symptoms of attention-deficit/hyperactivity disorder.* Applied Psychophysiology and Biofeedback, Vol 27, No 4, p231-249	100 children aged 6-19 with ADHD were put into two groups – both groups received Ritalin, academic support at school, and parent counseling. One group also received neurofeedback training, the other didn't (control group).	Whilst Ritalin was still being taken after 1 year by both groups, only the neurofeednack group showed a significant improvement in behavior as measured by parent and teacher rating scales. The researchers concluded that "the effect of Ritalin on parent and teacher ratings of inattention, hyperactivity, and impulsivity was not robust". Once Ritalin was stopped after 1 year and time allowed for the drug to leave the system, only the neurofeedback group showed significant improvements on an attention and impulsiveness test. Whilst Ritalin was still being taken by both groups, an EEG measurement showed an improvement in the area of the brain related to attention (central and frontal cortex) to 'normal' levels only in the neurofeedback group. The researchers conclude "stimulant therapy would appear to constitute a type of prophylactic intervention, reducing or preventing the expression of symptoms without causing an enduring change in the underlying neuropathy of ADHD", in other words Ritalin helps to hide the symptoms, whereas neurofeedback changes the biology of the brain to eliminate the symptoms.

Publication	Date	Research Reference	Summary of Research	Summary of Findings
Child and Adolescent Psychiatric Clinics of North America	2005	Monastra VJ (2005). Electroencephalographic biofeedback (neurotherapy) as a treatment for attention deficit hyperactivity disorder: rationale and empirical foundation. *Child Adolesc Psychiatric Clin N Am*, 14, 55– 82	This was a follow-up on the study above, to assess whether the findings were sustained 18, 24 and 36 months after the start of the original study.	The neurofeedback group continued to demonstrate improvements 36 months after the original study began, i.e. more than 2 years after neurofeedback ended on all 3 measures – biological (brain activity seen through EEG), behavioural (teachers and parents rating scales), and Neuropsychological (reaction and impulsivity test). 80% of the neurofeedback group had decreased their Ritalin dose by more than 50%. 85% of the control group had increased their Ritalin dose, none had reduced it.
Applied Psychophysiology and Biofeedback	2007	Leins U, Goth G, Hinterberger T, et al. (2007). Neurofeedback for children with ADHD: A comparison of SCP and Theta/Beta protocols. Appl Psychophysiol Biofeedback, 32(2) 73-88	38 ADHD children aged 7-13 randomly assigned to two groups, each group received neurofeedback training, but using different neurofeedback protocols.	Both groups improved as measured by 4 assessment methods.
International Journal of Bioelectromagnetism	2008	Gani, C., Birbaumer, N., Strehl, U. (2008), Long term effects after feedback of slow cortical potentials and of theta-beta-amplitudes in children with attention-deficit/hyperactivity disorder. *International Journal of Bioelectromagnetism*, 10, 4, 209 - 232.	The results were followed up 2 years later.	The improvements were still present as measured 6 months and 2 years after the end of the original trial.