

## Hyperbaric Oxygen Treatment In a Portable Chamber Improves Attention Span and Reaction Time in Patients with Acquired ADD

G. Heuser, MD, PhD, O. Aguilera, MD, S. Heuser, MA,  
J. Reeves, and C. Rogowski

### Introduction

Toxic chemical exposure (solvents, pesticides, mold toxins and others) can significantly affect brain function in children and adults. These effects may last for years after toxic exposure has ceased.<sup>1</sup>

In many of our patients, attention and reaction time become impaired. We have therefore suggested that Attention Deficit Disorder (ADD) can be acquired and thus develop *de novo* in a patient who had perfectly normal attention and reaction time before exposure. To test this assumption, we started evaluating our patients with a Test Of Variables of Attention (T.O.V.A).<sup>2</sup> We found that most of our patients indeed showed definite impairment.

In the past, we have shown that mild Hyperbaric Oxygen Therapy (mHBOT) significantly improves brain function as measured by SPECT brain scanning.<sup>3</sup> In this publication we describe T.O.V.A. as an indicator of attention and reaction time and evaluate the effect of mHBOT on those functions.

### Materials and Methods

All Patients selected for this study had a documented history of exposure to toxic chemicals (incl. mycotoxins) (Table 1) and underwent a T.O.V.A. test prior to mHBOT. This was given in the morning while the patient was comfortably seated in a quiet room and attended by a professional (O. Aguilera, M. D.) who instructed and observed the patient throughout the procedure. After ten consecutive sessions of mHBOT, the T.O.V.A. was repeated, again during the morning hours.

During T.O.V.A. testing, the patient sits in front of a computer screen which randomly brings up a square shape in two locations. Only when the square shape shows up in the upper center of the screen does the

patient push a button. If it shows up in the other location the patient should not push the button. This simple design measures the various categories displayed in Figures 1 through 10.

It is important to note that no learning takes place during T.O.V.A. testing which can therefore be repeated multiple times and remain valid. This is why we chose T.O.V.A. for this study. Finally, T.O.V.A. can be administered all the way from age four to advanced age.

T.O.V.A. constitutes a Continuous Performance Test (CPT).

Errors of omission are considered to be a measure of inattention and occur when the subject does not respond to the designated target. We have displayed this in our figures as a measure of attention.

Errors of commission are considered to be a measure of impulsivity and/or disinhibition and occur when the subject incorrectly responds to the non-target. We have displayed this in our figures as a measure of self-control.

Correct response time is the processing time (in msec) that it takes to respond correctly to a target. We have displayed this as reaction (quickness of response).

Response time standard deviation is considered to be a measure of variability or inconsistency and is the standard deviation of correct response times. We have displayed this in our figure as consistency.

Every individual T.O.V.A. test result is compared with a normal control population and expressed in a numerical fashion (see figures).

mHBOT was administered once or twice daily to a total of ten consecutive sessions, using a previously published protocol (1.3 ATA, 24% O<sub>2</sub>), in our portable chamber.<sup>3</sup>

Each treatment lasted one hour while the patient was reassured and observed by a trained technician.

Our portable chamber was previously discussed and shown on the cover of the published Proceedings of The 2nd International Symposium on Hyperbaric Oxygenation in Cerebral Palsy and The Brain Injured child.<sup>3</sup>

### Results

All Patients showed improvement after only ten sessions of mHBOT. Improvement was optimal when the patient had no more toxic exposure at all and was now living/working in a toxic-free environment.

As with SPECT brain scans<sup>3</sup>, T.O.V.A. showed further improvement when mHBOT was extended to a total of twenty or more sessions.

All patients reported subjective improvement which matched that of the T.O.V.A. results.

It should be noted that improvement was noted in several categories of performance.

### Discussion

Exposure to toxins, including mycotoxins, can lead to significant long-lasting impairment of brain function, often leading to temporary, even permanent disability. Typical complaints include impairment of short-term memory, intermittent disorientation, disturbed balance and coordination, inability to multi-task, and impairment of attention span and reaction time. This is seen in adults and also in the young.

While ADD is usually thought of as a disorder in the young, it certainly can occur in adults.<sup>4</sup> In our case it should be considered as acquired, i.e. secondary to toxic exposure.

In recent years, we have seen an increasing number of patients who were exposed to mold and mold tox-

**Table 2.**  
Scores of the study sample.  
B=Before mHBOT.  
A=After mHBOT.  
Black represents the improved scores.

**Table 2,**  
patients  
1-5

Patient	1	1	2	2	3	3	4	4	5	5
	B	A	B	A	B	A	B	A	B	A
Attention	108	108	<40	108	<40	108	<40	78	<40	<40
Self-Control	93	105	<40	49	109	114	104	102	68	107
Reaction	123	120	120	127	75	112	<40	92	100	83
Consistency	103	100	86	112	<40	83	<40	82	73	45
D'Prime	99	105	50	90	46	143	64	85	54	76

**Table 2,**  
patients  
6-11

6	6	7	7	8	8	9	9	10	10	11	11
B	A	B	A	B	A	B	A	B	A	A	B
<40	64	104	89	<40	108	108	108	85	108	65	101
108	112	105	110	67	97	103	109	82	89	90	105
<40	51	<40	101	130	132	115	116	116	127	92	98
<40	51	<40	95	118	121	111	104	122	130	81	89
53	113	73	66	62	101	77	83	82	93	76	89

**Table 1.**  
Characteristics of the study sample and changes in the T.O.V.A. test after ten HBOT sessions.

Patient	Gender	Age	Exposure Type	Changes
1	F	46	Mycotoxin	Some Improvement
2	F	49	Pesticides	Significant Improvement
3	F	46	Pesticides	Significant Improvement
4	F	55	Mycotoxin	Significant Improvement
5	F	41	Chlorine	Some Improvement
6	F	58	Pesticides	Significant Improvement
7	M	39	Diesel Fuel	Significant Improvement
8	F	40	Asbestos	Significant Improvement
9	F	41	Mycotoxin	Some Improvement
10	F	8	Mycotoxin	Significant Improvement
11	M	12	Chlorine	Significant Improvement

**Table 1**

ins. Many of these patients complain of impaired brain function and turn out to have abnormal neuropsychological tests, abnormal SPECT brain scans, and abnormal T.O.V.A. tests. Therefore, mycotoxin exposure can result in toxic encephalopathy with ADD. This also responds to mHBOT.

Other or related (to toxic encephalopathy) disorders also respond to mHBOT. These include autism,<sup>3</sup> stroke (our own clinical observation), and cerebral palsy (CP).<sup>5</sup> It should be noted that the Canadian authors of the CP study also found improvement in T.O.V.A. after treatment with mHBOT.

#### Conclusions

A number of conclusions can be reached from our studies:

T.O.V.A. is an excellent test for measuring attention span and reaction time in children (as early as age four) and adults. It can be repeated and remains valid.

ADD can be acquired as a result of toxic chemical exposure (solvents, fumes, perfumes, pesticides, mycotoxins).

Toxin-acquired ADD responds to mHBOT in a portable chamber with significant improvement in subjective symptoms and in T.O.V.A.

#### References

1. Heuser, G.; Mena, I. NeuroSPECT in Neurotoxic Chemical Exposure. Demonstration of Long Term Functional Abnormalities. *Toxicology and Industrial Health*, 14, #6: 813-827, 1998.
2. Greenberg, L; Kindischi, C. T.O.V.A. Test of Variables of Attention. Universal Attention Disorders, Inc. 1988-1996.
3. Heuser, et al. Treatment of Neurologically Impaired Adults and Children with "Mild" Hyperbaric Oxygen (1.3 ATA and 24% Oxygen). In: *Hyperbaric Oxygenation for Cerebral Palsy and the Brain-Injured Child. The Proceedings of the 2nd International Symposium.* (James, T. Joiner, Ed.), Best Publishing Co., Flagstaff, AZ 109-115, 2002.
4. Wasserstein, J.; et al. Editors. Adult Attention Deficit Disorder. *Annals of the New York Academy of Sciences.* Vol. 931. 2000.
5. Collet, J. P., et al. Hyperbaric Oxygen for Children with Cerebral Palsy: A Randomized Multicentre Trial. *The Lancet.* 357:582-586, 2001.

#### Key Words

Mold, Mycotoxin, Toxic Encephalopathy, ADD, T.O.V.A., Hyperbaric Oxygen (HBO)