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Observational study of children with autism who have participated in hyperbaric oxgen therapy

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OBSERVATIONAL STUDY OF CHILDREN WITH AUTISM WHO HAVE PARTICIPATED IN HYPERBARIC OXYGEN THERAPY

by

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Advisor Date

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DEDICATION

To my family

my parents, Jim and Ann Oxford

my children, Blake and JeAnnah

and my husband, Bruce.

ACKNOWLEDGEMENT

First and foremost my praise and thanks goes to the one who gives me the strength to make all things possible, my Lord and Savior, Jesus Christ.

Second, my family, who I can't imagine pursuing this without their support. My parents who never stop believing I can do whatever I put my mind to and then helping me to make it possible. They taught me as a child and as an adult what discipline and hard work is all about. Their countless trips to run errands for me, make dinner, run the kids around, and much more, were priceless. My children, Blake and JeAnnah, who have heard far too often, "Just let me finish this one page." Their support and constant encouragement means more than words can express. Bruce, my husband, who from day one of my telling him my desire to pursue a PhD never stopped encouraging me to keep going on, reminding me why I do what I do.

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PREFACE

For some individuals obtaining a PhD is for status, some for the ability to teach at the collegiate level, for others to fulfill a goal they set for themselves. For me this journey began with a quest for knowledge, for answers to many questions that all began one early morning on June 14, 2006.

It was June 14, 2006, a morning I will never forget, and one that changed the direction of my life as well as my family's lives forever. My nine year old daughter, who typically bounces down the stairs excited about going to school, practicing her dance steps from the previous night's dance class, suddenly was struggling to walk. She managed to get herself to the breakfast table, but was unable to bring the spoon to her mouth. As we rushed her to the emergency room we quickly felt her slipping from us. Upon arrival to the ER she was unable to walk or talk to us. The grim diagnosis of viral encephalitis was given to us within a few hours. Over the next few days she continued to regress, unable to hold her head up, breathing and heart rate irregular, kidneys shutting down. The hospital staff graciously told us there was no reason to transfer her to ICU, nothing more could be done and keeping her on a pediatric floor allowed me to stay by her side. We watched her struggle to hold onto life for the next few weeks. Then came the reality of the brain damage. She survived; however, she was not the same child as before. Her mental and speech capacity was tested at an 18 month capacity, she was ataxic, hypotonic (low muscle tone), visually impaired, sensory and emotionally impaired. We were told she would be discharged from the hospital once the wheelchair she was fitted for arrived. I remember thinking, "Wheelchair? Why, my daughter will walk again." However, reality soon hit when I began to care for a disabled child. We did

the traditional physical therapy, occupational therapy and speech and language therapy, but improvements were slow and minimal, and in many areas she regressed as seizure activity started and what little muscle done she had from the waist down diminished.

I had joined some internet support groups and through that I heard about hyperbaric oxygen therapy. I had never even heard the term before, or remembered hearing it, but I knew it was something she had to try. Through a connection we had at Detroit Receiving Hospital, JeAnnah began treating in their hyperbaric oxygen therapy center on July 31, 2006. Prior to her starting I had every evaluation I knew of done, from OT to cognitive. I wanted to know beyond a mom's feelings if she was really getting better.

The evaluations were almost unnecessary. She immediately had huge gains, able to kneel after one treatment, after one week she no longer meet the criteria for occupational or speech therapy, she was mentally back to grade level, with no more seizure activity. Ten days later she stood with support, and two months later she was tap dancing.

I was thrilled to have my little girl back, but it left a lot of questions in my mind. Could hyperbaric oxygen therapy help other special needs children? I have been teaching special needs children since 1985. I love that population of children, but what if there is something more than what we are offering in the schools to help them? Why did it bring my daughter back? Who else can it help?

The population of autism was a group I had seen go from almost non-existent to common place on my case load as a teacher. I watched as some children appeared to progress very rapidly in a short burst of time, while others made almost no gains. Those

with the gains parents claimed they had found their answer in complementary therapies. Was there any validation to their claims? I related what I saw with my daughter to the child with autism. I had to know if and why it could help. With a yearning for answers I began to research complementary/alternative therapies and the efficacy behind them.

With my yearning came answers, there is hope for recovery! There is more for a special needs child than the schools or traditional medicine can offer. As an educator we need to be aware of what is available to help our children.

Having a desire to help special needs children have access to complementary therapies I have founded a foundation, Oxford HBOT Kid's Foundation. Not only do we offer funds for therapies for special needs children we have a future goal of offering an all-in-one center where they can go to have an array of therapies all at one location. With the center will now come the responsibility of more studies, and with the studies will come answers. Do these complementary therapies really offer hope, healing, recovery? We owe it to these children, to the families, to continue to seek out answers to the beguiling questions of why, how, and what if.

This PhD, for me, is only the beginning, one piece of the puzzle put into place. There is so much more research to be done, so many more kids to help.

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CHAPTER 1

Introduction

Background

Autism is the fastest growing epidemic ever to occur with a prevalence of 1 in 80 children by the age of 8 (MMWR/CDC, 2009). According to the Data Accountability Center (DAC) and the Center for Disease Control (CDC), Michigan reported in 1992 1,180 cases of autism ages 6-22, by 2007 the number of reported cases went to 10,803, and 12,166 for ages 3-22. Children ages 6-22 had an increase of 816%; in contrast, all other disabilities combined only went up 35%. To date these are the most current figures available.

The costs of educating a child with autism are significant to the school systems and taxpayers as these children age and continue to increase in population. The CDC estimated the lifetime cost to care for an individual with autism to be 3.2 million dollars (Ganz, 2007). Below, the first graph exhibits the number of cases of autism from 1992-2006, the second graph exhibits the percentage of increase.

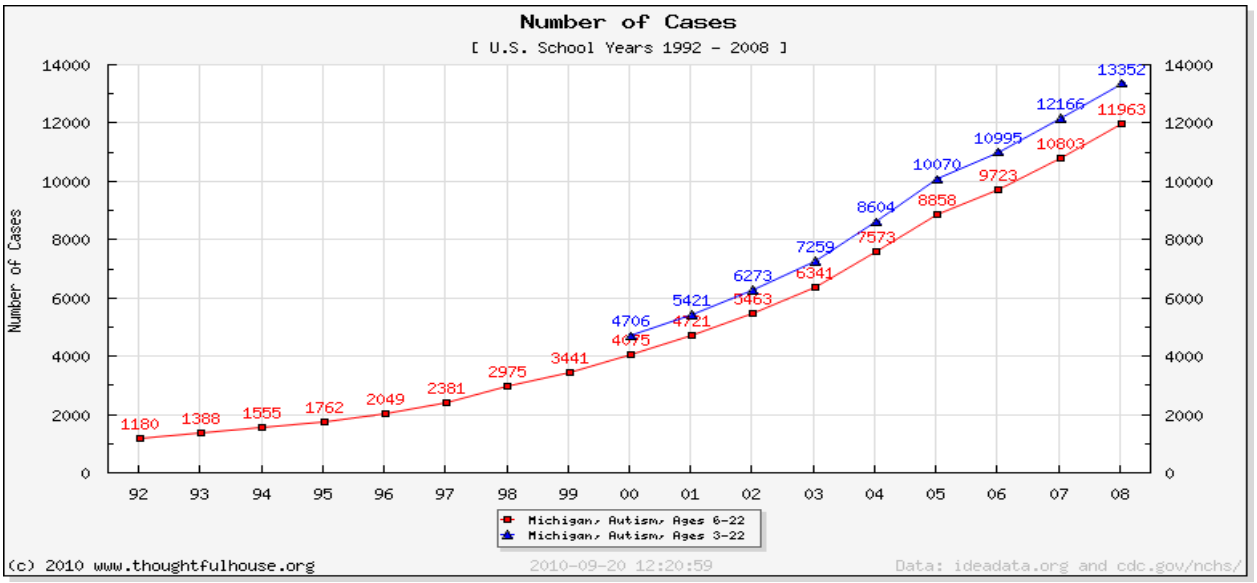


Figure 1: Michigan cases of autism and all other disabilities

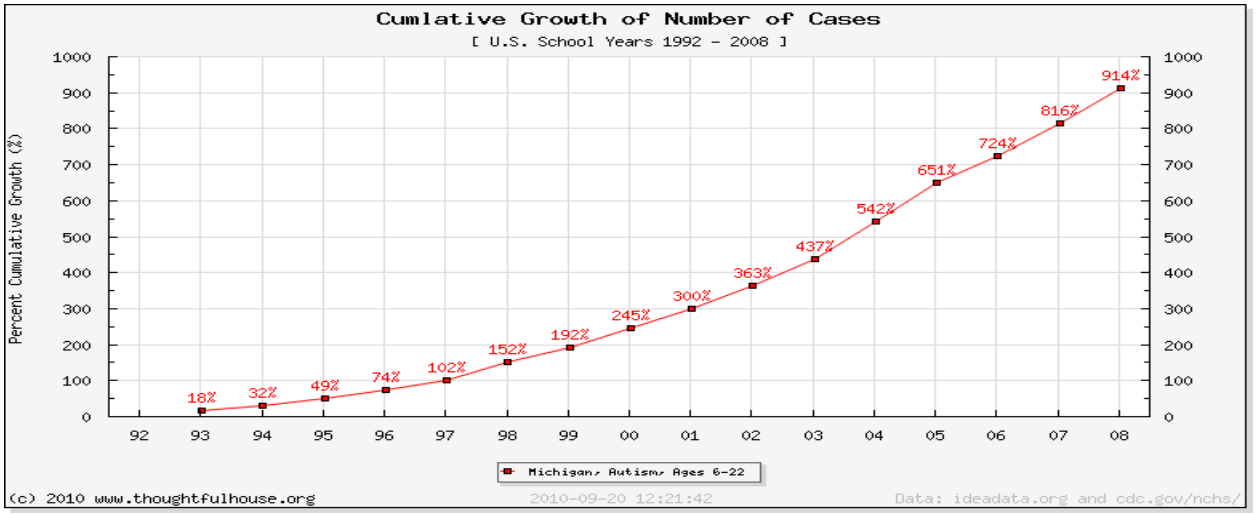


Figure 2: 50 US states cases of autism and all other disabilities (CDC, 2008)

Parents of autistic children who seek help are left with mixed messages between the medical and educational community (Carbone, 2010). Historically members of these two institutions do not work as a team with the parents to help the child, for the reason that identification policies have not been uniform (Stahmer, 2007; Filipek, Accardo, & Ashwal, 2000). One unique problem is a child may receive a medical diagnosis of

autism; however, the schools may not accept that as an educational diagnosis. Currently there is no medical test for diagnosing autism, requiring pediatricians who have had little to no training in autism to make a subjective diagnosis (Shah, 2001; Johnson & Myers, 2007). In order to receive a diagnosis in the schools of autism/autistically impaired a team consisting usually of five professionals, (psychologist, speech therapist, social worker, teacher, and special education teacher) most of who are trained in the evaluation of autism, conduct separate evaluations, next a consensus from the team is required in order to qualify a child as Autistically Impaired (Michigan Department of Education, 2004). Autism is the only condition that schools do not accept a medical diagnosis equivalent to an educational diagnosis; rather they must conduct a separate evaluation of their own due to the lack of specific guidelines in the medical community for diagnosing.

Consequently the mixed messages and lack of team work often encourages parents to seek out answers and treatments on their own, at times creating conflict between the schools and the parents (Scheuermann, Webber, Boutot, & Goodwin, 2003). Presumable, educating a child with autism can best be done when both the medical and educational community work together to educate themselves in what services and therapies are available along with the rationale behind the treatment.

Among the many services and therapies available is hyperbaric oxygen therapy (Rossignol, D., Rossignol, L., James, Melnyk, & Mumper, 2007). This therapy, as with many of the others, uses medical research as rationale behind treating the child with autism and educational assessments to show outcomes. For this reason, hyperbaric

oxygen therapy should be further researched as a potential treatment to demonstrate the benefits to a child with autism in their educational environment.

Public school personnel have been using what they refer to as best practice or evidenced-based curriculum/practices to educate children with autism, even though the research is not always favorable to the transferability of these skills or their success (Ganz, Simpson & Corbin-Newsome, 2008; White & Smith, 2002; Billstedt, Gillberg, C., & Gillberg, C., 2005). In conjunction with traditional academic curriculum, schools use three therapeutic interventions as part of the educational program: physical therapy, occupational therapy, and speech and language therapy. Although these programs are available to many parents through local therapy centers and paid for via their health insurance, the schools offer these services, sometimes with the requirement of a prescription and possible Medicaid reimbursement, to enhance the child's educational output. As a result teachers are able to document the educational benefit of medical intervention in a school setting.

Understanding the child's clinical and medical condition can play a key role in the educational success of the child. If a child does not feel well, educating them can be almost impossible as they are not in the mindset to focus on learning. Some areas, such as blood sugar levels with the diabetic child, are easier to understand and regulate. Educators recognized the correlation between focusing and the ability to learn, and proper blood sugar levels (Taras, Potts-Datema, 2005). Other areas, such as the gastrointestinal issues (GI) with the child with autism, are much more difficult to recognize and regulate (Rossignol et al., 2007). The discomfort a child experiences as a result of the GI issues often is expressed in anger outburst, self-abuse, or pulling away

from others, hence affecting the ability to educate the child (Jepson, 2007). As a result, it is presumably valuable for a teacher of children with autism to be educated in the clinical scientific data and treatments of this condition and have the knowledge to increase the effectiveness of the child's educational program by gaining an understanding off all clinical aspects and treatments.

Beginning of autism

Kanner (1943) published an early work on autism followed by Asperger (1944). Kanner (1943) described the children as ones "whose condition differs so markedly and uniquely from anything reported so far" (Kanner, 1943). At that time, autism was identified in approximately four to five per 10,000 children. (Kanner, 1943) There was no significant increase in the identified cases of autisms after the publication of their works; rather they sought to locate children with those characteristics. More recently, autism has shown an incredible growth, a growth faster and more globally spread than any other condition in history (Byrd, 2002). Today, according to the Center for Disease Control (CDC), autism is found in approximately 1 in 80 children with the prevalence four times more likely to occur in males versus females (CDC, 2009).

Definition

The guidelines for diagnosing autism are found in the Diagnosis and Statistical Manual of Mental Disorders (DSM). According to the CDC the autism diagnostic criteria first began in 1956 with the Kanner (1956) criteria. It stated the criteria as "Lack of effective contact; desire for sameness; fascination with objects; mutism or non-communicative language before 30 months of age" (Kanner and Eisenberg 1956 p.

557). The previous versions DSM-I (1952) and DSM-II (1968) did not include autism; at that time the prevalence of autism was not prevalent enough to be included.

In 1978 the CDC accepted the Rutter criteria, which emphasized delayed and unusual social and language development and early onset of unusual behaviors (Rutter, 1978). In 1980, autism was addressed in the DSM (third edition) for the first time. The DSM-III expanded the criteria to differentiate between schizophrenia and autism and introduced for the first time the concept of Persuasive Developmental Disorders (PDD). At that time autism was defined as infantile autism. In the 1987 version of DSM-IIIR the wording was revised to autistic disorder (Lord, Pickles, McLennan, Rutter, Bregman, Folstein…Minshew, 1997). The current version, DSM-IV (1994), includes qualitative deficits in the areas of social interaction, communication, repetitive or stereotype behaviors, interest or activities. The expansion also included a separate definition for Asperger's Disorder, Rett's Disorder, Childhood Disintegrative Disorder, and Pervasive Developmental Disorder Not Otherwise Specified (PDD-NOS), previously expanded through the ICD-10 (International Statistical Classification of Diseases and Related Health Problems, an international medical classification of diseases) in 1992. The expanded version of the DSM-IV introduced the definition of Persuasive Developmental Disorders, commonly referred to as ASD (Ozonoff, South & Miller, 2000).

According to the Center for Disease Control (CDC, 2009), Autism Spectrum Disorder (ASD) is an umbrella of disorders of developmental disabilities identified by deficits in communication and social interactions; along with unusual, sometimes repetitive, behaviors; having areas of interest often with a narrow focus; and frequently

insistence on sameness. The cognitive abilities can vary from superior intelligence to mental impairment. ASD is found in all races, ethnic and socioeconomic levels.

The quest for increased educational outcomes for children with autism is a challenge that confronts educators of children with autism. Alternative therapies, such as diets, supplements, chelation, and hyperbaric oxygen therapy, are often characterized by cynicism, rather than as educational and medical innovations that require further empirical research. Even after several decades of experimenting with more traditional methodology, best practice yields poor outcomes (Billstedt, et al., 2005), leaving educators to wonder what else is available. This was supported in a long-term study of 120 children with autism (Billstedt, et al., 2005). In that study, fifty-seven percent of those studied showed very poor outcomes. (Poor outcome was defined as: not employed or engaged in education/vocational training, and not living independently. Good defined as employed or engaged in education/vocational training and living independently.) None had a good outcome. Teachers have tried implementation of long-standing instructional methods and/or modernization of those techniques, with outcomes still not achieving desirable results. The implementation of alternative/complementary therapies has resulted in many parents feeling that it may be in conjunction with traditional school based methods and complementary therapies is where they will find the answer to enhance the learning capabilities of their child (Roylance & Cohn, 2011). Those parents are in agreement with Rimland, "Autism is treatable" (testimony of Bernard Rimland, Before House Committee on Government Reform, 2000). Hyperbaric oxygen therapy is one alternative therapy many parents are seeking.

Statement of Problem

The outstanding question is whether hyperbaric oxygen therapy provides a measurable benefit to children with autism versus those who only receive traditional school-based instruction. This question will be addressed with an observational study of students who receive hyperbaric oxygen therapy using the Autism Treatment Evaluation Checklist (ATEC) as a measurement tool.

The researcher will explore the relationship between the use of hyperbaric oxygen therapy and improvements in the child's language/communication, social interaction, and behaviors. To demonstrate the use of hyperbaric oxygen therapy on a child with autism the researcher will look at

- the possible etiologies of autism,
- the scientific research and history supporting these claims, and
- what scientific research ascertains about the brain of an autistic child, and
- how the above correlate to the use of hyperbaric oxygen therapy

This information can help bring light to developing the best educational program for a child with autism.

Research Questions

1. Is there an increase in speech/language/communication of an autistic child who has received hyperbaric oxygen therapy using the Autism Treatment Evaluation Checklist as a measurement tool?
2. Is there an increase in sociability of an autistic child who has received hyperbaric oxygen therapy using the Autism Treatment Evaluation Checklist as a measurement tool?

3. Is there an increase in sensory/cognitive awareness of an autistic child who has received hyperbaric oxygen therapy using the Autism Treatment Evaluation Checklist as a measurement tool?
4. Is there an increase in the health/physical/behavior of an autistic child who has received hyperbaric oxygen therapy using the Autism Treatment Evaluation Checklist as a measurement tool?

Rationale for study

Educators of children with autism continue to strive for ways to improve the education for these children. Complementary therapies, such as hyperbaric oxygen therapy, diet, vitamin/supplements, and chelation are increasing with popularity by the parents with little research as to the efficacy of these treatments and the correlation to the education of the child. The schools currently use speech and language therapy along with physical and occupation therapy, both of which are considered a medical intervention, for children with autism; however, evidential research for these, along with medical interventions are lacking. In order for educators and parents to know if complementary interventions, such as hyperbaric oxygen therapy work, research must be done. This paper will be presenting the data on clinical causes for this disease, the impact on the ability of the child to learn and the theory that hyperbaric oxygen therapy (HBOT) when used as an intervention can improve the educational and productive life of a student with autism.

Hypotheses

The etiology of autism may be rooted in the environmental insult resulting in brain damage inflammation that manifests itself in the symptoms exemplified in autism. These

symptoms can be treated and lessened through hyperbaric oxygen therapy. It is the primary hypothesis that children who undergo hyperbaric oxygen therapy will show clinical improvements measured through the Autism Treatment Evaluation Checklist that will improve the education of the child with autism.

Definition of terms

abort: a dive/treatment that is stopped part way through

alternative/complementary therapy: therapies/treatments that are not traditionally covered by insurance, and are seen as an additional to traditional covered treatments

amygdale: part of the limbic system, almond-shaped clumps of cells deep in the brain, deals with response to danger, anxiety, and possible social interaction

ascend: reduce atmospheric pressure

ASD: Autism Spectrum Disorder

ata: atmospheres absolute

CDC: Center for Disease Control and Prevention

cerebral hypoxia: impaired oxygen delivery

chamber: a device used to increase atmospheric pressure that is filled with 100% medical grade oxygen

descend: increase atmospheric pressure

dive: individual hyperbaric oxygen therapy treatment

FDA: Food and Drug Administration

fMRI: functional Magnetic Resonance Imaging

HBOT: hyperbaric oxygen therapy

hippocampus: short term memory and regulates emotions—includes gyrus, very sensitive to oxygen deprivation

in vitro: procedures or research done outside of a living organism

in vivo: procedures or research done inside a living organism, clinical trials are a form of in vivo

microglia and astroglia: cells dealing with immune system and neurological tissues

PDD-NOS: Pervasive Developmental Disorder, not otherwise specified

SPECT scans: single photon emission computed tomography

Limitations

1. The small size of the study, 5 participants, will not show statistically significant outcomes; rather a trend of improvements will be assessed.
2. Participation in the study is voluntary, thus findings may be reflective of those who exhibited a more positive attitude.
3. Parents are required to transport their child to the hyperbaric clinic five times a week at their expense; therefore, it may lend itself to a higher social economic status.
4. The study is limited to children with autism in the Metropolitan Detroit area.

Hyperbaric Oxygen Therapy

Hyperbaric Oxygen Therapy also called (HBOT), or in Europe High Density Oxygen Therapy (HDOT), is a specialized therapy administered by delivering one-hundred percent oxygen to a patient through increased atmospheric pressure above 1.3 atmospheres absolute (ata) in order to improve or correct health conditions. The use of oxygen under pressure is considered drug therapy to treat a multitude of neurological and physical maladies, requiring a prescription from a physician (Gill & Bell, 2004). The

effects of hyperbaric oxygen therapy are based on the gas laws. According to Henry's Law of physics, by providing pure oxygen in a pressurized chamber a patient receives 20-30 times more oxygen than is delivered at sea level or at normal atmospheric levels, saturating the body with oxygen. When a patient is in the chamber at 2.5 ATA the plasma carries and delivers as much oxygen to the tissues as do the red blood cells (Tibbles & Edelsberg, 1996). Of even greater importance to healing, the gradient between the plasma and red blood cells is so precipitous it drives a remarkable amount of oxygen far deeper into the oxygen poor tissue compared to normal conditions (Leach & Wilmshurst, 1998). Some of the effects are promotion of the growth of new capillaries, increased production of the body's stem cells, decrease in swelling and inflammation, increase in the body's ability to fight infections, clearing and deactivation of toxins and metabolic waste products from the body, and acceleration in the rate of healing (Marx, Ehler, Tayapongsak, & Pierce, 1990; Hunt, 1988; Knighton, Silver & Hunt, 1981, Knighton, Halliday & Hunt, 1984) These results change the cells and surrounding tissue significantly enhancing the body's ability to aid in its own healing.

There are two styles of medical devices that deliver this therapy, monoplace and multiplace chambers. The monoplace chamber is designed to hold one person. The patient lies on a gurney and is slid into a large eight foot acrylic chamber enclosed with steel ends. Once the patient is inside, the chamber is filled with one-hundred percent medical oxygen. The patient completes the treatment in 60-90 minutes; this is referred to as a "dive." The multiplace chambers hold two to eighteen people. It is a large steel chamber, resembling a submarine. Inside the patients sit in chairs or lay down on a gurney. The chamber is filled with ambient air and pressurized the same as the

monoplace. The oxygen is administered through a device referred to as a “hood” that is worn over the head. Both chambers are pressurized according to the prescription, usually between 1.5ata to 2.4ata, for a duration of 60-90 minutes once a day for 40 days, usually five times a week.

Hyperbaric oxygen therapy is not a new therapy. Henshaw (1662) first documented hyperbaric therapy in 1662 when he built his first hyperbaric chamber referred to as a domicilium. Since then, hyperbaric therapy has been used around the world to successfully treat a wide variety of medical conditions (Gill & Bell, 2004). In 1937 hyperbaric oxygen treatments were first used for decompression sickness (Yarbrough & Behnke, 1939), but it was not until 1955 that interest in hyperbaric medicine really expanded (Churchill-Davidson, Sanger, & Thomlinson, 1955). In Amsterdam the next year, Dr. Boerema reported that hyperbaric oxygen therapy was a therapeutic aid in cardiopulmonary surgery (Boerema, Kroll, Meijne, Lokin, Kroon, & Huiskes, 1956). Shortly after his colleague's discovery, W.H. Brummelkamp, published a discovery of his own, that anaerobic infections were inhibited by hyperbaric therapy (Brummelkamp, Hogenijk, & Boerema, 1961). International interest was rekindled in 1962 when reports of the enormous benefits of hyperbaric oxygen therapy in the treatment of carbon monoxide poisoning were published (Smith & Sharp, 1962). These discoveries, and more, pushed hyperbaric medicine into the modern era. Today, one of the most common uses is for diabetic wounds (Gill & Bell, 2004). Installations of hyperbaric units quickly began at some of the most revered and prestigious medical centers in the United States. A few of these early adopters were Harvard Children's

Hospital, New York Sinai Hospital, Duke University, and Good Samaritan Hospital in Los Angeles.

The wide variety of use in hyperbaric medicine is best understood by examining the body's reaction to injury. When the body sustains an injury of any kind, from ankle sprains, lacerations, cardiac arrest to near drowning, lightning strikes or complications at birth, the bodies activates the inflammatory reaction. This reaction is both fast and dramatic, with positive along with negative results. During the initial injury the body brings all its necessary resources, including toxic chemicals and digestive enzymes, to the injury (Munford and Pugin, 2001). In a sense, this cleans up the mess; however, in the process a scar is formed (Desmouliere, Redard, Darby & Gabbiani, 1995). The body can tolerate low oxygen levels fairly well, but it cannot tolerate low blood flow. The white blood cells that have come to the injury can create a blockage in the vessel, reducing blood flow. This is tolerable when it is a non-crush wound or a sprain, but when this occurs in an organ such as the brain or heart, the inflammation can be devastating (McGeer, 1995). Current research suggests that high pressure oxygen delivered within two to three hours after injury may prevent or minimize the damage (Yeo, McKenzie, Hindwood & Kidman, 1976). However, improvements have been shown up to fourteen years later with neurological conditions treated in 100% oxygen in hyperbarics (Harch & McCullough, 2007). This same concept can be applied to a child with autism in relation to the inflammation associated with the condition. Below are some pictures to clarify.

Normal Blood Flow

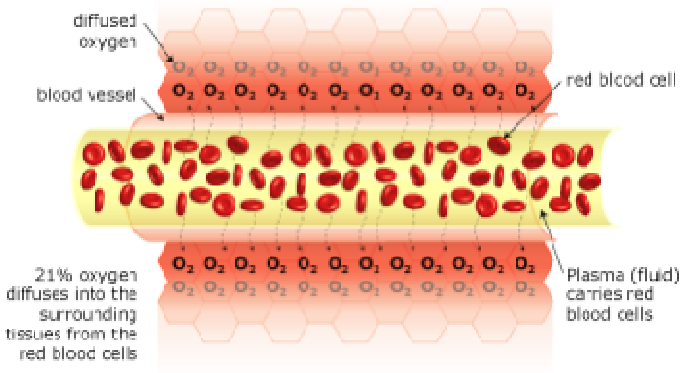


Figure 3:
Ambient air has approximately 21% oxygen. The red blood cells, carried by the plasma, distribute oxygen into surrounding tissue.

Restricted Blood Flow

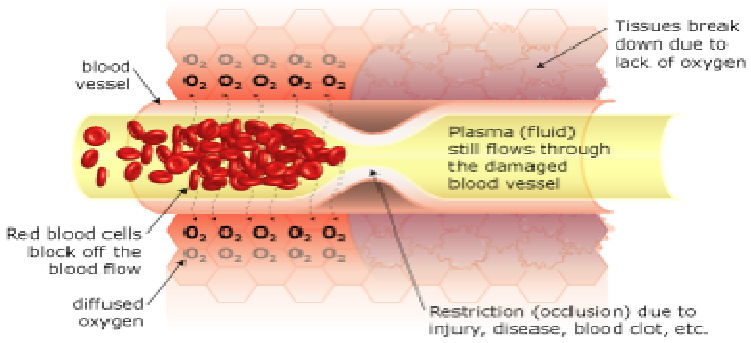


Figure 4: If the blood vessel has a restriction, the red blood cells no longer can travel, therefore oxygen cannot reach the tissue. The blockage and lack of blood flow causes inflammation, leading to hypoxia (lack of oxygen).

Hyperbaric Oxygenation

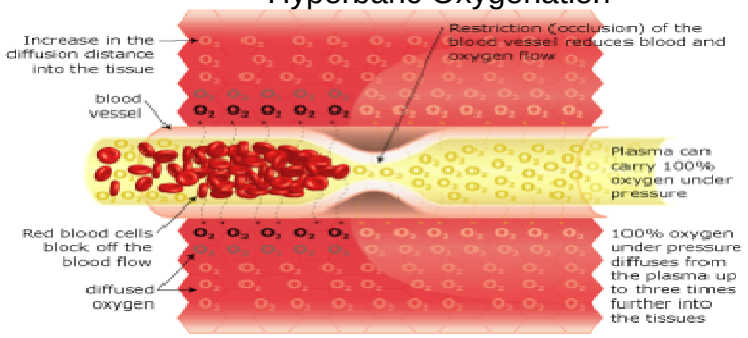


Figure 5:
While breathing 100% oxygen under pressure the plasma is saturated with oxygen. The plasma is then able to travel where the red blood cells cannot, bringing oxygen to the hypoxic tissue.

Blood Vessel Regeneration

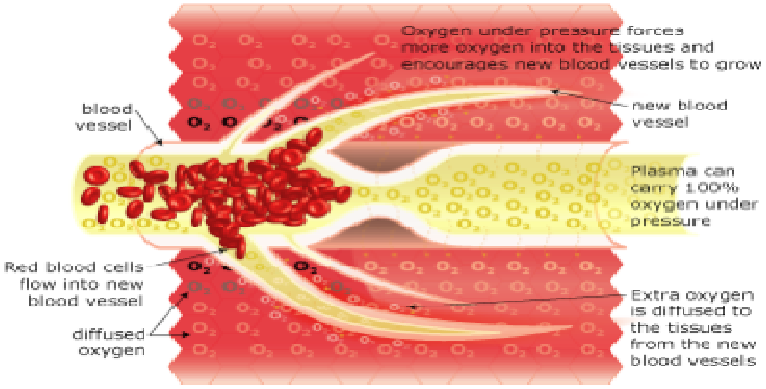


Figure 6:
The increased atmospheric pressure combined with 100% oxygen creates angiogenesis (new capillaries) and extended the length of the current capillaries, allowing the body to begin the healing process. (www.hyperbaricworx.com.au/whatis.aspx)

Hyperbaric oxygen therapy has only been used under physician supervision for children with autism for a little over four years (Rossignol et al., 2007). Hence, new research is constantly coming out reporting the benefits of hyperbaric oxygen therapy with these children. There are multiple studies currently being conducted throughout the

United States. To understand the reason hyperbaric oxygen therapy works for children with autism, it is necessary to review some of the current research of the medical conditions of children with autism.

CHAPTER 2

Literature Review

In order to achieve best educational outcomes for children with autism, and to understand why complementary therapies could achieve favorable results, it is essential the etiology of autism be explored. Achieving improvements in the behavior, social, and speech deficits with these students can best be accomplished with an understanding of the etiology and its implication, hence overcoming educational deficits. One must look at the common explanations for the growth in number of students with autism, and then explore the history, and research on the subject of those claims. One philosophy of growth would be a simple misdiagnosis; in other words, the number of autistics has always been there, however the children were labeled differently. Another common explanation is environmental toxins, often narrowed down to mercury or viral overload. One last school of thought, the cause of autism may be linked directly or indirectly to genetics.

Etiology: misdiagnosis

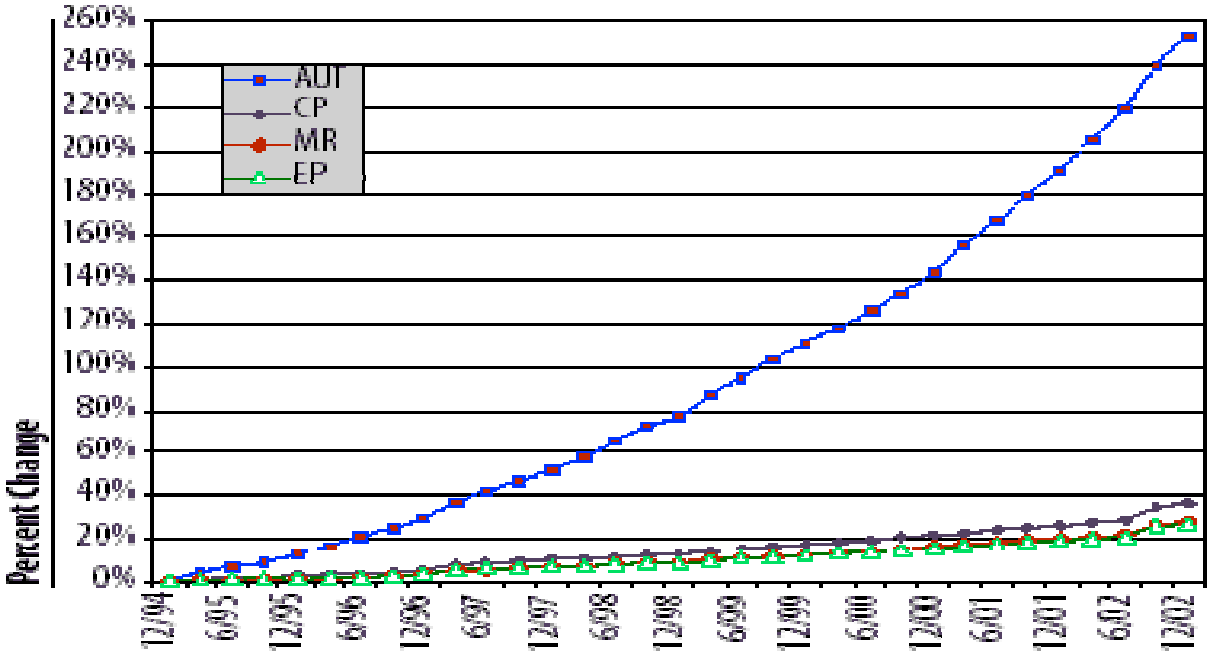
One explanation sometimes given for the rapid growth of autism is a previous misdiagnosis (King & Bearman, 2009). Believers in this theory feel, for the most part, the number of children with autism has not changed, rather the child's diagnostic label has changed. According to this viewpoint these children have been misdiagnosed with mental retardation, health impaired, or cerebral palsy, etc. However, if this were the case one would expect to see a correlation with a proportional reduction in numbers of other disabilities, such as mental retardation, health impaired or physically impaired, as

autism increases. The state of California, due to a statewide education system, has clear records of the numbers of students with disabilities. In 2002 a comprehensive randomized study was conducted at the M.I.N.D. Institute (Medical Investigation of Neurodevelopmental Disorders) to investigate possible explanations as to the increase in the number of children with autism, and if there really was an increase in the number of children with autism. They compared two groups; the first group was born between 1983-1985 the second group was between 1993-1995. The Principal Investigator in the study, Byrd stated in an interview with the Los Angeles Times, "The results of this study are, without a doubt, sobering" (Maugh, 2002). In the published report Byrd summarizes, "The unprecedented increase in autism in California is real and cannot be explained away by artificial factors, such as misclassification and criteria changes, according to the results of a large statewide epidemiological study." He also stated, "The observed increase in autism cases cannot be explained by a loosening in the criteria used to make the diagnosis (Byrd, 2002 p. 5) The study did not include persons with Pervasive Developmental Disorder (PDD), PDD-Not Otherwise Specified (PDD-NOS), Asperger's Syndrome, or any of the other milder autism spectrum disorders. The California data reflect only those children who have received a professional diagnosis of level one, DSM IV autism - the most severe form of autism.

Below is a graph tallying the number of students in the state of California from 1994 to 2002. As shown in Figure 3, the number of students with autism is rapidly increasing; however there is also small increase in the other disabilities that is about 2-3% (Byrd, 2002 p. 8-9). A more current study cites statistics from 1987-2007. In respect to autism there is over 1,100 percent increase in autism over two decades while the

other disabilities increased 136 percent. (California Health and Human Service Agency, 2007, p. 10)

Figure 7 - Percent Change in All Disabilities from 1994 through 2002



Legend defined:
AUT = autism, CP = Cerebral Palsy, MR = Mental Retardation, EP = Epilepsy.
(California Health and Human Service Agency, 2003, p. 7)

In Table 1 below, continuing the data with the percentage of growth from 1987 to 2002.

The statistics in the chart are similar to the graph.

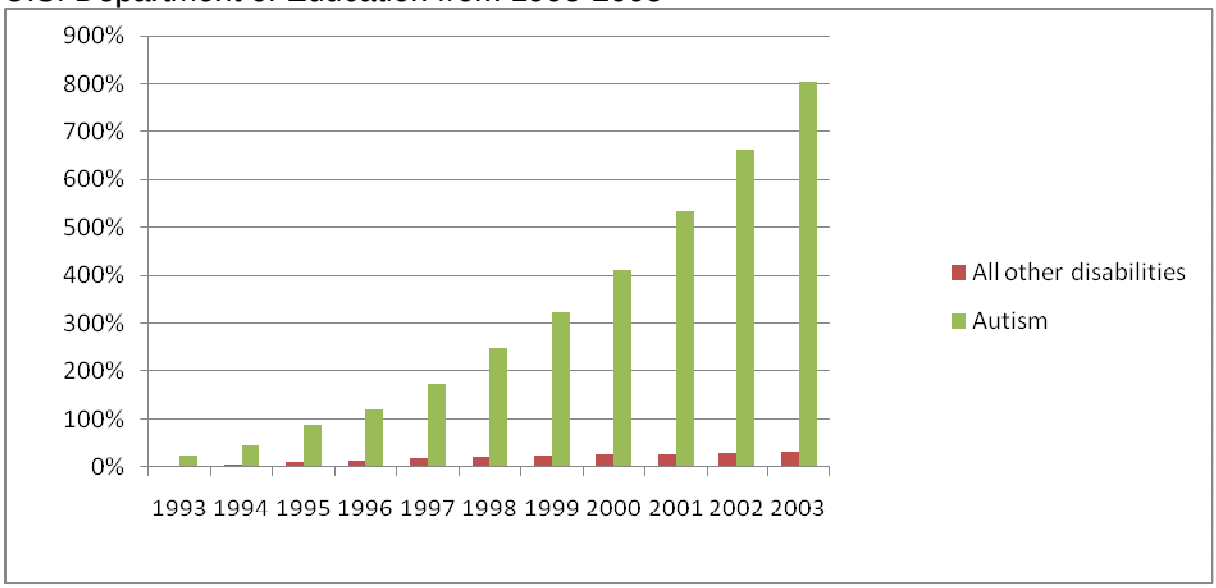
Table 1 - Percent Increase in All Diagnostic Populations from 1987 to 2002 and from 1998 through 2002

	Dec. 87	Dec. 02	% change	Dec. 98	Dec. 02	% change
Persons with autism	2,778	20,377	633.51%	10,360	20,377	96.69%
Persons with Mental Retardation	72,987	130,722	79.10%	108,563	130,722	20.41%
Persons with Epilepsy	22,683	35,689	57.34%	30.656	35,689	16.42%
Persons with Cerebral Palsy	19,972	33,071	65.59%	28,529	33,071	15.92%
Total Population with CDER's	80,389	163,792	103.75%	129,169	163,792	26.80%

Note: Some individuals have more than one of the above diagnoses and are therefore counted in multiple categories (M.I.N.D. 2003).

(California Health and Human Service Agency, 2003, p. 8)

Figure 8 – Percentage of increase in autism v. all other disabilities
U.S. Department of Education from 1993-2003



The table below gives the exact percentages for the above graph.

Table 2. Percentages of increase in autism v. all other disabilities

YEAR	ALL OTHER DIABILITIES	AUTISM
1993	3%	23%
1994%	6%	45%
1995	10%	87%
1996	13%	121%
1997	17%	173%
1998	20%	247%
1999	23%	324%
2000	25%	411%
2001	27%	533%
2002	29%	662%
2003	31%	805%

(US Department of Education, 2004)

As evident by the statistics in California and the U.S. Department of Education, the number of students with autism has had a significant percentage of increase. If the explanation of the enormous significant in the percentage of students with autism is nothing more than a re-diagnosing or misdiagnosing, the percentage of increase would have to remain relatively proportional with other disabilities decreasing, particularly in the area of Health Impaired and Mental Retardation. The graph illustrates the

percentage of increase in autism from 1987 to 2002 increased by 633.51% and in 1998 to 2002 increased by 96.69%. All other disabilities also increased; however, at a much smaller and more acceptable rate in concurrence with the population increase. Hence, the explanation of misdiagnosis statistically is not evident.

Etiology: Toxic Insult History

Another explanation, although often viewed as controversial, relates to vaccinations. There are three facets of concerns regarding vaccines: thimerosal (mercury), overtaxing the body with live viruses that contain viral contaminants (viral overload), and demyelination (Halsey & Hyman, 2001; Harrington, Patrick, Edwards, & Brand, 2006.). The most common school of concern is thimerosal, a mercury component added to childhood vaccines in the 1930's (Geier, et al., 2004). The proportional increase in autism with the increase in recommended vaccines, along with the coinciding identification of autism in the late 1930's with the beginning of thimerosal's use is one reason for the popular controversy (Burton, 2003). Therefore, a closer look at the history of thimerosal is warranted.

Vaccines and Thimerosal

Thimerosal is made basically of two compounds, ethylmercury and thiosalicylic acid. Thimerosal is 49.6% mercury by weight and releases ethylmercury as a metabolite (Clarkston & Magos, 2003). Once in the body ethylmercury is converted to inorganic mercury which preferentially accumulates in the brain and kidney (Baskin, Ngo, & Didenko, 2003). Essentially it is a manmade organic form of mercury, which converts to an inorganic form, with a preference for nerve cells, although it is known to freely travel through the body. When thimerosal enters the nerve cell it becomes tightly bound,

accumulating there for years. (Geier, et al., 2004; Baskin, Ngo, & Didenko, 2003). The theory is this can cause permanent degeneration of brain cells, with unpredictable damage. Mercury also is bio-accumulative in living things, in humans it is stored in fat cells that persists for many years (Clarkston & Magos, 2003). Ethylmercury can significantly increase the concentration of inorganic mercury in many organs (Magos, Brown, Sparrow, Bailey, Snowden, & Skipp 1985).

Thimerosal was developed by Dr. Morris Selig Kharasch, a chemist and fellow at Eli Lilly Pharmaceutical Company, on June 27, 1927; on June 5, 1928 Thimerosal was patented by Dr. Kharasch (Burton, 2003). (U.S. Patent 1,672,615 “alkyl mercuric sulphur compound and process of producing it.”)

In 1929 an outbreak of meningitis was causing many deaths. Dr. Smithburn was treating patients with meningitis unsuccessfully. After being told of a cure by Eli Lilly Pharmaceutical Company, and with no other options, he experimented by injecting twenty-two patients who were dying of meningitis with thimerosal,, not to examine the toxicology of thimerosal but rather, in desperation for a cure. The use of the thimerosal was published as a study by Powell and Jamieson (1931) using information provided by Dr. Smithburn. Powell and Jamieson (1931) stated, “It did not appear, however, to have any deleterious action when used in rather large doses intravenously when all the drug entered the vein” (p. 306). They failed to note significant information regarding the study, such as why one-third of the patients were only studied for one day due to death within 24 hours. Two of the patients developed phlebitis or sloughing of the skin, the breakdown of the skin itself. (Geier, et al., 2007). This study has been used for years as evidence for the safety of thimerosal until 2002. The specific clinical assessments were

not described and no laboratory studies were reported, the only stated report was that all of the patients died from the meningitis. Although the thimerosal was given in significantly larger amounts than children receive today, it is relevant that this is the only testing done on the thimerosal prior to its general use in vaccines.

A press release on March 17, 2002 revealed that during a discovery process in the case of Ounter v. Eli Lilly and Company, et al, that Eli Lilly & Company knew as early as 1930 of the dangers of thimerosal. At that time the study was fully disclosed and the outcome of death was exposed, but more importantly the study from Dr. Smithburn, Powell, and Jamieson on the meningitis patients could no longer be used as evidence of the safety of thimerosal.

On October 1929, Eli Lilly and Company registered thimerosal under the trade name Merthiolate. Thimerosal was first introduced into vaccines due to the need to reduce bacteria, as this was prior to the time of antibiotics (penicillin was first manufactured in 1942 as a response to streptococcal septicemia) and the injections were often given by general practitioners drawing vaccines from multi-dose vials in unsanitary conditions, however, the efficacy of its antibacterial properties has not been properly tested, and has been disputed (Burton, 2003). In 1935, with the growing concern of staphylococcus, a study was conducted to assess the efficacy of thimerosal killing the bacteria on chick tissue. Although the study was conducted in the Netherlands, they used the FDA phenol coefficient method, which was the method accepted by the US FDA at the time to examine and rate disinfectants. The results of the study determined the thimerosal was thirty five times more toxic to the heart tissue it was meant to protect, than the bacteria it was meant to kill (Salle, 1961).

On July 22, 1935 Jamieson, Director of Biological Division for Eli Lilly, received a letter from Pittman-Moore, an animal vaccine manufacturer, sent to inform Eli Lilly of their research with Thimerosal in vaccines for dogs. The letter stated,

“We have obtained marked local reaction in about 50 percent of the dogs injected with serum containing dilutions of Merthiolate varying from 1 in 40,000 to 1 in 5,000, and we have demonstrated conclusively that there is no connection between the lot of serum and the reaction. In other words, Merthiolate is unsatisfactory as a preservative for serum intended for use on dogs. I might say that we have tested Merthiolate on humans and find that it gives a more marked local reaction than does phenol and tricresol." Pittman-Moore pronounced Thimerosal “unsatisfactory as a preservative for serum intended for use on dogs” (letter, 1935).

About the same time, two doctors, Kanner and Asperger, both begin observing a newly discovered neurological disorder found in children. Kanner's (1943) first child studied began September 1931; the same year thimerosal was used in the vaccines. He described the children as ones "whose condition differs so markedly and uniquely from anything reported so far" (p. 217). Kanner was at John Hopkins University in Baltimore and Asperger was in Vienna, Austria-Hungary. Asperger’s works were not known in the United States until a British researcher published his findings in 1981 (Wing, 1981).

The FDA’s regulation of drugs did not have influence at the time of the introduction of Merthiolate (thimerosal) to stop the manufacturing; it was not until 1938 that the FDA began to have the power to regulate drugs marketed in the United States under the Food, Drug, and Cosmetic Act of 1938. Drugs manufactured prior to 1938 were almost all grandfathered in as being safe, devoid of safety or efficacy testing (Swann, 1998). To date, the FDA does not do any testing of any drugs. They rely solely on the test done by the manufacturer with the data presented to them.

In the 1940's children began receiving the DTP (Diphtheria, Tetanus, and Pertussis) and smallpox vaccines. The DTP and Tetanus vaccines contained thimerosal at twenty-five micrograms of mercury per shot. The DTP was the only mercury containing vaccine routinely given to young children (Burton 2003). Of interest, the FDA does not require the manufacture to test the DTP in combination; rather it accepts testing done by individually giving Diptheria, Tetanus, and Pertussis, as with the MMR. This is according to World Health Organization standards (WHO, 1979).

In 1967, Nelson and Gottshall published their study on the effects of Merthiolate (thimerosal) in relation to the Pertussis vaccine,

"Pertussis vaccines preserved with 0.01% Merthiolate are more toxic for mice than unpreserved vaccines prepared with the same parent concentrate and containing the same number of organisms...An increase in mortality was observed when Merthiolate was injected separately, before or after an unpreserved saline suspension of pertussis vaccine" (Nelson & Gottshall, 1967, p. 590).

Their research showed thimerosal killed mice when injected with a vaccine of pertussis. Interestingly, the time of death for the mice did not correspond with the amount of mercury; rather death occurred in all amounts tested. "The toxicity in mice of final lots of preserved vaccine prepared from concentrated vaccines which were atoxic or only slightly toxic has been observed in other laboratories and has been the source of much speculation" (p. 593). In response to the latest publications, the Medical/Science Department of Eli Lilly & Company requests that the claim "non-toxic" on thimerosal labels be deleted in the next printing run. The label for Eli Lilly & Company's Thimerosal changed to "non-irritating to body tissues" and non-toxic was omitted.

The following year in 1968 the Rho-GAM is introduced as a shot given to women who are Rh-Negative. The shot is to be given right after giving birth, later to be added at

twenty-eight weeks of pregnancy. The shot contains ten point five micrograms of mercury from thimerosal, absorbable through the mother's breast milk and to the fetus (Grigg, 2004; www.atsdr.cdc.gov; James, Slikker, Melnyk, New, Pogribna, & Jernigan, 2005).

In 1971, the Measles, Mumps and Rubella (MMR) vaccine was introduced. At this time only the DTP, MMR and Polio vaccines were being given to children. The DTP at that time was the only vaccine that contained thimerosal at 25 micrograms of mercury per shot. The MMR and Polio vaccines were both live virus vaccines. Routine smallpox vaccination ceased. The same year Bay-Rho, by Bayer Corporation, was introduced for women who are Rh-Negative. The shot is to be given directly after giving birth. Bay-Rho contained 35 micrograms of mercury from thimerosal.

Axton (1972) published an article on mercury poisoning. The symptoms and course of the six patients suggested mercury poisoning. Axton stated, "In chronic poisoning, where small amounts of mercury are ingested over a long period of time symptoms are mainly neurological." The quick death in these patients, "suggests that the mercury compounds produced by the degradation of Merthiolate [thimerosal] were in a non-chelatable form" (p.421).

In 1977 thimerosal was used as a preservative in antiseptic wipes at the Hospital for Sick Children in Toronto on infants for umbilical cord care. As a result ten infants died from "mercury intoxication" and many others reported to have "Pink Disease." (Amin-Zaki, Elhassani, Majeed, Clarkson, Doherty, & Greenwood, 1974). The researchers reported, "four infants exposed postnatally did not exhibit signs or symptoms, though their blood levels were >1000ppb, and one was >1500ppb. This

remarkable phenomenon is not easily explained, although part of the answer may lie in the difficulty of assessing neurological function in this group" (p. 83). The researchers also document one survivor they traced for several years. At ten years of age he did not show visual field narrowing or numbness, as the researchers expected; however, the school reported that he was restless, easily distracted, and not interested in schoolwork, much like an Attention Deficit Disorder child of today. The wipes were later discontinued. However, it was not until 1982 that the FDA determined thimerosal to be toxic to cells and banned its use in over-the-counter drugs (Kirby, 2005).

The dangers of thimerosal were not only being explored in the use of vaccines, but in topical ointments as well. There were many documented concerns about the effects from topical use (Fagan, Pritchard, Clarkson & Greenwood, 1977); however, one clearly correlates with the vaccines. In 1973 in the files of Eli Lilly is an article entitled, "Dangers of Skin Burns from Thimerosal" which reported the case of a woman who received severe burns resulting from a chemical interaction between thimerosal and aluminum. The article suggested that thimerosal and aluminum should not be used together (Burton 2003; Fiasco 2002). Eli Lilly did add to their labels, “Do not use when aluminum may come in contact with treated skin." However, thimerosal and aluminum continued to be used together in the DTP and DTaP vaccines for years and today are combined in the flu vaccine. In 1974 Eli Lilly stopped their production of vaccines; however they continue to produce thimerosal until 1991 with licensing agreements giving them profitability until at least 2010 (patent, 1,672,615).

Murkhtarova (1977) conducted a study in Russia. The findings suggested adults with neuropathology were in correlation to their exposure to low doses of ethylmercury.

It must be noted that, at this time, this concentration was at a much lower dose than what American children were receiving at the time in the vaccines.

"The pathology of the nervous system presented certain peculiarities by comparison with the early period. In evidence were changes in the sympatico-adrenal system function, vascular lesions of the brain after the type of transient derangements of the cerebral circulation in the vertebro-basilar basin and angiospasms, diffuse changes in the nervous system with the predominant involvement of the hypothalamic cerebral structures and in some cases psychic disturbances were on record" (p. 4).

January 5, 1982 the Hepatitis-B vaccine containing thimerosal was initiated for adults who were at high risk of contracting Hepatitis B, i.e., IV drug users, prostitutes, etc. The same year the Swedish did a study of sensitivity to thimerosal, their findings revealed sensitivity in 10% of school children, 18% of twins, 16% military recruits, and 26% of medical students (Burton 2003). NBC (1982) aired a documentary entitled, "DTP: Vaccine Roulette" presenting the risks related to the DTP vaccine. The response was vaccine manufactures and physicians lobbying the United States Congress to establish legislation to protect them against lawsuits from vaccine injuries. Parents of vaccine-injured children fought for safety provisions to be presented into the legislation that would require mandatory physician reporting and record keeping of vaccine reactions.

Kravchenko, Sovetova, & Chebotareva (1982), of the State Research Institute of Standardization and Control of Medical and Biological Pharmaceuticals at the Ministry of Health in Moscow, published his study on the DTP vaccine. He stated, "The components of B. pertussis antigens and thimerosal solutions have been found to produce the most pronounced cytotoxic effect on cells" (p. 54).

In 1983 Clinical Toxicology of Commercial Products, 5th edition referred to ethyl mercury as, "ethyl mercury derivatives are virulent neurotoxins on either acute or chronic exposure. They are especially hazardous because of their volatility, their ability to penetrate epithelial and blood-brain barriers and their persistence in vivo" (Gosselin, 1984, p. III-270, p. II-136, p. III-266-7).

In March 1983, Kravchenko again published concerns of thimerosal's use,

"The toxic action of preparations kills and damages the cells at the site of injection, thus inducing the formation of autoantigens whose effect on the body cannot be predicted. Thimerosal, commonly used as a preservative, has been found not only to render its primary toxic effect, but also capable of changing properties of cells. This fact suggests that the use of Thimerosal for the preservation of medical biological preparations, especially those intended for children, is inadmissible" (Kravchenko, Dzagurov, & Chervonskaia, 1983, p. 87).

In another paper he stated, the concentration of thimerosal in just one vaccination was found to be enough to damage cells. He concluded, "Methiolate usage (thimerosal) for medical and biological preservation should be discontinued due to its high toxicity" (Kravchenko, Chervonskaia, & Mironova, 1986 p. 490). Three years from when his original study was published Magos, et al (1985) came out comparing the toxicology of ethyl and methyl mercury. The results were stated, "There was little difference in the neurotoxicities of methlymercury and ethylmercury when effects on the dorsal root ganglia or coordination disorders were compared." The researchers also stated, "The neurological signs and symptoms of methyl and ethyl mercury intoxication are identical" (p. 263). Magos suggested one reason may be due to the fact that the dorsal root ganglia does not have the same protective blood brain barrier that the rest of the brain has (Magos, 2001). Magos often references Powell and Jamison’s 1931 study as evidence to the safety of thimerosal, however, does not note that Powell and

Jamieson’s study was shown in 1931 omitted evidence and distorted their data. (Geier et al., 2007)

In 1985 the HiB (Haemophilus Influenzae Type B) vaccine is licensed and included on the vaccine schedule to be given three times in the first six months of life and once more by the age of two years. The vaccine contains 25 micrograms of thimerosal per shot. However, it is only recommended to "high risk" population, in 1991 the recommendation changed, it is added for all children. (CDC)

The following year, on November 14, 1986, Congress passes a Bill called, "The National Childhood Vaccine Injury Compensation Act" establishing a no fault compensation system for children injured by vaccinations. President Reagan signed Public Law 99-660 into effect. Parents could no longer sue vaccine manufactures and would have to go through the Federal government instead. Now the government would be responsible for paying for a child of vaccine injury or death instead of the manufacturers. This is done through the Vaccine Injury Compensation Program (VICP) which was established in 1987. Money is collected as a fee for each vaccine given in order to establish capital to cover damage as a result of the vaccines. Physicians and vaccine manufacturers are no longer liable for any injury or death caused to a child who received a vaccine (Public Law 99-660).

The same year the CDC recommended the recombinant Hepatitis B vaccine to be given within hours of birth plus two more times before the age of six months. They also recommended the Haemophilus Influenzae Type B vaccine to be added to the childhood vaccination schedule. The cumulative amount of ethylmercury that children were now being exposed to nearly tripled. This exceeded the FDA's more relaxed

maximum threshold of 0.4 micrograms per kilogram of body weight (FDA; U.S. Enviornmental Protection Agency). Each shot contains thimerosal with 12.5 micrograms of mercury, totaling 187.5 micrograms of mercury by the age of six months. Hence, by twenty-four months of life, if all thimerosal containing vaccines were received, a child would have been given 237.5 micrograms of mercury. The average weight for a two year old child is 12.9 kg (28.4 pounds), making the acceptable dose 5.16 micrograms in contrast to the 237.5 micrograms they are receiving. This is 232.34 micrograms more than the recommended dose, approximately 45 times more than the FDA's maximum limit. At the same time the U.S. Environmental Protection Agency (EPA) sets, still in effect today, the maximum safe level of exposure to mercury at .1mcg per kilogram per day. With these numbers in mind, at the day of birth an infant who receives the required Hepatitis B vaccine within hours of birth receives 12 micrograms, thirty times the EPA's set safe level. At four months the same infant is required to get the DTaP and Haemophilus Influenzae Type B containing together 50 micrograms of mercury, six times the EPA's set safe level. These numbers continue to increase. The same influenza vaccine given to an infant is given to an adult. According to the safety standards the infant would be required to weigh 330 pounds.

Kravchenko (1986), along with his colleagues continued to publish concerns regarding the dangers of Merthiolate (thimerosal). His research stated, "Merthiolate had the strongest irreversible lethal effect" (p. 491). He continued stating, "Merthiolate is toxic in a dose of 0.8 micrograms/ml" (p. 491). At this time most vaccines had 25 micrograms of mercury, except the Hepatitis B which contained 12.5, much higher than the safety limits recommended by Kravchenko. The Russians and Japanese by this

time had complied numerous studies on the dangers of Merthiolate; these studies were published in English and available through PubMed. At this time the Institute of Medicine (IOM), CDC, FDA, American Academy of Pediatrics (AAP) always would clarify any of their reviews on thimerosal by stating no conclusive evidence is available on studies in English, disregarding the Japanese and Russian studies (Stratton, Wilson, McCormick, 2002).

In 1990 the CDC began recommending to all Rh-negative mothers Rho-Gam or BayRho during pregnancy as well as directly after the birth. At times more shots are to be given due to "complications". Rho-Gam contains 10.5 micrograms of thimerosal per shot; Bay-Rho contains 35 micrograms per shot. The same year the CDC began recommending a second Hib vaccine to all children at fifteen months, both containing 25 micrograms of thimerosal. The CDC established The Vaccine Adverse Event Reporting System (VAERS) to monitor the safety of vaccines. However, the reporting system is voluntary and the CDC estimates less than 10% of actual adverse reactions seen with vaccines are reported by physicians or parents (CDC).

In 1991 it was noted that children born beginning in 1988 to 1991 show a significant jump in autism rates (Bradstreet, 2001). Other disabilities such as Attention Deficit Disorder, Attention Deficit Hyperactivity Disorder, Speech and Language Disorders, Behavioral and Emotional Disorders and others also begin to jump, along with Juvenile Diabetes, asthma and allergies.

The Institute of Medicine (IOM) was asked to evaluate the science on a possible connection between vaccines and autism. In 1991 IOM published Adverse Effects of

Pertussis and Rubella Vaccines and confirmed that pertussis and rubella vaccines can cause brain and immune system damage. The researchers concluded the study with,

"The committee found many gaps and limitations in knowledge bearing directly and indirectly on the safety of vaccines. Such shortcomings relate, for example, to pathologic mechanisms of specific infectious agents, the molecular basis of vaccine injury, and the natural history of conditions such as encephalopathy, mental retardation, and chronic arthritis. Although the committee was not charged with, and has not attempted, full consideration of the kinds of studies that would be both ethical and especially informative, either in the areas of vaccines that it has been charged to study or more generally it recognizes, nevertheless, that opportunities may exist for informative experiments in human populations that take advantage of the possibility of using alternative schedules for administration of vaccines. The availability and introduction of new forms of pertussis vaccine, for example, could offer valuable opportunities for comparison of vaccine safety as well as efficacy" (Institute of Medicine (U.S.). Committee to Review the Adverse Consequences of Pertussis and Rubella Vaccines., Howson, Howe, & Fineberg, 1991, p. 206).

The same year under the Carter administration, a national campaign to vaccinate all children with all CDC recommended vaccines by the age of two begins. "Every Child By Two (ECBT)," co-founded by former First Lady Rosalyn Carter and Better Bumpers, funded in part by Merck, Lederle, and Connaught pharmaceutical companies who are all major vaccine manufactures. (ecbt.org)

In the spring of 1991, Dr. Maurice Hilleman, vaccinologist, also senior Vice President of Merck, sent an internal memo to CEO Dr. Gordon Douglas, head of Merck's Vaccine Division, stating a panel of vaccine experts at Merck had serious concerns regarding the recommended changes in the Childhood Vaccine Schedule. Their concern revolved around the high doses of mercury to infants. The memo specifically stated the babies would receive 89 times the legal acceptable limit of mercury exposure. Their recommendation was to remove thimerosal from the vaccines. Merck did not remove the thimerosal (Levin, 2005).

In 1991, manufactures of animal vaccines were banned from using thimerosal (Rock, 2004); in contrast that same year the CDC recommended infants be injected with a series of vaccines containing thimerosal. Their recommendation is that within twenty-four hours of birth newborns should be vaccinated for hepatitis B (HepB), and two-month-old infants should be vaccinated for haemophilus influenzae B (HiB) and diphtheria-tetanus-pertussis (DTP). All contain thimerosal, which increased the exposure 150%. Prior to 1989, preschoolers living in the U.S. were recommended to receive eleven vaccinations (some in multiples): polio, diphtheria-tetanus-pertussis and measles-mumps-rubella. By 1999, the CDC recommended that children were to receive twenty-two vaccinations by the time they reached first grade. Despite many warnings, including members of their own staff, thimerosal continued to be put into childhood vaccines. At two months of age, infants were recommended to receive three inoculations that contained a total of 62.5 micrograms of ethylmercury, 99 times greater than the EPA's limit for daily exposure to methylmercury, a related neurotoxin. There have been several research studies suggesting ethylmercury is actually more toxic to developing brains and stays in the brain longer than methylmercury (Clarkson. 2002).

On April 22, 1998 the FDA completed its proposed ban on the over-the-counter use of thimerosal from topical ointments and skin creams. This decision is based on a report from their advisory committee that was submitted in 1980, eighteen years previously.

In 1999 the U.S. Public Health Services (USPHS) and the American Academy of Pediatrics (AAP) issued a joint statement in which they identified thimerosal as a widespread organic mercury exposure in infants/small children and recommended that it

should be reduced or eliminated from childhood vaccines (Centers for Disease Control and Prevention, 1999).

A subset beneath the CDC is the “Agency for Toxic Substances and Disease Registry” (ATSDR). In their April 1999 release of information, mercury is listed as a toxic substance. They state,

"The nervous system is very sensitive to all forms of mercury. Very young children are more sensitive to mercury than adults. Mercury's harmful effects that may be passed from the mother to the fetus include brain damage, mental retardation, incoordination, blindness, seizures, and inability to speak. Children poisoned by mercury may develop problems of their nervous and digestive systems, and kidney damage. Effects on brain functioning may result in irritability, shyness, tremors, changes in vision or hearing, and memory problems." (www.atsdr.cdc.gov)

The symptoms listed by the ATSDR as mercury poisoning do correlate with symptoms of autism.

The CDC does not follow their own advice as found in the ATSDR's final comment on mercury, "Properly dispose of older medicines that contain mercury. Keep all mercury-containing medicines away from children." Ironically, the ATSDR who is directly under the supervision of the CDC has stated for years to keep mercury containing medicines away from children, yet children are still given vaccines containing thimerosal today through the influenza vaccine.

By 1999, there was a compilation of research relating to people's different sensitivity to mercury, almost reflecting that of an allergic reaction. Most of the research reflected the topical use of mercury, however there was substantial research also with the inoculations. Stejskal & Stejskal (1999), Associate Professor of Immunology in the Department of Clinical Chemistry at Danderyd Hospital and Karolinska Institute in Stockholm, Sweden, has extensively published on adverse effects of metals on the

human body. One publication in "Neuroendocrinology Letters" titled, "The role of metals in autoimmunity and the link to neuroendocrinology" stated,

> "In contrast to the toxic effects of metals, the concentration of the metal in a sensitized individual is of minor importance. Minute concentrations of an allergen can induce systemic reactions in sensitized individuals. In such a situation, metal induced inflammatory reactions in the brain or elsewhere could be triggered despite low concentrations detected in body fluids or locally" (p. 10).

Stejskal has also developed a blood test to diagnose a person's allergy to metal that is available in the United States; however, it is not used. This could offer one reason why some children appear to be more sensitive to the outcomes of mercury poisonings and the possible genetic link with the sensitivity.

June 28, 1999, Dr. Barry Rumack, a consultant to the FDA, developed a pharmacokinetic model to analyze the amount of mercury to which infants are being exposed. He demonstrated most children born in the 1990's received doses of ethylmercury through vaccination that exceeded the EPA's limits for exposure to methylmercury, which was 0.1 micrograms per kilogram, and the FDA's limits of 0.4 micrograms per kilogram, during the first six months of their life. The safety limits were also in excess of those established by the ATSDR and WHO (Peterson, 1978; Congress, 2003).

In response to the heated concern over thimerosal the CDC's Advisory Committee on Immunization Practices (ACI) met in Atlanta, Georgia. One issue presented was the option of stating a preference for the thimerosal-free DTaP, Hib and Hepatitis B. The DTaP thimerosal-free vaccine was now in production by SmithKline Beecham. The other three manufacturers, Aventis Pasteur, North American Vaccine and Wyeth, were still producing vaccines with thimerosal. Manufactures of the Hib and

Hepatitis B vaccine had recently converted to thimerosal-free or contained trace amounts of thimerosal, however, older versions on these vaccines containing thimerosal were still in inventory hence being used around the country. The conclusion was the CDC officials, led by Bernier, would not state a preference for thimerosal-free vaccines. His reasoning, it could entail financial losses if current vaccine inventory is wasted. It could harm one or more manufacturers and may then decrease the number of suppliers. He went on to compare it to the transition from oral polio to inactivated polio. In the end, the advisory committee voted unanimously not to state a preference for thimerosal-free vaccines (Levin, 2004).

In the fall of 1999 the CDC obtained data from the Vaccine Safety Database (VSD) to begin a study of the possible link between thimerosal and Neurodevelopmental Disorders that were documented to be caused by mercury exposure in children. Some of these conditions were Autism, Attention Deficit Disorder, Attention Deficit Hyperactivity Disorder, Speech Delays, Language Delays, Eating Disorders, Sleep Disorders, Emotional Disorders, Behavioral Disorders, Coordination Disorders, Tics, and others. Kidney disorders and, as a control, disorders not known to be associated with effects from mercury such as Mental Retardation and Cerebral Palsy were also added (Vaccine Safety Datalink Project, CDC). The first analysis showed a comparison of children who never received thimerosal compared to those who had. The results in the Neurodevelopmental Disorders demonstrated a level of causation in Autism, Attention Deficit Disorder, Attention Deficit Hyperactivity Disorder, Coordination Disorder, Sleep Disorders, Tic Disorders, Speech and Language Disorders, Convulsive Epilepsy and Kidney Disorders.

In a letter from Congressman David Weldon (R-Fla) to the director of the CDC, Dr. Julie L. Gerberding (copy in Appendix B), Weldon discuss Dr. Verstraeten's study "found a significant association between exposure to thimerosal containing vaccines (TCVs) and autism and neurological developmental delays (NDDs)." (Weldon, personal communication October 31, 2003). In response to the investigation, on December 17, 1999 at 4:40 PM, Dr. Thomas Verstraeten sent an e-mail to Robert Davis, CC'd to Frank DeStefano titled: "It just won't go away." In the e-mail Dr. Verstraeten discusses the different methods he used in the analysis. One method he wrote about was to drop the data of children who received the Hepatitis B Immunoglobulin. This vaccine contained 37.5 micrograms of mercury from thimerosal and was given at birth. When he eliminated those children, about 1/4 of most disorders and 1/3 of the autism cases were also eliminated. He concluded, "that except for epilepsy, all the harm is done in the first month." He referred to autism, Attention Deficit Disorder, Speech and Language Disorders, Sleep Disorders and Coordination Disorders as the "first five." He ended with, "...I haven't yet found an alternative explanation...Please let me know if you can think of one." All of the research conducted by Dr. Verstraeten was never released to the public, or given to Congress to evaluate during their investigation. Dr. Verstraeten was also questioned for falsely stating he "worked" for the CDC when he actually obtained his salary from GlaxoSmithKline (GSK). However, almost four years later, in the journal Pediatrics, he published the opposite, no correlation to any neurodevelopmental problems related to thimerosal exposure to infants (Verstraeten, 2003; Verstraeten, personal communication, December 17, 1999).

During the late 1980's to the early 2000's infants may have been exposed to a total of 237.5 micrograms of mercury during the first 18-24 months of life, if all thimerosal containing vaccines were received.

By April 2000 the statistics still were showing a correlation between thimerosal and autism. Concerned with the outcome, Coleen Boyle from the CDC advised more changes to manipulate the date in an e-mail to Frank Destefano entitled "comments of analysis." "Since most of the dx's [diagnosis] are generally not picked up until the 2nd or 3rd year of life had you considered eligibility criteria of at least 18 months or 2 years?? What happens if you do this? [Also], early dx of these disorders is strongly associated with SES -- can you control for your marker variable of SES (Not sure SES is related to thimerosal, but surely compliance with vaccination schedule.)" (Boyle, personal communication, April 25, 2000).

The Committee on the Toxicological Effects of Methylmercury (2000), Board on Environmental Studies and Toxicology, National Research Council published *Toxicological Effects of Methylmercury* in the National Academy of Sciences. In it they stated a correlation between the autoimmune disorders and mercury (National Research Council [U.S.]. Committee on the Toxicological Effects of Methylmercury, 2000). James, et al., (2005), FDA scientists, stated in the *Journal of Neurotoxicology* "Thimerosal crosses the blood-brain and placental barriers and results in appreciable mercury content in tissues including the brain" (James, et al., 2005 p. 5).

In April 2000, a document, "Autism: A Unique Type of Mercury Poisoning" was authored by Bernard, Enayati, Binstock, Roger, Redwood and McGinnis. They demonstrated similarities between the mercury poisoning, Acrodynia, commonly

referred to as Pink Disease, and children with autism. They refer back to the studies that show Acrodynia can occur from very small exposures. They concluded that mercury might be the likely etiology of Autism Spectrum Disorder, deriving from thimerosal in vaccines, "due to the extensive parallels between autism and HgP [mercury poisoning], the likelihood of a causal relationship is great" (Bernard, 2003 p. 467).

On June 7th and 8th, 2000 a very controversial meeting was held by the CDC at the Simpsonwood Retreat Center in Atlanta, Georgia. Those in attendance were the CDC Advisory Committee on Immunization Practices, members of the American Academy of Pediatrics, The National Immunization Program, the Chief Medical Officer for the Vaccine Injury Compensation Program, a representative with the European Agency for the Evaluation of Medicinal Products, a representative for the World Health Organization (WHO), the FDA, and representatives with HMO organization Northern California Kaiser, as well as pharmaceutical company representatives for SmithKline Beecham, Merck, North American Vaccine, Aventis Pasteur, and Wyeth. The controversy arose over the fact that the meeting, as required by law, was not announced publically in the Federal Register. The original transcripts of the meeting were stamped on the top of each page, “DO NOT COPY OR RELEASE**”** and “CONFIDENTIAL.” However, today the entire transcript is available through the Freedom of Information Act.

The contents of the meeting were nothing less than frightening in regards to the knowledge that was being kept from the public. In response to thimerosal and autism Dr. Weil comments, "The number of dose related relationships are linear and

statistically significant. You can play with this all you want, they are linear. They are statistically significant" (Simpsonwood, p. 207).

By July of 2000 the data collected by the Congressional Investigation documented an average of 8,000 children daily were being exposed to mercury that exceeded all federal guidelines. During the congressional hearing, Dr. Stephanie Cave, a physician who specialized in children with symptoms of autism testified before Congress. She discussed the tremendous increase in her patients with autistic symptoms. She referenced treating over 300 of these children with a waiting list of 150 more. She closed by stating autism to be a true epidemic and challenged anyone who disagreed to sit in her office for a few hours. After listening to the testimonies, Congresswoman Helen Chenweth-Hage expressed her frustration to Congress. She questioned members of the Federal government agencies who were still denying that all types of mercury are toxic and could cause harm. Her testimony included her statements,

"You listened to the testimony just as I did, and you are willing to, with a straight face, tell us that you are eventually going to phase this out after we know that a small baby's body is slammed with 62 times the amount of mercury that it is supposed to have...It doesn't make sense. No wonder people are losing faith in their government. And to have one of the witnesses tell us it is because mothers eat too much fish! Come on. We expect you to get real. We heard devastating testimony in this hearing today, and we heard it last April. And this is the kind of response we get from our government agencies? I am sorry. When I was a little girl, my daddy talked to me about something about a duck test. I would ask each one of you to read this very excellent work by Sallie Bernard and Albert Enayati, who testified here today. My daddy used to say if it walks like a duck and talks like a duck and sounds like a duck, for Pete's sake it is a duck. I recommend that you read this, side-by-side, page after page of analysis of the symptoms of people who are affected with mercury poisoning compared to autism. This is the duck test, and you folks are trying to tell us that you can't take this off the market when 8,000 children are going to be injected tomorrow; 80 children may be coming down, beginning tomorrow, with autism? What if there was an E. coli scare? What if there was a problem with an automobile? Mr. Egan, [FDA] I will address this to you. You

know, it was shown in the last panel that autistic symptoms emerge after vaccination. It was shown that vaccines contain toxic doses of mercury. It was shown that in autism and mercury poisoning, the physiological comparison is striking. There is altered neurotransmitter activity, abnormal brain neuronal organization, immune system disturbance, EEG abnormalities. It goes on and on and on, the comparisons. That is why I say, I back up what the Chairman and the ranking member are all asking you, that we cannot wait until 2001 to have this pulled off. You know, if a jury were to look at this, the circumstantial evidence would be overwhelming. Let's do something before we see it in the courts." (Congressional Hearing 2000)

Dr. Bernard Rimland, one of the most recognized researchers in the field of autism, began his research regarding connections between autism and vaccines. He had a data base, through the Autism Research Institute, where he collected data from over 30,000 cases of autism worldwide. His findings led him to conclude that before the early 1980's most parents of children with autism reported the conditions at birth or in the first year of life. In contrast, after the mid-1980's the parent's reports began to change to after the first eighteen months of life (Rimland, 2000).

Pollard, Pearson, Hultman, Deane, Lindh, & Kono (2001) conducted a study that showed that mice genetically susceptible to autoimmune disease developed a mercury-induced autoimmune disease after treatment with inorganic mercury. The researchers conclude with their findings "suggests that environmentally relevant tissue levels of mercury could be associated with exacerbations of autoimmunity in genetically susceptible hosts" (p. 30).

Fournie et al., (2001) published a study done in France looking at the effects of thimerosal on the autoimmune system. Their findings suggested that compounds such as thimerosal can trigger the development of autoimmunity through a bystander effect. They went on to say that understanding this effect can lead to better knowledge in screening individuals who could be at risk.

Sanfeliu, Sebastia, and Ki (2001) published a study in "*Neurotoxicology*" called, "Methylmercury Neurotoxicity in Cultures of Human Neurons, Astrocytes, Neuroblastoma Cells." The study implicates reactive oxygen species (ROS) and depletion of intracellular glutathione as major contributors to mercury-induced cytotoxicity, with neuroblastoma cells being the most sensitive to the mercury. Glutathione deficits are documented as a common trait in children with autism (James, Rose, Melnyk, Jerigan, Blossom, Pavliv, & Gaylor, 2009).

On April 25 and 26, 2001 there was another Congressional Hearing entitled, "Autism: Why the increase rates?" Dr. Boyd Haley, Chairman of the Chemistry Department at the University of Kentucky, testified after eleven years of studying the toxicity of mercury. Haley begins his testimony stating he was requested to perform an evaluation on the toxicity of vaccines containing thimerosal versus thimerosal free. Haley went on to compare his results with the toxicity reports of 1986, stating his results were very dramatic in relation to the toxicity of thimerosal. Haley responded to questioning by Burton,

> “I am probably one of the few people here who does not treat patients. I am a research scientist and I work in a lab. I was asked some time ago to look and go to the bottom line. Are the vaccine mixtures that we are placing in the children toxic? If they are going to have an effect on autism or any disease or any neurological disorder, there is a good possibility, if it comes from the chemical level, that vaccines have to show some toxicity at the molecular level. We did test vaccines, and I will make this very short because I know we are in a hurry. We compared the vaccines with and without thimerosal from the same source, the same type of vaccine, and those with thimerosal present were remarkably much more toxic--over 10-fold to 100-fold more toxic than those without thimerosal. There was one outstanding exception, and that was the MMR vaccine. The MMR vaccine was as toxic as the vaccines with thimerosal, but there is no thimerosal in the MMR. We measured I would point out also that the toxicity is thimerosal in a vaccine mixture. In our studies, we looked at combined toxicities because we are not rats living in a pristine cage. Aluminum is a neurotoxin, formaldehyde is neurotoxic, and you

throw that in with thimerosal, which breaks down to ethyl mercury, a well-known toxin." (p. 63)

When drilled about his study of non-thimerosal vaccines Haley reported,

Dr. Haley. We looked at the level of mercury. It fit what you would expect. There are low levels of mercury in the non- thimerosal-containing vaccines. There is some in all of them. The ones that had thimerosal added were quite high. The MMR came across as if it had no thimerosal added. There was a small amount in there. I think it would be similar to those that had no thimerosal added. There was mercury in there, but not very much. (p. 79-80)
Mr. Burton. There was mercury in the MMR vaccine?
Dr. Haley. Yes, but a very small amount.
Mr. Burton. But there was mercury in the vaccine?
Dr. Haley. Yes, but the toxicity----
Mr. Burton. Merck, when we called awhile ago, said that there was no mercury in the MMR vaccine. You are saying that there was a very small amount.
Dr. Haley. Yes, we found it. I would want to do 20 of them before I came up with an average, but we did find a small amount of mercury. It was very tiny, though. The MMR vaccine, unlike those vaccines without thimerosal, was very toxic. It was as toxic as if it had thimerosal in it.
Mr. Burton. So would you say it was 10 times more toxic than a vaccine without thimerosal?
Dr. Haley. I would say so, yes. (p. 80)

Haley went on to discuss the inability of infants to effectively remove mercury and aluminum from their systems. Haley discussed the fact that the best known way of removal of mercury is through their bile, and consequently infants do not make bile in their early months of life, and the removal of aluminum in the renal system, however, infants do not have a fully developed renal system, hence, they would therefore be unable to remove mercury and aluminum through the bilary transport and renal system. (Congress of the U.S. 2001).

Lucier (2001), a toxicologist and former Director of the Environmental Toxicology Program at the National Institute for Environmental Health Sciences presented a slide of the "Comparative Toxicity of Ethyl and Methyl Mercury" to the Institute of Medicine

Immunization Safety Review Committee July 2001. The presentation concluded thimerosal is a potentially toxic substance. On slide number 14, he listed the "Clinical Manifestations of Ethylmercury Poisoning Episodes" as: speech disorders, vision disorders, tremor, ataxia, spasticity, delirium, and death.

By mid-2001, vaccine manufactures independent from the CDC had claimed to have completed their transition to "thimerosal-free" or "trace amounts of thimerosal" Hib, DTaP, and Hepatitis B vaccine. However, due to the stockpiles of vaccines still available in the physician's office the transition did not occur until late 2001 to early 2003. However, The Health Advocacy in Public Interest (HAPI) conducted a study of "mercury free" vaccines. Four vials were sent to Doctor's Data, an independent lab that specializes in heavy metal testing. The lab found all four vials contained mercury. According to Haley, the mercury binds to the antigenic protein in the vaccine making it impossible to completely filter out the mercury. (The manufactures still use thimerosal in the production of vaccines because thimerosal is still a component in vaccines sent to third world countries.) In contrast, the CDC began to recommend pregnant women, infants and children receive a yearly flu vaccine, which contains thimerosal.

July of 2001 again proved to be a controversial time in the vaccine industry. Verstraeten, the lead researcher in the CDC studies, was asked to testify at a meeting held by the Institute of Medicine about the safety of thimerosal and its link to autism. He began his testimony with the announcement that just hours before the meeting he was hired by GlaxoSmithKline, one of the vaccine manufactures who produced thimerosal vaccines and who was named in a lawsuit filed by parents of autistic children. Even after his announcement, Verstraeten continued to work on the CDC study designed to

determine if there was a connection between neurodevelopmental disorders and autism despite an apparent conflict of interest as being an employee of the vaccine manufacturer.

October 2001, Merck Pharmaceuticals continued to send out the remaining thimerosal Hepatitis B vaccine to pediatricians that were manufactured in 1999. Due to the fact that they had made a statement that all Hepatitis B vaccines being manufactured were now mercury free versions most parents and physicians were unaware that they were still receiving vaccines with mercury. The vaccines were marked to expire during the year 2003.

In January 2002, for the first time ever, the CDC's Advisory Committee on Immunization Practices recommended that pregnant women in their second or third trimester and infants between 6 months and 24 months to get a flu vaccine. Flu shots still contain a full dose of thimerosal, 25 micrograms, with only one manufacturer, Evans, producing a flu vaccine with reduced Thimerosal.

February 2002 Dr. Thomas Clarkson, with the Department of Environmental Medicine at the University of Rochester School of Medicine in New York published his findings on mercury. He referenced the amount of mercury already found in adults and children from eating fish and how thimerosal in vaccines compiles with it. Clarkson concluded with, "In attempts to estimate health risks from thimerosal in vaccines, a key gap in our knowledge on the human toxicology of mercury has become apparent. Little is known about the tissue distribution and toxicity of mercury in human infants, or in animals for that matter" (Clarkson, 2002, p. 17).

Westphal (2002), Department of Occupational Health in Gottingen, Germany published his findings on thimerosal. The purpose of the study was to evaluate the relationship between thimerosal and the levels of glutathione S-transferase (GST) which is the body's defenses against thimerosal. They concluded their research with, "In conclusion, thimerosal induced strong effects in the cytochalasin B block in vitro micronucleus test in human lymphocytes. Inter-individual differences in the response were not linked to different GST genotypes. Since thimerosal was repeatedly shown to be genotoxic in vitro and in vivo, there is reason for concern about its widespread use" (p. 54).

On December 10, 2002 there was another committee hearing in Washington, before the House of Representatives. One of those who testified was Dr. David Baskin. He introduced himself by stating,

> "I'm a professor of neurosurgery and anesthesiology at Baylor College of Medicine. I'm a neurosurgeon. I do complex spine and brain surgery, about 350 cases a year. I have also been involved in research, looking at ways to protect the nervous system from damage and to reverse damage, for over 20 years, and have over $1 million in Federal funding, both from NIH and BIA, as well as State funding and private funding from foundations, to look at a variety of issues in terms of brain damage" (Baskin's testimony if found in Vaccines and the autism epidemic: Reviewing the federal government's track record and charting a course for the future 2002, p. 30).

When questioned about thimerosal his response was, "We are talking about a known poison, neurotoxin, that's been added to these vaccines with the initial idea that it would function as a preservative." He goes on to say, "Thimerosal was placed in vaccines in the late 1930's; and guess what: Three years later Kanner first described the syndrome of autism—never ever been described before in the medical literature. The neurotoxicity of mercury has been very well established in terms of brain injuries since the 1960's, as

you'll see." He goes on to explain the Iraq case when ethylmercury was used as a fungicide on grain and the knowledge that was gained about the neurological damage. When comparing what we have learned from past research and our current findings of autism he testifies,

"The brain damage in these cases was studied, and it's interesting that the type of brain damage seen was the loss of the Purkinje cells, which are cells in the cerebellum, and the loss of the cortical column, which is the part of our brain that is involved in complex thought. And guess what: At the recent meeting for autism research at the Society for Neuroscience, this exact same histopathology has been described in autism" (p. 34).

He goes on to name numerous studies that show evidence for the correlation between mercury poisoning and autism. He was asked in summary if he personally believed from his studies that mercury is a contributing factor to the cases of autism we have in this country. He answered with a simple, "Yes." He went on to discuss some of his research,

"We have the opportunity to actually grow human frontal cortex cells in cell culture. So these are cells from the front part of the brain that grows in culture. We incubate these cells with thimerosal at various doses, and we use a number of very sophisticated techniques to detect cell death and cell damage....These are the cells committing the suicide program and breaking themselves into tiny little pieces with a very low dose of mercury" (p. 46).

He continues,

"Here is a slide where you see a lot of blue cells. This is a blue dye that normal cells don't take up. In order for something to turn blue, the cell has to have holes punched in their membranes. And guess what: At an extraordinarily low dose of thimerosal, most of the cells are blue. It means that this stuff grabs hold of the membrane and punches holes into it, so that the dye can penetrate, not only into the cytoplasm but into the very center of the cell, the nucleus, where all the DNA exists. We found this to be dose-and time-dependent. We found that 101 nanograms per gram is the lowest dose we've studied, and it's toxic. And we didn't even expect this to be toxic, yet if you consider a five-times preferential uptake and you use FDA numbers, infants receive 380.5 nanograms, three times the dose that we found to be toxic to brain cells" (p. 47).

Baskin at Baylor College of Medicine demonstrated, “that thimerosal in micromolar concentrations rapidly induces membrane and DNA damage and initiate caspase-3-dependent apoptosis in human neurons and fibroblasts.” The researcher summaries the research with the need for more research in the area of toxicity of thimerosal since mercury can be retained in body organs for months to years (Baskin, Ngo, and Didenko, 2003, p 361).

Qvarnstrom, Lambertsson, Havarinasab, Hultman, and Frech (2003) published a study done in Sweden that analyzed the distribution of thimerosal into the tissue of mice. The researchers used Inductively Coupled Plasma Mass Spectrometry (ICPMS) which uses radioactive isotope labeling of mercury to determine the distribution of mercury species transformed from standard ethylmercury in the thimerosal. They concluded that thimerosal is rapidly taken up in organs, it is considered to be converted to inorganic mercury more rapidly than methylmercury. They go on to clarify their findings of the ethylmercury carbon bond being less stable than that of methylmercury. These findings could offer evidence as to the enhanced toxicity of thimerosal as opposed to the methylmercury found in fish.

It was not until 2003 that the makers of the Rho-GAM, now given to Rh-negative women in their twenty-eighth month of pregnancy and immediately after birth, removed the thimerosal. However, that same year the CDC and its Advisory Committee for vaccines still refused to state a preference for thimerosal-free vaccines, four years after the joint statement, the U.S. Public Health Services (USPHS) and the American Academy of Pediatrics (AAP) made the recommendation for the removal of thimerosal. According to the FDA, children were still recommended to get shots containing

thimerosal in vaccines: DTaP, Hib and Hepatitis B until the expiration dates expired in January 2003.

In June 2004, a study lead by Mady Hornig at Columbia University explored more into the effects of thimerosal on the autoimmune system and autistic like symptoms. In their report, the findings are again demonstrating the potential harm caused by thimerosal. There studies were done by giving mice thimerosal. They reported that exposure to thimerosal can increase the risk of autism-like damage in autoimmune strains of mice, including increased brain size. Other symptoms found were growth delay, reduced locomotion, anti-social behaviors, a decreased number of purkinje cells, densely packed hyperchromic hippocampal neurons with altered glutamate receptors and transporters, and significant abnormalities in brain architecture affecting areas subserving emotion and cognition (Hornig, Chian, & Lipkin, 2004).

On July 27, 2004, a group called Health Advocacy in the Public Interest (HAPI) had a meeting between their executive director, Dawn Winkler, and the FDA. The concern presented was the misrepresentation of ingredients in vaccines as licensed by the FDA through mislabeling, specifically labeling that stated mercury-free. The group had previously had four vaccines tested at a private laboratory, Doctor's Data, an independent lab which specializes in heavy metal testing. What they discovered is thimerosal is still being used in the vaccines, although they are not promoting it as a preservative. The vaccine manufactures claim was they were "filtering out" the thimerosal. Dr. Boyd Haley confirmed that mercury binds to the antigenic protein in vaccines; therefore, mercury cannot be completely filtered out. Two of the vials containing mercury were stated, "mercury free." Haley took a position to state that if

mercury can be detected in any vaccine using standard instrumentation, the content should be disclosed in the product insert and should not be labeled "mercury free." Another concern was all four contained aluminum, with one of the vials containing nine times more than the other three (Winkler, 2004). Aluminum mixed with mercury, as shown in the 1973 reports, greatly enhanced the toxicity (Burton 2003; Fiasco 2002).

September 2004, the United Kingdom banned all thimerosal-containing vaccines due to their concern of neurotoxicity, and more specifically the links between metal and autism. At this time many states have independently banned thimerosal containing vaccines; however, the federal government has not made this stand and further, the Homeland Security Bill allows the federal government to issue “forced vaccines,” including those tainted with thimerosal.

On February 8, 2005 an article came out in the Los Angeles Times, by Myron Levin, disclosing a memo a whistle blower released from Merck regarding their knowledge about the amount of mercury given on the vaccine schedule. The memo was from Dr. Maurice Hillman to Gordon Douglas in March 1991. Hillman said in the memo that "6-month-old children who received their shots on schedule would get a mercury dose up to 87 times higher than guidelines for the maximum daily consumption of mercury from fish. “When viewed in this way, the mercury load appears rather large,” said the memo from Dr. Maurice R. Hilleman, an internationally renowned vaccinologist. It was written to the president of Merck’s vaccine division (Levin, 2005). This was eight years before the health officials requested the removal of thimerosal from vaccines. Merck blamed the printing company for failure to copy the information in the memo to inform all of their staff.

March 6, 2008, a decision about an influential suit against the federal government was ruled on. Hannah Poling became the first case in which the federal authorities have conceded a connection between her autistic symptoms and the vaccines she received. A panel of medical evaluators at the Department of Health and Human Services concluded that Hannah had been injured by vaccines, thus came the recommendation that her family be compensated for the injuries. The panel said that Poling had an underlying cellular disorder (a mitochondrial dysfunction) that was aggravated by the vaccines, causing brain damage with features of Autism Spectrum Disorder (ASD). Because of a series of ear infections, Hannah had fallen behind in the vaccine schedule, so in a single day she was given five inoculations covering nine diseases: measles, mumps, rubella, polio, varicella, diphtheria, pertussis, tetanus, and Haemophilus influenzae. Not only was that a large dose of thimerosal, but a concerning level of viruses on one given day. The biggest question throughout the hearing was if the mitochondrial dysfunction was a result from the vaccines or the cause of the injury, that question was left unanswered.

Thimerosal, or mercury, in vaccines has been a controversial debate since the mid-1980's as to its effects on autism. There have been numerous studies comparing the behaviors of children with autism to those of mercury poisoning. Some have questioned why only some are affected and others are not. The above researchers answer that question with studies on the genetic make-up of those who are predisposed to a sensitivity to mercury versus those who are not; just as some can smoke and not get lung cancer, or someone directly exposed to a virus does not get sick while the person on the other side of the room is more susceptible to the virus and becomes ill.

Ever since 2005, most vaccines have removed thimerosal, except some DTaP and Influenza. However, the controversy over thimerosal and autism is still very much alive, some would go as far as to say due to the extensive parallels between autism and mercury poisoning the likelihood of a causal relationship is plausible.

Vaccines and Viral Overload

The second concern with vaccines and the relationship to autism lies in the relationship between viruses, autoimmune dysfunction, and the impact on the gastrointestinal (GI) system. Dr. Asperger also identified a link between celiac disease and their behavior (Asperger, 1961).

In the 1980's autism numbers began increasing at an alarming rate, at the same time the MMR vaccines was introduced. Wakefield, a leader in the philosophy of a connection between autism and the MMR vaccine, along with a team of researchers explored the connection between the MMR and autism. Wakefield, et al (1998) research documented, "evidence of anemia and IgA deficiency in some children, would support the hypothesis that the consequences of an inflamed or dysfunctional intestine may play a part in behavioral changes in some children" (Wakefield, 1998, p. 639). As a doctor of gastrointestinal medicine, he felt there was a correlation between the GI symptoms and autistic children. Several doctors in practice with him did intestinal biopsy samples on 160 children with GI issues, 90 autistic and 70 control. The results were the discovery of the measles virus in 75 of the 90 children with autism, but only 5 of the 70 control. This finding led him to the philosophy if he would treat the GI issues it may relieve the autistic behavior. Since that time Wakefield has published over 135 peer reviewed articles. Wakefield was not the only one looking at the GI connection with autism. Dr. Bernard

Rimland, after over 40 years of studying autism at the time also agreed with Dr. Wakefield's findings (Rimland, 2000). He also referred to Andrew Wakefield's work linking the MMR vaccine to autism, as a link to the large increase with "late-onset of autism" that arose during the 1980's when the MMR was first administered. Dr. Brent Taylor also did a study on the connection between the MMR and autism. Taylor's reported no connection. The article was also published in The Lancet, refuting Wakefield's study. As a researcher, Rimland asked for a copy of the data from Taylor's study published in *The Lancet* in order to reanalyze, a common professional courtesy. Taylor refused, as did the editor of *The Lancet*. Dr. Rimland, amongst many, has asked *The Lancet* to retract Taylor's comments if the data cannot be made available for reanalysis. *The Lancet* has been inconsistent with the issue. Even with the debate, the link to autism and the GI issues has grown, and more doctors are treating the GI issues in hopes to change the negative behavior of children with autism.

Wakefield is not the only one researching the GI connection with autism. Robert Bryd, principal investigator, in the California study, also in his summary of his research project stated a common trait of the autistic children born between 1983-1985 was gastrointestinal symptoms, including constipation and vomiting (MIND, 2003). In June 2006, Stephen J. Walker, Ph.D., an assistant professor of physiology and pharmacology at Wake Forest University Baptist Medical Center issued an abstract to be presented at the International Meeting for Autism Research. His research evidenced a high percentage of autistic children, tested by his colleagues and himself, as having chronic bowel disease. Walker explains that exploring the causes of chronic bowel disease in autistic children is the major impetus for his research. He expressed that the bowel

condition has a direct influence on cognitive and behavior issues that are associated with autism. He stated,

> “These kids experience it hour after hour every single day of their lives. Many of them are non-verbal so they can’t tell anybody what the problem is, and the behavior that they exhibit as a result of a severe stomach ache was once attributed to just being autistic and having weird behaviors, for example, leaning over the sharp edge of a coffee table for hours at a time. That seems weird, but what they’re doing is relieving pressure on their lower abdomen” (Press release from Wake Forest Baptist Medical Center, Walker 2008).

Posturing is a common trait of autistics that is researched in conjunction with GI issues. He goes on to state, “There’s case after case where kids improved cognitively, behaviorally and biomedically when you treat the bowel disease. There is a great improvement from better nutrition alone. You see improvements in their overall condition” (Walker, International Meeting for Autism Research Montreal, Canada 2006).

Over the past few years, there has been extensive publicity in the area of autism and GI issues. The focus has been to treat these conditions with the gluten free/casein free diets (GF/CF). Parents who have done the diet have made statements including their child has recovered, speech has begun, no longer fussy, and more attentive. Much of the publicity stemmed around the actress Jenny McCarthy when she announced her autistic son had recovered from autism by the diet. Many refute these statements saying these children are not actually autistic to begin with, but it is hard to convince the parents of these previously diagnosed children they have not recovered, or shown great improvements (Elder, Shankar, Shuster, Theriaque, Burns, Sherrill, 2006).

The link between gastrointestinal problems and autism appears to show a connection, especially in the 1980's. Some researchers link it to the MMR vaccine, but

the reason for the link appears to be coupled with the autoimmune dysfunction of those children and their sensitivity to the overload of viruses in their system.

Vaccines and Autoimmune

Singh (2002) has published extensively on the issue of autism and autoimmune disease. Along with Singh's research there are numerous other studies regarding the deficits of autoimmune system, all using the basic science of autoimmune disease generally suspected of being triggered by viruses, hence the correlation with the MMR. In one study, Singh, Lin, Newell, and Nelson (2002) used serum samples of 125 autistics and 92 control. The antibodies were analyzed by Enzyme-linked Immuno Sorbent Assay (ELISA), a technique used to detect the presence of an antibody or antigen. The results of the study showed the autistics had significant increase in MMR antibodies, but not in the control group. "Moreover, the elevated level of measles antibodies was strongly associated with brain autoantibodies, which led us to postulate a pathogenetic association of the measles virus to autoimmunity in autism" (p. 360).

Singh, et al., (2002) research, along with many others gave evidence that autistic children have numerous immune abnormalities: serum IgG3 increase, serum IgA decrease, (Gupta, Aggarwal, & Heads, 1996; Plioplys, Greaves, Kazemi, & Silverman, 1994) reduced number and function of lymphocytes, especially T helper cells and natural killer cells, (Warren, Foster, & Margaretten, 1987; Stubbs & Crawford, 1977) and increase plasma levels of autoimmunity-specific cytokines. Singh's (1996) research also had concluded, "Therefore, the increase of IL-l 2 and IFN-7 may suggest a defect of immunoregulatory T cells in autism (p.145). Singh's research referred often to the autoimmune system having a significant link to autism.

Singh and Jensen (2003) also studied the correlation with measles and autism in the published study, "Elevated Levels of Measles Antibodies in Children with Autism". A finding of the study demonstrated the correlation to the autoimmunity may play a causal role in autism, as related to the central nervous system, especially to the Myelin Basic Protein (MBP). The findings may be attributed to the correlation that the autistic children showed a serological correlation between MMR and brain autoimmunity, i.e., over 90% of MMR antibody-positive autistic sera also had autoantibodies to brain MBP. This is quite an intriguing observation in favor of a connection between atypical measles infection and autism; an atypical measles infection in the absence of a rash and unusual neurological symptoms was recently described to suggest the existence of a variant measles virus in children and adults. In light of the findings, it may suggest that considerable proportion of autistic cases may result from an atypical measles infection that does not produce a rash but causes neurological symptoms in some children. The source of this virus could be a variant measles virus or it could be the MMR vaccine.

On common trait in autism that cannot be disputed is the deficit in the autoimmune system. Whether the vaccines, especially the MMR, caused the deficit or the deficit was always there genetically is yet to be answered.

Vaccines and Demyelination

The last area of concern in regards to vaccines and autism is the concept of overtaxing the body with live viruses that contain viral contaminants that result in demyelination. There are several aspects of viral overload. One facet simply being too many vaccines given at one given time, causing an overload of viruses in the child that their body is unable to handle, often leading to autoimmune issues. (Kawashima, H.

Mori, Kashiwagi, Y., Hoshika, and Wakefield, 2000) The other facet is viral contamination, the fact that no vaccine is clean of other viruses that are obtained during the culturing and DNA acquired from the aborted fetal tissues used in many vaccines, hence the overload (Manufacture inserts from: Sanofi, Merck, and GlaxoSmithKline).

When a child's body is exposed to excess viral loads the body's response can be an inflammatory process in which the vessels become inflamed. When the vessels inflame, one of the responses of the body is hypercoagulabilty, in simple terms the tendency to form blood clots, also referred to as excessive thrombus formation. Clotting is the body's natural response to injury. This begins when the blood vessel is injured, it begins to leak blood, the body stops the leak through hemostasis, where the injured blood vessel constricts to reduce blood flow, and platelets adhere to the site of injury and clump together to form a platelet plug. This process begins the coagulation cascade. During the cascade process the body goes through a sequence of events beginning with bringing proteins to the site that create a net of fibrin threads that are woven through the platelet plug to strengthen the blood clot. The clot acts as a barrier to stop continuation of blood loss. However, in the brain this process also reduces the cerebral blood flow, not allowing the blood to adequately flow to the cells on the other side of the coagulation to bring the necessary oxygen and nutrients. Hence, the ischemia leads to hypoxia which leads to continuation of the inflammation. This environment traps the toxins, increases free radicals and thus may affects the myelination process. These findings regarding the biological effects upon nerves may attribute to the behavior and learning deficits of children with autism.

The main purpose of the sheath, or myelin layer, is to increase the speed at which impulses move along the myelinated fiber. Nerves can only conduct the energy correctly if covered by myelin. When there are unmyelinated fibers the flow of electrical current can become interrupted. The myelination helps avoid electrical current from leaving the axon; although the axon itself is not damaged it will cease to function if the myelin is not properly intact. When the myelination is not working correctly, a demyelinating disease, a disease of the nervous system, is evidenced by the myelin sheaths of neurons being damaged. This impairs the message being sent, affecting sensation, movement, cognition and other functions that rely on the nerves. There are very few pathways of myelin insulation at birth. The myelination continues to form in the human brain until about twenty years of age. Typically at the age of ten there are still areas of the cortex not yet myelinated. Between ten and twenty years of age the myelination of the frontal lobes begin to develop. (Edwards, Meade, Decker, Reed, Rennels, Steinhoff, 1995) The demyelination can be caused by an autoimmune reaction, or heavy metals, such as mercury (Bigazzi, 1994; Descotes, 1986). The myelinated axons are white in appearance, hence the term "white matter" of the brain. These connection cables are in the white matter of the brain. There have been numerous studies on the white matter differences in autistics. (Waiter, Williams, Murray, Gilchrist, Perrett, and Whiten 2005).

This process is very similar to the "leaky gut" syndrome that is spoken of in children with autism, except the inflammation process begins with the viruses in the gut and the leaking is reflective with the child having food allergies. (Leaky gut syndrome refers to a defect in the intestinal wall, the mucous layer, causing it to become porous.

This allows toxic substances, i.e., undigested proteins and fats, parasites, viruses and bacteria to enter the bloodstream. When these toxic substances enter the bloodstream the immune system reacts by forming antibodies. This becomes the groundwork of food allergies and auto-immune conditions.)

Another consequence of the virus overload is evidenced when the virus makes its way through the blood brain barrier. This can cause the meninges to inflame causing meningitis or even encephalitis. Often these symptoms, excessive crying, poor sleeping, grabbing head, ataxia, and high fever are not recognized by the medical community as an emergency situation. According to the medical community documentation on meningitis, viral meningitis is often misdiagnosed as the flu because of its similar symptoms. The Emergency Room rarely performs a lumbar puncture to check the white cell count in their spinal fluid, which would verify meningitis or encephalitis. Due to flu-like symptoms the parents are advised to wait it out. The symptoms may go away in a few days, however, the outcome of the encephalitis or meningitis may manifest itself as brain damage with traits seen in regressive autism (Gupta, Rapin, Houroupian, Roy, Llena, and Tandon, 1984).

In order to confirm the correlation between vaccines and autism, a comparison study within families would be ideal. Byrd (2002) attempted to do this during the California study. When he interviewed parents to what they felt caused the autism, an alarming number blamed the vaccines. He then attempted to do a comparison study with younger siblings; however, because such a large number of those parents did not vaccinate the younger child, the study, according to Byrd, was not feasible. The next

best thing would be to look at populations of people who vaccinate versus those who do not, Olmsted and Blaxill (2010) attempted to accomplish this task.

In order to look for a comparison of vaccinated children to unvaccinated children Olmsted did what he claims is the research the vaccine industry and the media refused to do, look for groups of unvaccinated population. The Amish children in rural Lancaster became one area of exploration for him. In his discoveries, there were virtually no children with autism amongst the thousands of unvaccinated children of the Amish. "I have not seen autism with the Amish," said Dr. Frank Noonan, a family practitioner in Lancaster County, Pennsylvania, who has treated thousands of Amish for a quarter-century. "You'll find all the other stuff, but we don't find the autism. We're right in the heart of Amish country and seeing none, and that's just the way it is" (Olmsted and Blaxill, p. 156). In dispute to these findings, CDC Director Dr. Julie Gerberding states "(the Amish) have genetic connectivity that would make them different from populations that are in other sectors of the United States" (Park, 2008). Gerberding presents the different genetic connectivity as a fact, although this claim has never been tested. Outside of the Amish, in metropolitan Chicago is a fairly large medical practice that has served between 30,000 and 35,000 children, Homefirst Health Services. While very different from the Amish, what they do have in common with them is the absence of vaccinations. Dr. Mayer Eisenstein, the medical director at Homefirst Health Services, who also has a Bachelor's Degree in Statistics, a Master's Degree in Public Health and a Law Degree, along with his Medical Doctor's Degree, states, "I don't think we have a single case of autism in children delivered by us who never received vaccines," His practice was founded in 1973. According to Dr. Paul Schattauer, who has been a doctor

in their practice for over 20 years, says they treat at least 100 children a week. Dr. Schattauer confirms Dr. Eisenstein's observations stating, "All I know is in my practice I don't see autism. There is no striking 1-in-166," he said (Homefirst Health Services, 2010).

The correlation between vaccines and autism does present with some strong evidence. However, the research that showed improvements in autistic symptoms such as behavior, speech and socialization when the children were treated for the reaction that may have occurred from the vaccines.

Etiology: Genetics

Pure genetics is another theory as to the etiology of autism, outside of the theory of genetic susceptibility. Some claim children with autism would be autistic, no matter what, due to genetics. However, it is statistically impossible to have a genetic epidemic in such a short period of time, according to the epidemiologists involved in the Byrd (2002) California study. Hence, why much of the research involving genetics and autism involves looking at how genetics has a role in susceptibility to toxins and the autoimmune dysfunction, again the link back to vaccines (Haley, 2005). Haley (2007), of the University of Kentucky, has spent many years studying the effect of mercury on the body. He has researched one possible genetic risk factor in autistics. There is a protein in the brain called APO-E. Haley refers to this protein as the housekeeping protein that removes dangerous waste out of the brain. Some individuals are born with a variety of this protein that can effectively remove mercury, APO-E, some people have a variety of this protein, APO-E4, that cannot carry out the mercury. Interestingly, when these proteins have been analyzed in autistic children a huge number of them had APO-E4.

This would reflect in an inability to detoxify the mercury from the vaccines thus being a key element in the genetic element of autism.

As evidenced by the previous information, when looking at the possible etiologies of autism, misdiagnosis, vaccines, or genetics, it appears that some ideas have very little validity, while others could clearly be explained more with further research. However, one fact is clear; vaccines show a plausible link to autism. One researcher, Dr. Bernard Rimland, spent over 50 years researching in the field of autism, leaving the field with a tremendous amount of knowledge from his studies.

Bernard Rimland

Bernard Rimland, PhD, was one of the first to question autism as an emotional/physiological disorder, disputing the “refrigerator mother” theory. After his son was born in 1956, he soon found himself in the world of autism. On an interesting note, although he had a degree in psychology and a doctorate degree in Experimental Psychology his wife was the one to diagnose their son with autism by referencing Rimland’s college textbooks. Autism at the time was almost unheard of. In 1964, after years of intense research on the subject of autism, Bernard Rimland published his book *Infantile Autism: the syndrome and its implications for a neural theory of behavior*. In his book, Rimland, insisted, “Autism is a biological disorder which can be treated with biomedical and behavioral therapies” (p. 29) In 1965, he founded the Autism Society of America and in 1967 the Autism Research Institute. He is probably best known for his intense push for Applied Behavioral Analysis (ABA) in the United States, a therapy pioneered by the Norwegian psychologist Ivar Lovaas from the University of California, Los Angeles. Although Rimland fully believed in the practice of traditional educational

interventions such as ABA, he did not believe in the traditional theories of the etiology of autism. He never left his theory of autism being a result of environmental factors that must be addressed and researched.

Not dismissing the genetic elements of autism, Rimland was convinced that "genetic susceptibility was triggered by external insults." He cited three main areas, environmental pollutants, including food dyes and fertilizers, antibiotics which destroy as much as 85% of the good bacteria in the gut (gut flora) causing an increase in Candida and GI disorders, MMR and its link to GI disorders, and lastly, he was convinced that thimerosal was a vital link to autism (Rimland, 2006).

Lastly, after devoting his life to intense research, Rimland was insistent that autism was on the increase. He would not accept the theory that doctors and educators are just becoming more aware, therefore increasing the diagnosing of autism. In April of 2000 Rimland testified before the House Committee on Government Reform. He stated, "That is nonsense. Any pediatrician, teacher or school official with 20 or more years of experience will confirm there is a real increase in autism and the numbers are rising" (Rimland, 2000).

Rimland's views on biomedical treatments are just as radical. He was in full support of vitamin supplements, and the Gluten Free/Casein Free (GF/CF) diets. He felt the child with autism had a weak immune and digestive system, making the child more susceptible to environmental factors and having difficulty absorbing nutrients. After all his years of study, Rimland was convinced "autism is treatable" (testimony of Bernard Rimland, Before House Committee on Government Reform, 2000).

Etiology: summary

In review of the data from the FDA, CDC, congressional hearings, and scientific evidence, exposure to mercury in humans can result in immune, sensory, neurological, motor, and behavioral dysfunctions. These symptoms parallel the core deficits of autism. Whether, thimerosal latent vaccines are or are not the cause of autism, there are many unanswered questions as to the damage caused by thimerosal.

Whatever the reason for the increase in autism, parents are agreeing with Rimland and are looking intently for alternative therapies and interventions to treat their child/ren. Throughout the years there have been many new, and some revision of old, therapies being used to treat children with autism; however, there is a lack of empirical research for these therapies. In order to better inform the parents there is a need for research in the increasing realm of biomedical therapies for children with autism (Roylance and Cohn, 2011). One area of growing interest with these parents is hyperbaric oxygen therapy.

The analysis of possible etiologies of autism can be further evaluated and applied diagnostically through medical research. The premise of a toxic insult or viral overload as possible cause of autism would give necessity to findings of neurological abnormalities in people with autism that align with the medical research of effects of heavy metal poisoning and viral overload. The review of literature in the area of autism is necessary to understand further the possible etiology of autism and giving application to the correlations to possible treatments and educational plans.

Brain Research--Hypoperfusion

When a typical person focuses on a task or generates speech, the brain is doing more work and there is an increase perfusion with the blood flow to the brain. This

increase in the blood flow to the brain supplies the brain with more oxygen and glucose, giving the cells their needed energy to perform their task. In autistic children, several studies have shown the opposite; these children actually have diminished blood flow to begin with, and when their brain is attempting to perform a task, such as generating speech or focusing, their blood flow does not increase giving them the needed oxygen and glucose the cells need (Fox, 1986, Muller, 1999). There is vasoconstriction instead of vasodilatation in the blood vessels. (Allen, 2003) This has been verified by studies that show an increase in p53 and a decrease in Bcl-2 in the brains of some children with autism. (Araghi-Niknam, 2003) Thus giving evidence for an indication of damage as a result of cerebral hypoxia (impaired oxygen delivery), resulting from the hypoperfusion. This is in correlation with the previously stated outcome of viral overload affecting the myelination process as a result of the ischemic effects from inflammatory process in which the vessels become inflamed and a downward spiral effects takes place resulting in cerebral hypoperfusion.

Cerebral hypoperfusion is simply decreased blood flow to the brain. There have been numerous studies in the medical literature demonstrating hypoperfusion in children with autism. “Bi-temporal hypoperfusion was confirmed in three independent groups of autistic children and provided the first robust evidence for localized dysfunction of the cerebral cortex in school-age children with primary autism.” (Boddaert and Zilbovicius 2002, p. 4) With newer upgraded brain-imaging cameras, detecting hypoperfusion in children with autism continues to become more defined. One way this has been documented is through the use of SPECT scans. One study conducted by Wilcox (2002) in the Department of Psychiatry at Texas Tech University Health

Sciences Center showed the hypoperfusion typically worsened with the age of the child, becoming quite profound in older children. The diminished blood flow can be seen with a clear correlation to many core autistic symptoms/behaviors. For example, when the Thalamus has hypoperfusion the results are repetitive, self-stimulatory, and unusual behaviors. When hypoperfusion is found in the temporal lobes the results are desire for sameness and social/communication impairments, or in the cingulate gyrus the outcome is manifested in difficulty recognizing familiar faces. Reduction on cerebral blood flow in the amygdale results in social deficits such as the ability to feel emotion and understand other's emotions, and response to danger, and anxiety. (Ohnishi Matsuda, Hashimoto, Kunihiro, Nishikawa, Uema, and Sasaki, 2000)

In order to look further into hypoperfusion, specifically in the temporal lobe, Zilbovicius, Boddaert, Belin, Poline, Remy, Mangin, J…. Samson (2000) conducted a study using a PET scan. The advancements in PET scans allowed the researchers to look for abnormalities in regional cerebral blood flow (rCBF). The study consisted of twenty-one children with autism and ten non-autistic children. Later, twelve more children with autism were added to the study. The children each had a PET scan and the image was reconstructed into 63 slices. The images were compared with t and Z statistics. The results revealed that the autistic group had significant hypoperfusion. There was no hypoperfusion in the comparison group. Regions with maximal hypoperfusion in the autistic group were centered in the left superior temporal gyrus, the right superior temporal gyrus, and in the right superior temporal sulcus (thought to process the human voice and coding facial expressions). These areas are involved in auditory processing. The left side generates an understanding of individual words; the right side deals with

pitch, melody and sound intensity. When this study was redone on an additional twelve children with autism, the results were within millimeters of the initial study. They concluded there could be a correlation between the hypoperfusion and the deficits found in children with autism. The temporal lobe dysfunction is related to sensory abnormalities, thought also to be central to the processing information about the world around us. The right superior temporal sulcus hypoperfusion may reflect the difficulties for the children to respond to voices and/or read faces.

Critchley, Daly, Bullmore, Williams, Amelsvoort, Robertson, Rowe, et al. (2000) colleagues published a study where they measured for changes in the cerebral blood flow when people with autistic disorder process facial expressions. Although high-functioning individuals with autistic disorder have normal to superior range of intelligence; they have abnormalities in social communication and emotional behavior that tends to not improve over time. The difficulty processing facial expressions of individuals with autism may be linked to the deficits in social behavior. The study used a Functional MRI (fMRI) to investigate brain activity in nine adults with autistic disorder and nine controls when consciously and unconsciously processing emotional facial expressions. The individuals all met clinical diagnosis for Asperger syndrome or autism using ICD-10. Subjects were shown pictures with different facial expressions, they then rated the emotion. Their research showed significant differences between the subjects with autism and the control group in processing facial expressions. More specifically this would stem from abnormalities in the medial temporal lobe, striatum and insula when processing facial emotions. This correlates with other studies that associate autism with cerebellar abnormalities. The amygdale (part of the brain that allows you to feel emotion

and understand other's emotions), part of the medial temporal lobe, is crucial to learning and representing the motivational meaning of stimuli. Critchley and colleagues concluded that while these findings give clues to the difficulty for individuals with autism to process facial expressions, it is not clear as to the origin of the deficits.

Similiar to Critchley, Ohnishi and colleagues also reported reduced cerebral blood flow in people with autism. They addressed the problem of people with autism having impaired functioning in communication and social interaction, abnormal response to sensory stimuli, and desire for sameness that is obsessive in nature. They hypothesize that these areas of deficits may be associated with perfusion in the medial prefrontal cortex and anterior cingulated gyrus of the brain. The study consisted of twenty-three children with infantile autism and twenty-six non-autistic mentally retarded children who underwent SPECT scans (single photon emission computed tomography). Just prior to the scan each patient received an intravenous injection that allowed the researcher to examine the brain perfusion. The patients' scores from the Childhood Autism Rating Scale (CARS) were compared with the areas of perfusion. The researchers discovered that there were decreases in regional cerebral blood flow in the patients with autism versus the non-autistic patients in the bilateral insula, superior temporal gyri, left inferior frontal gyrus, and left middle frontal gyrus. For the patients with autism there were no areas of increase in cerebral blood flow. There was also a positive correlation between the reduction in cerebral blood flow in the hippocampus (the area for short term memory and the area that regulates emotions—including the gyrus which is very sensitive to oxygen deprivation) and the amygdale, which is part of the limbic system (almond-shaped clumps of cells deep in the brain, deals with

response to danger, anxiety, possible social interaction.) In conclusion, there was a reduction of cerebral blood flow in children with autism compared to the non-autistic population. These areas are related to the deficits found in children with autism, for example the left anterior cingulated gyrus is associated with communication and social interaction deficits. There is also some question as to the correlation with the amygdale and social deficits. People with frontal damage often show deficits related to the stereotypical and rigid behaviors often found in children with autism. These areas of reduced blood flow appear to be directly related to the deficits found in people with autism (Ohnishi, 2000).

Another study linked the reduction in cerebral blood flow to damage in the cerebellum that is often found in people with autism. Muller (1999) et al., conducted their study by doing PET scans on high-functioning adults with autism, with the premise that people with autism have deficits in language that according to former studies are directly related to deficits neurologically. With modern technology in brain imaging techniques, researchers can now study autism as a neurobiological disorder. Studies of normal adults show attention tasks activate the cerebellum; however, studies of patients with autism have shown the opposite. The researchers took five autistic adults and matched their gender matched with five controls. Cerebral blood flow was evaluated while subjects, autistic group versus control, were at rest, listening to tones, and listening to, repeating, and generating sentences using PET scans. The cerebral blood flow was evaluated on two elements, peaks and mean changes. They discovered that the subjects with autism showed reduced cerebellar activation during nonverbal auditory perception, suggesting cerebellar anomalies. This however was not related to motor

activities, as the deficit was not shown during sentence repetition. The autistic population versus the control group also showed reduced activation during acoustic stimulation in the auditory cortex. The autistic group showed bilateral weaker activations in the superior temporal. They also showed an absence of activation in the middle temporal. However, in the left anterior cingulate gyrus (brodmann's 24/32) there was an increase in activation that was not seen in the control group. They concluded that their findings suggest the autistic group may have deficits in language developed in the cerebellum region. The brain mapping suggested the dominance for language might be reversed or reduced. This might suggest early damage to areas of the brain, especially in the cerebellum.

Brain Research--Inflammation

Vargas, Nascimbene, Krishnan, Zimmerman, and Pardo (2005) conducted a study at John Hopkins University on neurological conditions of autism by conducting autopsies on individuals with autism. They addressed the issue of people with autism having deficits in areas of communication, need for sameness, and social dysfunctions. These skills are directly related to specific areas of the brain. The question they sought to answer was do those with autism have increased neuroinflammation in areas related to those deficits. They conducted autopsies and evaluated brain tissue from eleven people with autism for inflammation and tissue contents. The cerebrospinal fluid was also evaluated. The control group was seven patients with frozen tissue. They also collected cerebrospinal fluid from tissues of six living patients with autism. There was evidence of neuroinflammation, or inflammation of the brain. The results showed chronic neuroinflammation in the patients with autism. Vargas (2005) found the common

trait of all the patients with autism was a chronic inflammatory process affecting both the brain and immune system functioning. The cerebellum showed considerable affects. It is not clear as to how the brain became affected, neurotoxins was one area considered. The researchers expressed they did not feel the inflammation occurred exclusively during the prenatal development, but rather ongoing chronic neuroinflammation involving both microglia and astrogli, (cells dealing with immune system and neurological tissues). They concluded that there is chronic neuroinflammation in patients with autism. They recommend therapeutic interventions dealing with the inflammation as a possible treatment for autism.

Neuroinflammation was also addressed as a possible result of enlarged activated astroglia. Aschner, Allen, Kimelberg, LoPachin, and Streit, (1999) "observed swelling of astrocytes is associated with a nearly 50% decrease in the average capillary lumen as measured by electron microscopy, which will result in decreased blood flow because the flow of red blood cells is impeded" (p. 159). Helt (2008) brings that one step further to show the inflammation results in increasing difficulty in the body's ability to eliminate waste products from the blood system, "hence impairing the cellular activities associated with neural activity and synchronization" (p.359), correlating to Just (2004) and Castelli's (2002) research. As a result, with time, different areas of the brain develop the inability to work together (Muller 2007). Once again, Helt stated, "If this inflammation could be controlled early in life, it might prevent such atypical development from taking place" (p. 359).

Multiple studies have confirmed the neuroinflammation of children with autism. The inflammation in the brain causes edema, which increases the area between the

cells, and therefore, could increase the amount of fluid inside the brain cells. Two studies confirmed this through a functional MRI (fMRI) (Hendry, et al., 2006). The question with children affected by autism may not be if they demonstrate neuroinflammation, but why they have the inflammation in the first place.

Zerrate, Pletnikov, Connors, Vargas, Seidler, Zimmerman (2007) addressed the issue of why the neuroinflammation by researching the link between the inflammation, behavioral abnormalities and Terbutaline, a preterm labor drug. The researchers hypothesized a correlation between prenatal drugs or chemical exposure could be a cause of autism. The study consisted of giving pregnant rats Terbutaline on selected days. After the pups were born, they were analyzed for behavior. Later they were anesthetized and the brains removed. The brains were then studied. The results demonstrated increased hyperactivity in the rats exposed to Terbutaline. There was also neuroinflammation. The most critical times of exposure were the second to third trimester of human brain development. They concluded a chemical exposure could affect the growing fetus in behavioral issue and neuroinflammation. This many contribute to the increase in the incidents of autism (Zerrate, et al., 2007).

Herbert and Anderson (2008) suggest viruses or heavy metals infiltrating the body during early development as possible causes for the neuroinflammation. The body’s inability to eliminate the virus overload or heavy metals from the body may stimulate an oxidative stress response which may lead to neuroinflammation, leading to deficits with brain synchronization. These early immunological insults to the brain may thus be core to the deficits seen in autism.

Brain Research—Synchronization

Some more resent research is taking the brain research a step further by looking at how the brain of the autistic child works in synchronization. Just, et al. (2004) looked specifically at the brain's synchronization during a sentence comprehension task. They knew that high-functioning individuals with autism often display enhanced cognitive functioning with high vocabulary, yet they show a deficit in processing verbal instructions. The researchers hypothesized, "autistic participants may rely more on an enhanced word-processing ability (which would be indicated by more-than-normal activation in Wernicke's area), and rely less on integrating processes that bring the words of a sentence together into an integrated syntactic and semantic structure (indicated by less-than-normal activation in Broca's area)" (Just, 2004, p. 1812). The researchers conducted the study with seventeen high-functioning autistic patients and seventeen normal participants. They were each given fMRI while asked questions that required sentence comprehension tasks. The participants were asked to press a button on either their right or left hand with the correct response to the question. Then the data was analyzed looking specifically at the left inferior frontal gyrus (LIFG) (Broca's area) and the left superior and middle temporal gyrus (LSTG) (Wernicke's area) and their synchronization. They discovered the autistic patients had a lower degree of synchronization between LIFG and the LSTG. The autistics showed less activation in the left inferior frontal gyrus versus the control group; however, they showed more activation in the left posterior superior temporal gyrus. The researchers concluded that the reduction in synchronization may give explanation for the deficits with auditory comprehension. The possible reason for this may be the autistic brain puts more

emphasis on the individual words and details, with difficulty in higher-level abstraction, instead of comprehending the entire passage. The lack of synchronization may also account for social deficits in with the ability to integrate different types of information at abstract levels such as facial expressions, personal intent, and pragmatics (Just, 2004).

Another study conducted by Castelli (2002), intergraded synchronization with a reduction in cerebral blood flow. Again the research team looked at the functional deficits of a person with autism and compared it to the actual diagnostic deficits happening in the brain. They used a comparison study with ten adults diagnosed with autism and ten people in the control group made up of students and staff recruited from a university. The participants were shown twelve different brief animations, four different animations from three different types. After viewing, the subjects were questioned about what was happening in the animation. Their descriptions were coded in regards to intentionality, appropriateness, and length. Each subject underwent twelve scans, both PET and MRI, on the same day. The results were analyzed using software from the Wellcome Department of Cognitive Neurology in London, United Kingdom. The results demonstrated a direct comparison on the two groups there was a significant reduction in blood flow velocity in the autism subjects in the basal temporal area, superior temporal sulcus, and the medial prefrontal area. The extrastriate regions (brodmann's 18/19) activated at the same rate; however, they were not interacting appropriately with the mentalizing network that showed a reduction. They concluded that people with autism do have impaired brain function with reduction in cerebral blood flow and lack of connectivity, especially evident when subject is mentalizing. One area of possible origin is the Amygdala (Castelli, 2002).

The pathophysiology of children with autism appears to include a number of different brain abnormalities. However, the area that is most often referred to as the site of the most abnormality is the cerebellum. The cerebellum damage shows consistent area for inflammation and also cell damage. One cell in particular is the Purkinje cell. Not only do multiple studies show a reduction in the Purkinje cell, but also Fatemi and colleagues have shown not only a reduction in the number of Purkinje neurons, but also a reduction in size (Fatemi, 2001). Chronic, ongoing process of neuroinflammation is a likely source for the reduction of the Purkinje Cells. Based on the research of Vargas and colleagues the findings of immune responses in the cerebellum were closely associated with degenerating Purkinje Cells, granule cells, and axons. In correlation to thimerosal, a side-effect of mercury poisoning is reduction in the number of Purkinje Cells (Sorensen, Larsen, Eide, and Schionning, 2000, Choi, Lapham, Amin-Zaki, Saleem, 1978).

In summary as a relationship to hyperbaric oxygen therapy

Brain deficits in the area of hypoperfusion/decreased cerebral blood flow, reduction of the Purkinje cells, inflammation, and lack of synchronization is common research in the area of autism. These deficiencies are clearly linked to the deficits found in people with autism. Neurological effects of mercury on the brain are in the amygdale, hippocampus, basal ganglia, cerebral cortex, damages Purkinje and granule cells in the cerebellum, paralleling the damage found in the autistic brain.

The neurological abnormalities manifest as deficits in cerebral blood flow, hypoperfusion, neuroinflammation, and lack of brain synchronization. This is important to understand in order to begin to find ways to treat people with autism, and understand

the theory behind the treatment. This is reflective in the treatment of hyperbaric oxygen therapy. When a person receives hyperbaric oxygen therapy the blood flow in the brain is increased, and hypoxia and inflammation are reduced. There is also speculation of the mucous lining in the gut healing with hyperbaric oxygen therapy. Hence, it is reasonable to recognize how hyperbaric oxygen therapy may decrease neurological deficits and reduce symptoms of autism.

Benefits from hyperbaric oxygen therapy may not be limited to the child's early years. In a study by Guy (2007) called "Reversal of neurological defects in a mouse model of Rett syndrome" he demonstrated reversing symptoms associated to Rett's Syndrome was shown through biological treatment. The researchers activated MeCP2 in adult mice affected with Rett's Syndrome. The results were phenotypic reversal of the syndrome. Guy et al. demonstrated defective neurons have the ability to be repaired into adulthood, contrary to popular belief of the damage being permanent after the "critical period."

No matter the cause of the neuroinflammation the effects can be devastating. However, hyperbaric oxygen therapy may be one answer to addressing the neurological deficits in autism to be treatable by reducing the inflammation.

The exact reasons hyperbaric oxygen therapy helps children with ASD are still being researched; however, there are some clear correlations one can make with the data from current research. The occurrence of inflammation in the brain and gastrointestinal tract of these children has been shown to be significant. There have been several studies of treating the inflammation with drugs such as corticosteroids, minocycline and non-steroidal anti-inflammatory drugs, however, the negative side

effects make the use of these drugs undesirable. The effects of hyperbaric oxygen therapy, promoting the growth of new capillaries, increasing the production of the body's stem cells, decreasing swelling and inflammation, increasing the body's ability to fight infections, clearing and deactivating toxins and metabolic waste products from the body, reduce these negative symptoms. Therefore, it is understandable why the results from the initial studies of treating children with autism in hyperbarics are resulting in positive outcomes. Hyperbaric oxygen therapy is well known as an anti-inflammatory, and has virtually no negative side effects. With the known effects of hyperbaric oxygen therapy and the inflammation found in children with autism, there warrants continued studies of treating children with autism in hyperbaric oxygen therapy. The risk-benefit analysis is strongly in favor of pursuing hyperbaric oxygen therapy as a potential therapy for autism.

CHAPTER 3

Methodology

Participants

All children receiving hyperbaric oxygen met Michigan Rule 340.1715: Autism Spectrum Disorder Eligibility for autism (addendum A) and have an Individual Education Plan (IEP) for Autism filed with their school system. The children will be enrolled in an educational environment that supports the autism diagnosis. The geographic area will be Metropolitan Detroit area. The children's parents have chosen to do hyperbaric oxygen therapy at a private clinic with no relationship to the research. In order to evaluate eligibility, the participants will be asked to answer question before participation can be determined. The questionnaire is found in the Appendix D.

Eligibility Criteria

1. Eligibility for autism was determined by a prior comprehensive evaluation conducted by a Multi-Disciplinary Evaluation Team (MET) that included ALL of the following:
    a. A psychologist or psychiatrist
    b. An authorized provider of speech & language per Rule 340.1745(d).
    c. A school social worker.
2. The student has a current MET that states they are eligible for services under the area of autism.
3. Participants must agree to completing The Autism Treatment Evaluation Checklist (ATEC) within 30 days prior to the child's first hyperbaric treatment.

4. Participants must agree to a release of information from the student's classroom teacher to fill out the ATEC prior and post treatment.
5. Child's teacher must be able to complete the pre and post test, ATEC, within 30 days prior and post of their final, fortieth hyperbaric oxygen treatment.
6. Participants must be able to complete the post test, ATEC within 30 days of their final hyperbaric oxygen therapy treatment.
7. Participant's child will be hyperbaric oxygen therapy treatment naive prior to treatment, meaning they have not undergone hyperbaric oxygen treatment prior to this set of treatments.
8. Participant's child must be able to complete forty sessions of hyperbaric oxygen therapy within eleven weeks of starting treatment, doing five treatments per week. A typical set of forty treatments is completed in eight weeks. The extended three weeks allows for illness or vacation time.

Exclusion Criteria

1. Participant's child does not meet the MET criteria for special education services for autism
2. Participant's child has previously treated in hyperbaric oxygen therapy.
3. Participants have not signed a release of information to contact the student's teacher.

Human Investigation Committee

The study was conducted with approval of the Wayne State University Human Investigation Committee. Permission to conduct the research for the study was obtained from a parent and teacher of each child in the study prior to admittance into the study. Participation in the study was voluntary. Respondents were assured that their

responses were completely anonymous and there was no personal identification information included with any returned responses. There was no compensation for participation in the study.

Technique

A combination of qualitative and quantitative techniques was used for data analysis to establish continuity between the statistical analysis and the narrative documentation of the parents and techs. The Autism Treatment Evaluation Checklist (ATEC), a Likert-type scale, was used for the quantitative portion of the study. A parent and teacher of each participant filled out the ATEC prior to the child starting their treatment and after the completion of their treatment. All five children were able to have the ATEC completed by a parent and teacher. The ATEC evaluates children with autism with four categories: speech/language/communication, sociability, sensory/cognitive awareness, and health/physical/behavior. Declining scores on each scale indicate clinical improvements. Dive logs, notations from the Certified Hyperbaric Technologist (CHT) and parents input or journal were used for the qualitative portion.

Statistical analysis

The ATEC's scores will be compared using Pearson correlation coefficient to measure interrater reliability between parents' scores and the ATEC and teachers' scores. A combination of qualitative and quantitative techniques will be used for data analysis to establish continuity between the statistical analysis and the narrative documentation of the parents and techs. A t-test with Paired Samples Statistics data analysis will be used to compare the pretest and post test scores. The dependent

variable is the changes in the student as measured by the ATEC. Nominal alpha will be set at 0.05.

Assumptions:

1. Normal Distribution: The dependent variable should be normally distributed within groups.
2. Observations are independent from one another, teacher and parent
3. Homogeneity of Variances: Homogeneity of variances assumes that the dependent variables exhibit equal levels of variance across the range of predictor variables.
4. Homogeneity of Variances and Covariances: The homogeneity of variances assumption described earlier also applies. However, since there are multiple dependent variables, it is also required that their intercorrelations (covariances) are homogeneous across the cells of the design.

Instruments Used in Data Collection

The Autism Treatment Evaluation Checklist (ATEC) was designed by Dr. Bernard Rimland and Dr. Stephen Edelson from the Autism Research Institute. The purpose of the evaluation was not to diagnose autism, but rather “to help researchers evaluate the effectiveness of various treatments for autistic children and adults and to help parents determine if their child benefited from the treatment. Parents and teachers use the ATEC to monitor or track how well their children are progressing over time” (Edelson, 2010).

The ATEC evaluation consists of 4 subtest: speech/language/communication (14 items), sociability (20 items), sensory/cognitive awareness (18 items), health/physical/behavior (25 items).

Instrument Reliability and Validity

According to the Autism Research Institute the internal consistency of the ATEC was evaluated using split-half reliability test on 1,358 completed ATECs. The internal consistency was .94. The subscale reliabilities were: Scale I Speech .920, Scale II Sociability .836, Scale III Sensory/Cognitive Awareness .875, Scale IV Health/Physical/Behavior .815, Total ATEC Score .942.

Methods/Procedures Used

Participants will be children whose parents have chosen to do forty sessions of hyperbaric oxygen therapy in a private setting at 2.0 ata (atmospheres absolute, 14.7 psig, or 33 feet of sea water). At the time the parents sign up for therapy they will be asked if they would agree to be part of a study. The participants are not consenting to doing hyperbaric oxygen therapy, rather consenting for the child's parent/s and teacher to fill out pre and post evaluation, and to use the data.

The participants will be prescreened to see that they meet the initial criteria and exclusion requirements. The participants will be interviewed to assure they understand the assessment being used. It will be explained to the participants the role their child’s teacher will play by evaluating their child also before the set of treatments and after the completion. If they agree a release will be signed to contact the child’s teacher. The teacher will be contacted to see if they are willing to fill out the evaluation on the child.

The Autism Treatment Evaluation Checklist (ATEC) is conducted by filling out a Likert style questioner. A copy of the questions is found in Appendix D. The Autism Treatment Evaluation Checklist (ATEC) will be completed by the parent/s of the child prior to their treatment. The evaluation will also be given to the child's teacher to be filled out prior to evaluation. A survey/questionnaire will be conducted with the caretaker to verify the participant meets the criteria. (Appendix D).

1. Participants will be referred to researcher by Oxford Hyperbaric Oxygen Therapy Center.
    a. Oxford Hyperbaric Oxygen Therapy Center will ask the parents when they enroll their child into the therapy if they are interested in having their child be part of a research study on autism and hyperbaric oxygen therapy.
    b. If the parents verbalize they are interested they will be given a release to have the researcher contact them.
    c. Parents will be contacted by the researcher and the questionnaire will be given to them over the phone.
    d. If the child qualifies the parents will be given a release of information form in order for the researcher to contact the child's teacher.
    e. The teacher will be contacted and asked if he or she will agree to filing out an evaluation about their student.
    f. If the teacher agrees to fill out the evaluation, the child will be part of the research study.
    g. The parents and teacher will be asked fill out a pre-evaluation by circling the letter that best describes the current level of the participant.

h. At dive number 37 the parents and teacher will be contacted to know the post evaluation will soon need to be filled out. They will be contacted soon as to the exact date.

i. The day the child completes dive forty the parents and teacher will be contacted to ask to fill out a post-evaluation of the student. This should be completed within five days of the child's 40 dive completion.

ATEC Scoring

The ATEC test uses a simple Internet scoring procedure that automatically calculates subscale scores and a summary score from the ATEC, which are weighted according to the response and the corresponding subscale. The Autism Treatment Evaluation Checklist (ATEC) is not copyrighted and may be used free of charge by any researcher. The higher the subscale and total scores, the more impaired the subject. Alpha will be set at .05. Due to the fact this is an observational study; the number of participants will be small.

Summary of data (Appendix E)

Pretest/Post-test sample (Appendix F)

Chapter 4

Results

The purpose of the study was to obtain data on the efficacy of treating a child with autism in hyperbaric oxygen therapy by assessing changes in speech/language/communication, sociability, sensory/cognitive awareness, and health/physical/behavior.

The chapter presents the results of the findings related to the study's specific research questions.

Demographic Characteristics of Participants

There were five children in the study, two female and three male. All five participants lived in the Metropolitan Detroit Area. The ages of the participants were between 2.9 and 7.2 years of age at the start of their treatment, with the mean age being 4.6. The participants began their forty treatments in hyperbaric oxygen therapy between February 17, 2011 and March 4, 2011. They completed their treatments between March 28, 2011 and May 2, 2011. All participants were able to complete the study design of forty treatments.

Reliability Indicators of internal consistency

The Pearson correlation coefficient was used to measure interrater reliability between parent's scores and the ATEC and teacher's scores. The Pearson correlation coefficient measures the strength of a linear association between two variables. The pretest for Speech/Language/Communication had a strong positive correlation of .957, which was statistically significant (p= .011), the post test for the same was .948 (p= .014). In the area of Sociability the pretest was .748 (p= .116), and

post test was .852 (p= .067), both showing a strong positive correlation but are not statistically significant due to the obviously small sample size. For sensory/cognitive awareness the pretest was again a strong positive correlation of a .829 (p= .083), the post test was .853 (p= .066), which are also obviously not statistically significant due to the small sample size. In the area of health/physical/behavior, the pretest showed a strong positive correlation of .833 (p= .080) and the post test was positive correlation of .646 (p= .239), which are interpreted as the previous two measures. When combining the subcategories, the teacher pre correlated to the teacher post had a strong positive correlation of .941 (p= .017), which was statistically significant. Lastly, the post test teacher correlated to the parents again showed a strong positive correlation of .847 (p= .071) which was not statistically significant due to sample size.

Correlations between Speech/Language/Communication teacher and parent pre test

Correlations

		SLC Teacher Pre	SLC Parent Pre
SLC Teacher Pre	Pearson Correlation	1	.957*
	Sig. (2-tailed)		.011
	N	5	5
SLC Parent Pre	Pearson Correlation	.957*	1
	Sig. (2-tailed)	.011	
	N	5	5

*. Correlation is significant at the 0.05 level (2-tailed).

Table 3

Correlations between Speech/Language/Communication teacher and parent post test

Correlations			
		SLC Teacher Post	SLC Parent Post
SLC Teacher Post	Pearson Correlation	1	.948*
	Sig. (2-tailed)		.014
	N	5	5
SLC Parent Post	Pearson Correlation	.948*	1
	Sig. (2-tailed)	.014	
	N	5	5
*. Correlation is significant at the 0.05 level (2-tailed).			

Table 4

Correlations between Sociability teacher and parent pretest

Correlations			
		SO Teacher Pre	SO Parent Pre
SO Teacher Pre	Pearson Correlation	1	.784
	Sig. (2-tailed)		.116
	N	5	5
SO Parent Pre	Pearson Correlation	.784	1
	Sig. (2-tailed)	.116	
	N	5	5

Table 5

Correlations between Sociability teacher and parent post test

Correlations			
		SO Teacher Post	SO Parent Post
SO Teacher Post	Pearson Correlation	1	.852
	Sig. (2-tailed)		.067
	N	5	5
SO Parent Post	Pearson Correlation	.852	1
	Sig. (2-tailed)	.067	
	N	5	5

Table 6

Correlations between Sensory/Cognitive teacher and parent pretest

Correlations			
		COG Teacher Pre	COG Parent Pre
COG Teacher Pre	Pearson Correlation	1	.829
	Sig. (2-tailed)		.083
	N	5	5
COG Parent Pre	Pearson Correlation	.829	1
	Sig. (2-tailed)	.083	
	N	5	5

Table 7

Correlations between Sensory/Cognitive teacher and parent post test

Correlations			
		COG Teacher Post	COG Parent Post
COG Teacher Post	Pearson Correlation	1	.853
	Sig. (2-tailed)		.066
	N	5	5
COG Parent Post	Pearson Correlation	.853	1
	Sig. (2-tailed)	.066	
	N	5	5

Table 8

Correlations between Health/physical/behavior teacher and parent pretest

Correlations			
		PHY Teacher Pre	PHY Parent Pre
PHY Teacher Pre	Pearson Correlation	1	.833
	Sig. (2-tailed)		.080
	N	5	5
PHY Parent Pre	Pearson Correlation	.833	1
	Sig. (2-tailed)	.080	
	N	5	5

Table 9

Correlations between Health/physical/behavior teacher and parent post test

Correlations			
		PHY Teacher Post	PHY Parent Post
PHY Teacher Post	Pearson Correlation	1	.646
	Sig. (2-tailed)		.239
	N	5	5
PHY Parent Post	Pearson Correlation	.646	1
	Sig. (2-tailed)	.239	
	N	5	5

Table 10

Correlations between teachers and parents

Correlations			
		Tr	Pr
Tr	Pearson Correlation	1	.941*
	Sig. (2-tailed)		.017
	N	5	5
Pr	Pearson Correlation	.941*	1
	Sig. (2-tailed)	.017	
	N	5	5

Table 11

Correlation between teacher pretest and parent pretest

Correlations			
		tpo	Ppo
tpo	Pearson Correlation	1	.847
	Sig. (2-tailed)		.071
	N	5	5
ppo	Pearson Correlation	.847	1
	Sig. (2-tailed)	.071	
	N	5	5

Table 12

The teacher's responses and parent's responses reflects the changes in scores between the pre and post testing as scored by the teacher and parents. The parents calculate an 11.08% mean improvement and the teachers a 9.91% mean improvement. The parent's largest area of improvement was in the area of health/physical/behavior with a 17.61%, while the teachers largest are of improvement was the area of Sensory/Cognitive Awareness with a 14.29%. All areas showed a mean average with improvements.

Mean averages of all areas in percentage.

	Mean Score Before HBOT Parents	Mean Score After HBOT Parents	Percentage of Improvement	Mean Score Before HBOT Teacher	Mean Score After HBOT Teacher	Percentage of Improvement
Speech/Lang/ Communication	15.8	14.8	6.33%	17.4	15.6	10.34%
Sociability	15.2	13.6	10.53%	20.2	19.4	3.96%
Sensory/Cog/ Awareness	14.6	14.0	4.11%	23.8	20.4	14.29%
Health/Physical/ Behavioral	28.4	23.4	17.61%	27.4	24.6	10.22%
TOTAL	74.0	65.8	11.08%	88.8	80.0	9.91%

Table 13

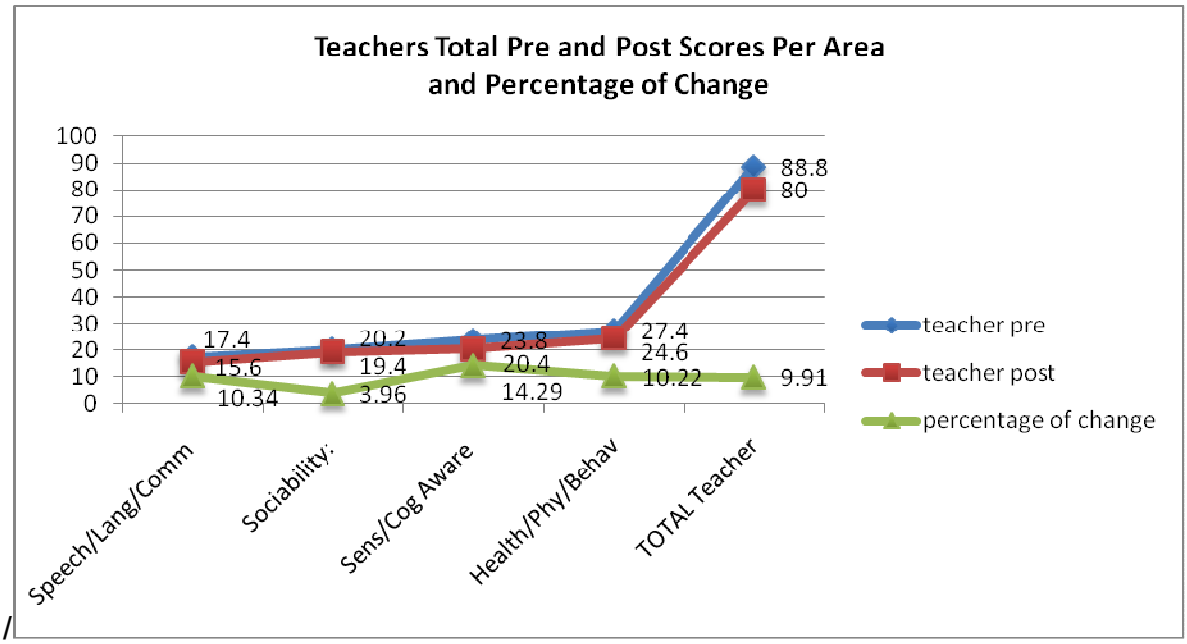


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Figure 9

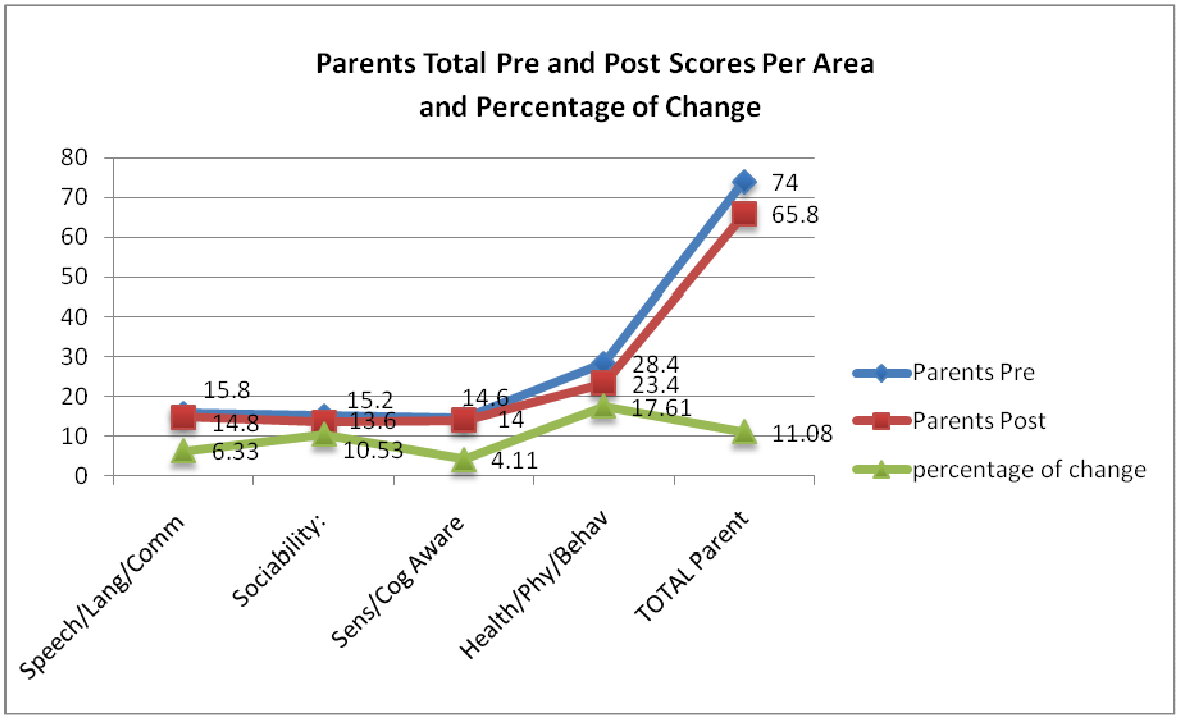

Figure 10

Data analysis

A t-test with Paired Samples Statistics data analysis was performed with SPSS (Statistical Package for the Social Sciences Personal Computer) software. The Paired-Samples Test or the dependent t-test compares the means between two related groups on the same continuous variable. It provides relevant descriptive statistics.

Data from the ATEC was entered into the SPSS software in order to form a t-test calculation. Despite the pattern of improvement for all children, with respect to the t-test, there reveals only one significant difference between the pre and post test, most likely due to the small sample size. However, even with the small sample size, the teacher checklist revealed a statistical significant difference in the area of sensory/cognitive awareness according to the Pearson t-test. Although not a close runner up, the next closest score would be in the teacher's rating of speech/language/communication.

Paired samples correlations Pretest and Post test

Paired Samples Correlations				
		N	Correlation	Sig.
Pair 1	SLC Teacher Pre & SLC Teacher Post	5	.970	.006
Pair 2	SO Teacher Pre & SO Teacher Post	5	.741	.152
Pair 3	COG Teacher Pre & COG Teacher Post	5	.947	.015
Pair 4	PHY Teacher Pre & PHY Teacher Post	5	.979	.004
Pair 5	SLC Parent Pre & SLC Parent Post	5	.987	.002
Pair 6	SO Parent Pre & SO Parent Post	5	.923	.025
Pair 7	COG Parent Pre & COG Parent Post	5	.887	.045
Pair 8	PHY Parent Pre & PHY Parent Post	5	.869	.055

Table 14

Paired Sample Statistics with T-Test

Paired Samples Statistics					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	SLC Teacher Pre	17.4000	5	8.26438	3.69594
	SLC Teacher Post	15.6000	5	6.73053	3.00998
Pair 2	SO Teacher Pre	20.2000	5	5.93296	2.65330
	SO Teacher Post	19.4000	5	6.34823	2.83901
Pair 3	COG Teacher Pre	23.8000	5	6.22093	2.78209
	COG Teacher Post	20.4000	5	7.23187	3.23419
Pair 4	PHY Teacher Pre	27.4000	5	17.03819	7.61971
	PHY Teacher Post	24.6000	5	12.11610	5.41849
Pair 5	SLC Parent Pre	15.8000	5	7.19027	3.21559
	SLC Parent Post	14.8000	5	8.40833	3.76032
Pair 6	SO Parent Pre	15.2000	5	7.19027	3.21559
	SO Parent Post	13.6000	5	6.22896	2.78568
Pair 7	COG Parent Pre	14.6000	5	6.42651	2.87402
	COG Parent Post	14.0000	5	6.40312	2.86356
Pair 8	PHY Parent Pre	28.4000	5	18.87591	8.44156
	PHY Parent Post	23.4000	5	7.43640	3.32566

Table 15

Pair sample test pretest to post test mean

Paired Samples Test				
		Paired Differences		
		Mean	Std. Deviation	Std. Error Mean
Pair 1	SLC Teacher Pre - SLC Teacher Post	1.80000	2.38747	1.06771
Pair 2	SO Teacher Pre - SO Teacher Post	.80000	4.43847	1.98494
Pair 3	COG Teacher Pre - COG Teacher Post	3.40000	2.40832	1.07703
Pair 4	PHY Teacher Pre - PHY Teacher Post	2.80000	5.71839	2.55734
Pair 5	SLC Parent Pre - SLC Parent Post	1.00000	1.73205	.77460
Pair 6	SO Parent Pre - SO Parent Post	1.60000	2.79285	1.24900
Pair 7	COG Parent Pre - COG Parent Post	.60000	3.04959	1.36382
Pair 8	PHY Parent Pre - PHY Parent Post	5.00000	12.94218	5.78792

Table 16

Paired Samples Test Pretest Post test (2-tailed)

Paired Samples Test			
		df	Sig. (2-tailed)
Pair 1	SLC Teacher Pre - SLC Teacher Post	4	.167
Pair 2	SO Teacher Pre - SO Teacher Post	4	.708
Pair 3	COG Teacher Pre - COG Teacher Post	4	.034
Pair 4	PHY Teacher Pre - PHY Teacher Post	4	.335
Pair 5	SLC Parent Pre - SLC Parent Post	4	.266
Pair 6	SO Parent Pre - SO Parent Post	4	.269
Pair 7	COG Parent Pre - COG Parent Post	4	.683
Pair 8	PHY Parent Pre - PHY Parent Post	4	.436

Table 17

Paired Samples Test with t

Paired Samples Test				
		Paired Differences		
		95% Confidence Interval of the Difference		
		Lower	Upper	t
Pair 1	SLC Teacher Pre - SLC Teacher Post	-1.16443	4.76443	1.686
Pair 2	SO Teacher Pre - SO Teacher Post	-4.71109	6.31109	.403
Pair 3	COG Teacher Pre - COG Teacher Post	.40968	6.39032	3.157
Pair 4	PHY Teacher Pre - PHY Teacher Post	-4.30032	9.90032	1.095
Pair 5	SLC Parent Pre - SLC Parent Post	-1.15063	3.15063	1.291
Pair 6	SO Parent Pre - SO Parent Post	-1.86778	5.06778	1.281
Pair 7	COG Parent Pre - COG Parent Post	-3.18657	4.38657	.440
Pair 8	PHY Parent Pre - PHY Parent Post	-11.06984	21.06984	.864

Table 18

The Wilcoxon Signed Ranks Test was also performed using the SPSS software. This is a nonparametric test equivalent to the dependent t-test. It is used to examine difference in means between two sets of scores that come from the same participants when the underlying distribution cannot be asserted to be normally distributed. The comparison data that was used was the pretest and post test of the individual students, giving a natural pair. If the null hypothesis is true there would be no difference and the rank sums for positive and negative ranks would be the same. Because the test is based on

the rank order of differences versus the actual value of the differences, distributional assumption is avoided, although assumption is assumed that the distribution of the differences is symmetric.

Wilcoxon Signed Ranks Test

Ranks				
		N	Mean Rank	Sum of Ranks
post - pre	Negative Ranks	4[a]	3.25	13.00
	Positive Ranks	1[b]	2.00	2.00
	Ties	0[c]		
	Total	5		
a. post < pre				
b. post > pre				
c. post = pre				

Table 19

Wilcoxon Signed Ranks Test continued

Test Statistics[b]	
	post – pre
Z	-1.483[a]
Asymp. Sig. (2-tailed)	.138
a. Based on positive ranks.	
b. Wilcoxon Signed Ranks Test	

Table 20

The Wilcoxon Signed Ranks Test showed that a 40 treatment hyperbaric oxygen therapy course did not elicit a statistically significant change in (list 4 areas) individuals with autism (Z = -1.483, P = 0.138).

Analysis of Research Questions One through Four

For question number one, “is there increase an increase in speech/language/communication of an autistic child who has received hyperbaric oxygen therapy using the Autism Treatment Evaluation Checklist as a measurement tool?” the answer would be yes. The parents reported a 6.33% of improvement and the teacher reported a 10.34% of improvement. This is also evidenced by the narrative report from the parent. For question number 2, “is there an increase in sociability of an autistic child who has received hyperbaric oxygen therapy using the Autism Treatment Evaluation Checklist as a measurement tool?” the answer would be yes. The parents reported a 10.53% of improvement and the teachers reported a 3.96% of improvement. For question number three, “is there an increase in sensory/cognitive awareness of an autistic child who has received hyperbaric oxygen therapy using the Autism Treatment Evaluation Checklist as a measurement tool?” the answer would be yes. The parents reported a 4.11% of improvement and the teachers reported a 14.29% of improvement. Lastly, for question number four, “is there an increase in the health/physical/behavior of an autistic child who has received hyperbaric oxygen therapy using the Autism Treatment Evaluation Checklist as a measurement tool?” the answer is yes. The parents reported a 17.61% of improvements and the teachers reported a 10.22% of improvements.

Qualitative

The CHT recorded notes from parent/s and their observations at the time of each child’s dive. Also, several parents filled out a journal and/or summary of their child’s changes. The logs and journals are in Appendix G Improvements noted were very much

in line with the improvements documented on the ATEC. Some of the comments for T-TW, “more alert, more interest in people and new things presented to him, comprehension, now following simple one-step commands consistently and some two step commands, more speech and in appropriate context.” T-JC’s parent wrote in a journal daily. Some of the comments were, “playing with dog better, eating better, saying prayers slower, not as hyper, loving, playful and not yelling as much, went out to lunch and did best ever in a restaurant, using brother’s DS first time ever, first 6 word sentence, no more yelling” T- SC’s parents and CHT’s notes, “Increase in independent behavior, increase in eye contact, increased focus, more smiles, focus and conversation.

T-AO’s parents and CHT’s notes, “much calmer at home and less temper, able to sleep at night after the very first dive, she was not sleeping before, she slept all night long, no tantrums with her coat, no longer climbing the walls and pulling cabinet doors off the hinges, no longer plays as rough, less bruises on her legs.” By dive 33, “her eating is back to normal, sleeping back to normal, no waking up, teacher said she said her name, she has a comprehension of emotion and mimics from the DVD.” The CHT and parents notes for S-DR, “has been more relaxed for a week or so, attending church has been more pleasant as S- DR has been calmer, engaging visually and a little more attentive.” The parents overall made positive comments in the four areas of question: speech/language/communication, sociability, sensory/cognitive awareness, and health/physical/behavior.

Parent's comments could be put into the five categories below: cognitive, speech, affect/behavior, calmer, more alert/eye contact. These were all positive comments by the child's parent.

Parent Observations:

	Cognitive	Speech	Affect/behavior	Calmer	Alert/eye contact
T-TW	X	X	X	X	X
T-JC	X	X	X	X	
T-SC	X	X		X	X
T-AO	X	X		X	
S-DR	X			X	

Table 21

The parents overall all commented on positive improvements with cognitive issues. From the parents perspective this was seen by such things as following verbal directions, reading, playing with puzzles, and playing video games. All parents also commented on the child being calmer. This was the most popular and consistent comment given by the parents. Improvements in speech were given by four out of the five parents. Of note, S-DR whose parents did not comment on improvements with speech did not begin with a speech delay. Improvements in affect/behavior were mostly noted by the child's affect being happier, seeming to have fun. This was noted by two out of the five parents. Lastly, more alert and eye contact was noted by two out of the five parents.

Summary

In summary, as evidenced by the review, all four areas of question showed improvement after a two-month therapy. As an observational study a trend of improvement was being assessed. This trend was clearly achieved. There was a large difference in pretest and post test mean scores of the two groups. Although the t-test reveals there is not a consistent statistically significant difference once the differing variances of the two groups are taken into account, the small group size clearly was a determent in achieving significant scores between the pre and post test. In Chapter 5, a discussion of the findings and implications for the use of hyperbaric oxygen therapy with children diagnosed with autism will occur. Recommendations for further research and conclusions are presented as well.

Chapter 5
Summary and Discussion

Purpose

The purpose of the study was to obtain data on the efficacy of treating a child with autism in hyperbaric oxygen therapy by assessing changes in speech/language/communication, sociability, sensory/cognitive awareness, and health/physical/behavior. The study was designed with the knowledge that the small number of participants would not achieve statistically significant outcome, but rather the researcher was looking for a trend to show if there is efficacy in duplicating the study with a larger sample. A combination of qualitative and quantitative techniques was used for data analysis to assess the changes with participants who have autism.

Autism is the fastest growing epidemic ever to occur in the world, with prevalence of 1 in 80 children by the age of 8 (MMWR/CDC 2009). According to the Data Accountability Center (DAC) and the Center for Disease Control (CDC), Michigan alone reported in 1992 1,180 cases of autism ages 6-22, by 2007 the number of reported cases went to 10,803, and 12,166 for ages 3-22. Children ages 6-22 had an increase of 816%, in contrast all other disabilities combined only went up 35%. The costs of educating a child with autism are significant to the school systems and taxpayers as these children age and continue to increase in population. The CDC estimates the lifetime cost to care for an individual with autism to be 3.2 million dollars (Ganz 2007).

Definition

At the present day, according to the Center for Disease Control, Autism Spectrum Disorder (ASD) is an umbrella of disorders of developmental disabilities

identified by deficits in communication and social interactions; along with unusual, sometimes repetitive, behaviors; having areas of interest often with a narrow focus; and frequently an insistence on sameness. The cognitive abilities can vary from superior intelligence to mental impairment. ASD is found in all races, ethnic and socioeconomic levels.

Rationale for study

The study looked first at the etiology of autism and the physical effects it has on these children to assess the efficacy of treating a child with hyperbaric oxygen therapy. Three etiologies were researched: genetics, increase of diagnosing, and environmental toxin such as mercury or viral overload. The first two etiologies were found to have little to no evidence supporting them as a possible reason for the enormous increase in children with autism, on the contrary the evidence found those theories to be in error. The last possible cause, environmental, did have vast amounts of evidence correlating to the increase in autism.

Next, research on the impact of the child physically in correspondence to environmental toxins was explored. Brain deficits in the area of hypoperfusion/decreased cerebral blood flow, reduction of the Purkinje cells, inflammation, and lack of synchronization is common findings in the research in the area of autism. These deficiencies are clearly linked to the deficits found in people with autism. Interestingly, neurological effects of mercury on the brain are in the amygdale, hippocampus, basal ganglia, cerebral cortex, damages Purkinje and granule cells in the cerebellum, paralleling the damage found in the autistic brain.

The neurological abnormalities manifest as deficits in cerebral blood flow, hypoperfusion, neuroinflammation, and lack of brain synchronization. The occurrence of inflammation in the brain and gastrointestinal tract of these children has also been shown to be significant. This is important to understand in order to begin to find ways to treat people with autism, and understand the theory behind the treatment. This is reflective in the treatment of hyperbaric oxygen therapy. When a person receives hyperbaric oxygen therapy the blood flow in the brain increases, it promotes the growth of new capillaries, increases the production of the body's stem cells, decreases swelling and inflammation, increases the body's ability to fight infections, and clears and deactivates toxins and metabolic waste products from the body. Hence, hypoxia and inflammation are reduced resulting in reduction of negative symptoms listed above. Hence, it is reasonable to recognize how hyperbaric oxygen therapy may decrease neurological deficits and reduce symptoms of autism. Hyperbaric oxygen therapy may be one answer to addressing the neurological deficits in autism to be treatable.

Hyperbaric oxygen therapy is well known as an anti-inflammatory, and has virtually no negative side effects. With the known effects of hyperbaric oxygen therapy and the inflammation found in children with autism, there warrants continued studies of treating children with autism in hyperbaric oxygen therapy. The risk-benefit analysis is strongly in favor of pursuing hyperbaric oxygen therapy as a potential therapy for autism.

Aim of study and design

The study aimed to ascertain the efficacy of a child with autism treating with hyperbaric oxygen therapy to lessen the negative effects of autism. The current

functioning level of the participants was scored by both a parent and teacher just prior to treatment and immediately following treatment with scores on the ATEC. The researcher also acquired qualitative data collected by the Certified Hyperbaric Technologist (CHT) and the parents.

After IRB approval and participants were screened and accepted, the first step in the study was to verify interrater reliability between parent's and teacher's ATEC scores. Using Pearson correlation coefficient the pretest scores from the ATEC were compared. Both sets of scores were compared to explore the possibility of not needing to collect both sets of data for replicated studies in the future. The Pearson correlation coefficient measured the strength of a linear association between the pretest filled out by the parent to that filled out by the teacher.

Results

The correlations between parents and teachers on the ATEC were significant and provides support for interrater reliability. The implications for future studies would only suggest collecting data from parents; however, the teacher's input on their perception on changes is very important in assessing the functioning improvements in the education of a child with autism.

Some of the teachers were apprehensive completing the ATEC. The attitude of two of the teachers was pessimistic. One teacher called the researcher to exclaim, "The pre and post results will be the same as children won't show any improvements with money wasting alternatives the parents are using." Another teacher was resistant to fill out the information, fearing their name will somehow show up in the future, and didn't

want to be any part of alternative therapies. These attitudes of the teachers could have skewed the results to not have them be as positive as they could have been.

The second step was to compare the pretest and post test scores of the child to assess for any changes in current level of performance. Although the small sample guaranteed low statistical power, the participants showed improvements in all areas. Even with low statistical power, sensory/cognitive awareness was statistically significant. The results of the ATEC reported a 14.29% change in the area of sensory/cognitive awareness of the participants. Another significant improvement was reported by the parents in the area of Health/Physical/Behavior with a 17.61% of improvement.

Conclusions

Children with autism can go months, even years, with little to no improvement in their functioning abilities. Teachers and parents alike celebrate little milestones as huge. A 17.61% improvement in the health and behavior and 14.29% sensory cognitive awareness of a child with autism is huge in the eyes of parents and teachers. These gains often give the child enough of a jump to continue to progress at a faster rate of improvement.

Of interest to note is the largest areas of improvements differed from parents and teachers. Teachers, as would be expected, focused more on the cognitive growth, and that is the area they found the largest area of improvements in. On the other hand, parents saw behavior and health as the largest area of growth, the area they would be expected to see the most in a home environment.

The parent's narrative agreed with the ATEC scores, commenting on the child eating better, calmer, sleeping better and interacting more with the parents and siblings. Improvements with the child's sleep alone can offer the entire family great relief. Also, interaction with other, joint attention, improves their ability to absorbing information around them.

The child in the study that showed the least amount of improvements was the only one with a questionable diagnosis of autism. The parents shared that a doctor told them their child was not autistic, rather cognitively impaired. The child is a twin; during gestation he received less nutrition and oxygen than his twin brother, weighing almost half his brother's weight at birth. The school's original diagnosis was cognitively impaired. Through much pressure from the parents, the school agreed to the label of autistic impaired. The parents conveyed they felt he would get a better education without a cognitively impaired label. The dad also expressed he too had a "mentally impaired" diagnosis during his schooling. This situation is an example of the difficulty of selecting a primary diagnosis with a child who has autism. Often children have a co-morbidity of two or more conditions that go along with the autism. This child presented both as cognitively impaired and autistic.

Research Questions

The four questions in the study were all answered with affirmation of improvements. The data from the participants demonstrated improvement in all areas deficit listed in the questions below.

Is there an increase in speech/language/communication of an autistic child who has received hyperbaric oxygen therapy using the Autism Treatment Evaluation

Checklist as a measurement tool? The parents reported a 6.33 percentage of improvements and the teachers reported a 10.34 percentage of improvements in the area of speech/language/communication.

Is there an increase in sociability of an autistic child who has received hyperbaric oxygen therapy using the Autism Treatment Evaluation Checklist as a measurement tool? The parents reported a 10.53 percentage of improvements and the teachers reported a 3.96 percentage of improvements in the area of sociability.

Is there an increase in sensory/cognitive awareness of an autistic child who has received hyperbaric oxygen therapy using the Autism Treatment Evaluation Checklist as a measurement tool? The parents reported a 4.11 percentage of improvements and the teachers reported a 14.29 percentage of improvements in the area of sensory/cognitive awareness.

Is there an increase in the health/physical/behavior of an autistic child who has received hyperbaric oxygen therapy using the Autism Treatment Evaluation Checklist as a measurement tool? The parents reported a 17.61 percentage of improvements and the teachers reported a 10.22 percentage of improvements in the area of health/physical/behavior.

It is also interesting to note the children all enjoyed the treatment, requesting to go in as soon as they got to the center. Several parents stated they were able to get their child to dress independently for the first time with the reward being going into the hyperbaric chamber.

Conclusions and Implications

Taking in account the limitations of sample size, the study is suggesting the following:

1. Children with autism do show a trend of improvement in speech/language, sociability, sensory/cognitive awareness and health/behavior when treating with hyperbaric oxygen therapy.
2. Teacher and parents responses were statistically similar enough to warrant only collecting data from one in the future, although both inputs do show value.
3. Further research could reveal more insight in the recovery of autism.

Future Work

Duplicating the study in the future with a larger sample size would give validation for the efficacy of treating children with autism in hyperbaric oxygen therapy. Another study could take children who have already done the forty treatments and assess if there is any continuation of improvements in treating the children with another set of forty treatments. Research combining other types of therapy such as gluten free diets or methyl-B 12 injections with hyperbaric oxygen therapy could also have justification.

With the tremendous growth in the population of children with autism, and the financial impact it will have on society as these children age, not to mention the impact on the family, continual research is vital to one day find an effective treatment for autism.

APPENDIX A

Michigan Rule 340.1715: Autism Spectrum Disorder Eligibility

(1) Autism spectrum disorder is considered a lifelong developmental disability that adversely affects a student's educational performance in 1 or more of the following performance areas: (a) Academic. (b) Behavioral. (c) Social.
Autism spectrum disorder is typically manifested before 36 months of age. A child who first manifests the characteristics after age 3 may also meet criteria. Autism spectrum disorder is characterized by qualitative impairments in reciprocal social interactions, qualitative impairments in communication, and restricted range of interests/repetitive behavior.
(2) Determination for eligibility shall include ALL of the following:
(A) Qualitative impairments in reciprocal social interactions including at least 2 of the following areas: (i) Marked impairment in the use of multiple nonverbal behaviors such as eye-to-eye gaze, facial expression, body postures, and gestures to regulate social interaction. (ii) Failure to develop peer relationships appropriate to developmental level.
(iii) Marked impairment in spontaneous seeking to share enjoyment, interests, or achievements with other people, for example, by a lack of showing, bringing, or pointing out objects of interest.
(iv) Marked impairment in the areas of social or emotional reciprocity.
(B) Qualitative impairments in communication including at least 1 of the following: (i) Delay in, or total lack of, the development of spoken language not accompanied by an attempt to compensate through alternative modes of communication such as gesture or mime. (ii) Marked impairment in pragmatics or in the ability to initiate, sustain, or engage in reciprocal conversation with others. (iii) Stereotyped and repetitive use of language or idiosyncratic language. (iv) Lack of varied, spontaneous make-believe play or social imitative play appropriate to developmental level.
(C) Restricted, repetitive, and stereotyped behaviors including at least 1 of the following: (i) Encompassing preoccupation with 1 or more stereotyped and restricted patterns of interest that is abnormal either in intensity or focus. (ii) Apparently inflexible adherence to specific, nonfunctional routines or rituals.
(iii) Stereotyped and repetitive motor mannerisms, for example, hand or finger flapping or twisting, or complex whole-body movements.
(iv) Persistent preoccupation with parts of objects.
(3) Determination may include unusual or inconsistent response to sensory stimuli, in combination with subdivisions (A), (B), and (C) of subrule 2 of this rule.
(4) While autism spectrum disorder may exist concurrently with other diagnoses or areas of disability, to be eligible under this rule, there shall not be a primary diagnosis of schizophrenia or emotional impairment.
(5) A determination of impairment shall be based upon a comprehensive evaluation by a multidisciplinary evaluation team including, at a minimum, a psychologist or psychiatrist, an authorized provider of speech and language under R 340.1745(d), and a school social worker.

APPENDIX B

Dave Weldon, M.D.
15th District, Florida
Congress of the United States
House of Representatives
Washington DC 20515

October 31, 2003

Julie L. Gerberding, M.D., M.P.H.
Director, Centers for Disease Control and Prevention
1600 Clifton Road, N.E.
Atlanta, GA 30333

Dear Dr. Gerberding:

I am writing to follow up on our conversation about the article (Verstraeten et. al.,) that will be published in the November 2003 issue of Pediatrics. I have reviewed the article and have serious reservations about the four-year evolution and conclusions of this study.

Much of what I observed transpired prior to your appointment a year ago as the Director of the Centers for Disease Control and Prevention (CDC). I am very concerned about activities that have taken place in the National Immunization Program (NIP) in the development of this study, and I believe the issues raised need your personal attention.

I am a strong supporter of childhood vaccinations and know that they have saved us from considerable death and suffering. A key part of our vaccination program is to ensure that we do everything possible to ensure that these vaccines, which are mandatory, are as safe as possible. We must fully disclose adverse events. Anything less than this undermines public confidence.

I have read the upcoming Pediatrics study and several earlier versions of this study dating back to February 2000. I have read various e-mails from Dr. Verstraeten and coauthors. I have reviewed the transcripts of a discussion at Simpsonwood, GA between the author, various CDC employees, and vaccine industry representatives. I found a disturbing pattern which merits a thorough, open, timely, and independent review by researchers outside of the CDC, HHS, the vaccine industry, and others with a conflict of interest in vaccine related issues (including many in University settings who may have conflicts).

A review of these documents leaves me very concerned that rather than seeking to understand whether or not some children were exposed to harmful levels of mercury in childhood vaccines in the 1990s, there may have been a selective use of the data to make the associations in the earliest study disappear. While most childhood vaccines now only have trace amounts of mercury from thimerosal containing vaccines (TCVs), it is critical that we know with certainty if children were injured in the 1990s.

Furthermore, the lead author of the article, Dr. Thomas Verstraeten, worked for the CDC until he left over two years ago to work in Belgium for GlaxoSmithKline (GSK), a vaccine manufacturer facing liability over TCVs. In violation of their own standards of conduct, Pediatrics failed to disclose that Dr. Verstraeten is employed by GSK and incorrectly identifies him as an employee of the CDC. This revelation undermines this study further.

The first version of the study, produced in February 2000, found a significant association between exposure to thimerosal containing vaccines (TCVs) and autism and neurological developmental delays (NDDs). When comparing children exposed to 62.5 ug of mercury by 3 months of age to those exposed to less than 37.5 ug, the study found a relative risk for autism of 2.48 for those with a higher exposure level. (While not significant in the 95% confidence interval for autism, this meets the legal standard of proof exceeding 2.0.) For NDDs the study found a relative risk of 1.59 and a definite upward trend as exposure levels increased.

A June 2000 version of the study applied various data manipulations to reduce the autism association to 1.69 and the authors went outside of the VSD database to secure data from a Massachusetts HMO (Harvard Pilgrim, HP) in order to counter the association found between TCVs and speech delay. At the time that HP's data was brought in, HP was in receivership by the state of Mass., its computer records had been in shambles for years, it had multiple computer systems that could not communicate with one another (Journal of Law, Ethics and Medicine Sept. 22, 2000), and it used a health care coding system totally different from the one used across the VSD. There are questions relating to a significant underreporting of Autism in Mass. The HP dataset is only about 15% of the HMO dataset used in the February 2000 study. There may also be significant problems with the statistical power of the HP dataset.

In June of 2000 a meeting was held in Simpsonwood, GA, involving the authors of the study, representatives of the CDC, and the vaccine industry. I have reviewed a transcript of this meeting that was obtained through the Freedom of Information Act (FOIA). Comments from Simpsonwood, NJ meeting include: (summary form, not direct quotes):

* We found a statistically significant relationship between exposures and outcomes. There is certainly an under ascertainment of adverse outcomes because some children are just simply not old enough to be diagnosed, the current incidence rates are much lower than we would expect to see (Verstraeten);

* We could exclude the lowest exposure children from our database. Also suggested was removing the children that got the highest exposure levels since they represented an unusually high percentage of the outcomes. (Rhodes)

* The significant association with language delay is quite large. (Verstraeten);

* This information should be kept confidential and considered embargoed;

* We can push and pull this data anyway we want to get the results we want;

* We can alter the exclusion criteria any way we want, give reasonable justifications for doing so, and get any result we want;

* There was really no need to do this study. We could have predicted the outcomes;

* I will not give TCVs to my grandson until I find out what is going on here.

Another version of the study - after further manipulation - finds no association between TCVs and autism, and no consistency across HMOs between TCVs and NDDs and speech delay.

The final version of the study concludes that "No consistent significant associations were found between TCVs and neurodevelopmental outcomes," and that the lack of consistency argues against an association. In reviewing the study there are data points where children with higher exposures to the neuortoxin mercury had fewer developmental disorders. This demonstrates to me how excessive

manipulation of data can lead to absurd results. Such a conclusion is not unexpected from an author with a serious, though undisclosed, conflict of interest.

This study increases speculation of an association between TCVs and neurodevelopmental outcomes. I cannot say it was the author's intent to eliminate the earlier findings of an association. Nonetheless, the elimination of this association is exactly what happened and the manner in which this was achieved raises speculation. The dialogue at the Simpsonwood meeting clearly indicates how easily the authors could manipulate the data and have reasonable sounding justifications for many of their decisions.

The only way these issues are going to be resolved - and I have only mentioned a few of them - is by making this particular dataset and the entire VSD database open for independent analysis. One such independent researcher, Dr. Mark Geier, has already been approved by the CDC and the various IRBs to access this dataset. They have requested the CDC allow them to access this dataset and your staff indicated to my office that they would make this particular dataset available after the Pediatrics study is published.

Earlier this month the CDC had prepared three similar datasets for this researcher to review to allow him to reanalyze CDC study datasets. However when they accessed the datasets - which the researchers paid the CDC to assemble - the datasets were found to have no usable data in them. I request that you personally intervene with those in the CDC who are assembling this dataset to ensure that they provide the complete dataset, in a usable format, to these researchers within two weeks. The treatment that these well-published researchers have received from the CDC thus far has been abysmal and embarrassing. I would also be curious to know whether Dr. Verstraeten, an outside researcher for more than two years now, was required to go through the same process as Dr. Geier in order to continue accessing the VSD.

You have not been a part of creating this current situation, but you do have an opportunity to help resolve this issue and ensure that confidence and trustworthiness in the CDC and our national vaccination program is fully restored. I would ask that you work with me to ensure that a full, fair, and independent review is made of the VSD database to fully examine this matter. I would like to meet with you at your earliest convenience to move this process forward.

Thank you for your consideration. I look forward to working with you on this urgent matter of great importance to our nation's most precious resource, our children.

Sincerely,
Dave Weldon, M.D.
Member of Congress

APPENDIX C

COPY

WAYNE STATE UNIVERSITY

HUMAN INVESTIGATION COMMITTEE
87 East Canfield, Second Floor
Detroit, Michigan 48201
Phone: (313) 577-1628
FAX: (313) 993-7122
http://hic.wayne.edu

NOTICE OF EXPEDITED APPROVAL

RECEIVED
JAN 20 2011
BY: BB

To: Tamela Powell
College of Education

From: Dr. Scott Millis
for Chairperson, Behavioral Institutional Review Board (B3)

Date: December 22, 2010

RE: HIC #: 1110710B3E
Protocol Title: Observational Study of Children with Autism who have Participated in Hyperbaric Oxygen Therapy
Funding Source:
Protocol #: 1012009137

Expiration Date: December 21, 2011

Risk Level / Category: Research not involving greater than minimal risk

The above-referenced protocol and items listed below (if applicable) were **APPROVED** following *Expedited Review* Category (#7)* by the Chairperson/designee *for* the Wayne State University Institutional Review Board (B3) for the period of 12/22/2010 through 12/21/2011. This approval does not replace any departmental or other approvals that may be required.

- Revised Protocol Summary Form, received 12/20/10.
- Research Informed Consent for Teacher, dated 12/14/10.
- Research Informed Consent for Parents, dated 12/14/10.
- Revised Questionnaire for Parents of Prospective Participant
- NOTE: Only the separate consents for teachers and parents are approved. The combined consent is NOT approved.

° Federal regulations require that all research be reviewed at least annually. You *may* receive a *"Continuation Renewal Reminder"* approximately two months prior to the expiration date; however, it is the Principal Investigator's responsibility to obtain review and continued approval ***before*** the expiration date. Data collected during a period of lapsed approval is unapproved research and can ***never*** be reported or published as research data.

° All changes or amendments to the above-referenced protocol require review and approval by the HIC **BEFORE** implementation.

° Adverse Reactions/Unexpected Events (AR/UE) must be submitted on the appropriate form within the timeframe specified in the HIC Policy (http://www.hic.wayne.edu/hicpol.html).

NOTE:

1. Upon notification of an impending regulatory site visit, hold notification, and/or external audit the HIC office must be contacted immediately.
2. Forms should be downloaded from the HIC website at ***each*** use.

*Based on the Expedited Review List, revised November 1998

APPENDIX D

Questionnaire for parents of prospective participant:

1. Date of Birth: _____
2. Does the child have a school eligibility to receive services in the area of autism?
3. Has the school conducted a Multi- Disciplinary Evaluation Team (MET) to determine eligibility? When/age?
4. Does the child have an IEP?
5. Would you agree to have your child be part of a research study?
6. Would you agree to let me contact your child's teacher to see if he or she would be willing to participate in the study by filling out a pre and post evaluation regarding your child?
7. Has the child ever participated in hyperbaric oxygen therapy?
8. Can the parent/caretaker provide written consent to be part of the study?

APPENDIX E

Summary of the Data

Range of scores

ATEC scores range from zero to 180. The lower the score, the better.

If a child scores zero or close to zero, that child cannot be distinguished from other normal children. He or she can be considered fully recovered and not autistic.

The important benchmarks in scoring are as follows:

- ATEC < 30. This level places the child in the top 10 percentile. A child with score of less than 30 – or, better still, less than 20 – would have some ability to conduct normal, two-way conversations, and more or less behave normally. Such children have high chances of leading normal lives as independent individuals.

- ATEC < 50. This places the child in the 30th percentile level. The child has good chances of being semi-independent. More importantly, he or she will not likely need to be placed in an institution. For many parents of autistic children, being able to achieve improvement up to this level is already considered very significant.

  ATEC > 104. Even though the maximum score is 180, any person with a score of

  more than 104 would already be in the 90th percentile, and be considered very

  severely autistic.

APPENDIX F

Sample test scoring from ATEC

Date: 11/2/2010 2:11:15 PM
Child's Name: **Student Test**

TOTAL AND SUBSCALE SCORES
Total Score: **131**
I. Speech/Language/Communication: **24**
II. Sociability: **36**
III. Sensory/Cognitive Awareness: **32**
IV. Health/Physical/Behavior: **39**

I. Speech/Language/Communication
1. Knows own name: **Somewhat true**
2. Responds to `No' or `Stop': **Somewhat true**
3. Can follow some commands: **Somewhat true**
4. Can use one word at a time: **Somewhat true**
5. Can use 2 words at a time: **Not true**
6. Can use 3 words at a time: **Not true**
7. Knows 10 or more words: **Not true**
8. Can use sentences with 4 or more words: **Not true**
9. Explains what he/she wants: **Not true**
10. Asks meaningful questions: **Not true**
11. Speech tends to be meaningful/relevant: **Not true**
12. Often uses several successive sentences: **Not true**
13. Carries on fairly good conversation: **Not true**
14. Has normal ability to com municate for his/her age: **Not true**

Total for Section I: **24**

**II. Sociability
1. Seems to be in a shell - you cannot reach him/her: **Very descriptive**
2. Ignores other people: **Very descriptive**
3. Pays little or no attention when addressed: **Somewhat descriptive**
4. Uncooperative and resistant: **Somewhat descriptive**
5. No eye contact: **Very descriptive**

6. Prefers to be left alone: **Very descriptive**
7. Shows no affection: **Very descriptive**
8. Fails to greet parents: **Very descriptive**
9. Avoids contact with others: **Very descriptive**
10. Does not imitate: **Very descriptive**
11. Dislikes being held/cuddled: **Somewhat descriptive**
12. Does not share or show: **Very descriptive**
13. Does not wave `bye bye': **Very descriptive**
14. Disagreeable/not compliant: **Very descriptive**
15. Temper tantrums: **Somewhat descriptive**
16. Lacks friends/companions: **Very descriptive**
17. Rarely smiles: **Very descriptive**
18. Insensitive to other's feelings: **Very descriptive**
19. Indifferent to being liked: **Very descriptive**
20. Indifferent if parent(s) leave: **Very descriptive**

Total for Section II: **36**

III. Sensory/Cognitive Awareness

1. Responds to own name: **Somewhat descriptive**
2. Responds to praise: **Somewhat descriptive**
3. Looks at people and animals: **Not descriptive**
4. Looks at pictures (and T.V.): **Somewhat descriptive**
5. Does drawing, coloring, art: **Not descriptive**
6. Plays with toys appropriately: **Not descriptive**
7. Appropriate facial expression: **Not descriptive**
8. Understands stories on T.V.: **Not descriptive**
9. Understands explanations: **Not descriptive**
10. Aware of environment: **Not descriptive**
11. Aware of danger: **Not descriptive**
12. Shows imagination: **Somewhat descriptive**
13. Initiates activities: **Not descriptive**
14. Dresses self: **Not descriptive**
15. Curious, interested: **Not descriptive**
16. Venturesome - explores: **Not descriptive**
17. Tuned in - Not spacey: **Not descriptive**
18. Looks where others are looking: **Not descriptive**

Total for Section III: **32**

IV. Health/Physical/Behavior
1. Bed-wetting: **Minor Problem**
2. Wets pants/diapers: **Minor Problem**
3. Soils pants/diapers: **Not a Problem**
4. Diarrhea: **Moderate Problem**
5. Constipation: **Moderate Problem**
6. Sleep problems: **Serious Problem**
7. Eats too much/too little: **Minor Problem**
8. Extremely limited diet: **Serious Problem**
9. Hyperactive: **Moderate Problem**
10. Lethargic: **Minor Problem**
11. Hits or injures self: **Minor Problem**
12. Hits or injures others: **Minor Problem**
13. Destructive: **Minor Problem**
14. Sound-sensitive: **Serious Problem**
15. Anxious/fearful: **Moderate Problem**
16. Unhappy/crying: **Minor Problem**
17. Seizures: **Not a Problem**
18. Obsessive speech: **Minor Problem**
19. Rigid routines: **Moderate Problem**
20. Shouts or screams: **Minor Problem**
21. Demands sameness: **Moderate Problem**
22. Often agitated: **Moderate Problem**
23. Not sensitive to pain: **Minor Problem**
24. Hooked or fixated on certain objects/topics: **Moderate Problem**
25. Repetitive movements: **Serious Problem**

Total for Section IV: **39**

APPENDIX G

Dive Log documented notes and observations:

T-TW

1) 2/14/2011 – T-TW very upset yelling and kicking 1st ten minutes of tx. To 2.0 ata
2) 2/15/2011 - T-TW more relaxed – to 2.0 ata
3) 2/16/2011 - 2.0 ata – nothing remarkable
4) 2/17/2011 - 2.0 ata
5) 2/18/2011 – T-TW is more calm, relaxed and attentive - 2.0 ata
6) 2/23/2011 - 2.0 ata
7) 2/28/2011 - 2.0 ata – T-TW much better. Behavior, calmer, playful, joyful
8) 3/01/2011 - 2.0 ata
9) 3/02/2011 - 2.0 ata
10) 3/03/2011 - more smiles, focus and conversation
11) 3/04/2011 - 2.0 ata
12) 3/07/2011 – T-TW calm, relaxed entire time. Very good mood – 2.0 ata
13) 3/08/2011 - 2.0 ata
14) 3/10/2011 – T-TW is more alert. Great kid. 2.0 ata
15) 3/11/2011—2.0 ata
16) 3/15/2011- 2.0 ata
17) 3/16/2011- 2.0 ata
18) 3/17/2011 – pre dad: T-TW pays attention more when asked to do something. 2.0 ata
19) 3/18/2011 – was screaming, then calmed down, had bad day. 2.0 ata
20) 3/21/2011 - 2.0 ata
21) 3/25/2011 - 2.0 ata
22) 3/28/2011 - 2.0 ata
23) 3/30/2011 - 2.0 ata
24) 3/31/2011 - 2.0 ata
25) 4/1/2011 - 2.0 ata
26) 4/11/2011 - 2.0 ata
27) 4/12/2011 – was screaming, then calmed down. Out of routine, spring break. 2.0 ata
28) 4/13/2011 – same as dive 27. 2.0 ata
29) 4/14/2011 – seemed calmer. 2.0 ata
30) 4/15/2011 – seemed calmer. 2.0 ata
31) 4/18/2011 – calm 2.0 ata

32) 4/19/2011 – calm 2.0 ata
33) 4/21/2011 - 2.0 ata
34) 4/22/2011 - 2.0 ata
35) 4/25/2011 – good day, watching cars go by when blinds were opened. 2.0 ata
36) 4/26/2011 – good day, watched cars go by 2.0 ata
37) 4/27/2011 – good day, watched cars go by 2.0 ata
38) 4/28/2011 – good day 2.0 ata
39) 4/29/2011 – good day 2.0 ata
40) 5/2/2011 – good day 2.0 ata

3/30/2011—note from mom

As of today, Wednesday March 30, 2011, my son, T-TW has completed 23 “dives.” We looked into this treatment for his Autism Spectrum Disorder. Before the “dives” one of the behaviors T-TW had was an indifference to people and things around him. Since the “dives” he has shown more interest in people, to the point of at least acknowledging a stranger by glancing at them and especially in new “things” presented to him. The other significant improvement has been with his comprehension. Before the Hyperbaric Oxygen Therapy, if or when, we told T-TW to do something, he wouldn’t or couldn’t. As if he didn’t understand what he was being asked of him. Now he is following simple one-step commands consistently and some two-step commands as well. As an added benefit, we also are seeing more speech. He does receive speech therapy at school and independently at an outside facility, but besides just being able to “speak” or say the words, he is using the speech appropriately and in context. I am eager to see our results after completing all 40 “dives.” (K. W., mother)

T-JC.

Dive Log documented notes and observations:

1) 2/14/2011 - Great 1st tx. T-JC sweated profusely. 2.0 ata (Playing with fridge magnets. Spelled, “welcome harry potter” playing with our dog better. Also saying, “come here Rio.”)
2) 2/15/2011 – T-JC was toe-walking but excited to tx. 2.0 ata (Going into chamber said, “come on let’s go in.”)
3) 2/16/2011 - 2.0 ata T-JC eager to start (Jumpy in chamber. Playful and talking about movie)
4) 2/17/2011 - 2.0 ata T-JC sweating and yelling, almost Tourette like to stim. (Jumpy in chamber)
5) 2/18/2011 - 2.0 ata (Jumpy in chamber)
6) 2/19/2011—(Said “hey, where’s Luke” when Luke was in bathroom.)
7) 2/20/2011—(Eating better. Saying prayers slower, not as hyper, loving, playful and not yelling as much.)
8) 2/21/2011 - 2.0 ata Dad said they are please with T-JC improvements. (Jumpy in chamber, eating good, poops a lot. Went out to lunch and did best ever in a restaurant.)
9) 2/22/2011 (no HBOT due to ice. Eating good. Talking good.)
10) 2/23/2011 (no HBOT due to ice. Eating good.)
11) 2/24/2011 - 2.0 ata – very vocal. Lots of yelling (playing good with Rio and Luke. Jumpy in chamber)
12) 2/25/2011 - 2.0 ata (Worse ever in chamber)
13) 2/26/2011 (playing good)
14) 2/27/2011 (T-JC had runs bad in morning)
15) 2/28/2011 (Prayers slower and using L**’s DS first time ever. Hand held video games. Playing with my calculator.)
16) 3/01/2011 - 2.0 ata – very vocal (same)
17) 3/02/2011 - 2.0 ata – saw Dr. **** for blood test, said he is weird (same)
18) 3/03/2011 - 2.0 ata – verbal (same)
19) 3/04/2011 - 2.0 ata – verbal (eating good. Good in chamber. Playing with more and more. Still playing DS. Harder poop. Kissing a lot. Asked for horsey ride. When I put him down he said, “come on you can do it.” First 6 word sentence. Saying “Hi” to people at Kroger’s.)
20) 3/05/2011 (Playing good with R** and L**. Comes up and hugs without me asking for it. Hung up towel after using in bathroom. Harder poop. Pee stinks

bad. Helped me make chicken soup for first time. Using squirt gun shooting L*** saying, “got you.”)

21) 3/6/2011 (level day)
22) 3/07/2011 - 2.0 ata – verbal for seemingly attention (level day)
23) 3/08/2011 - 2.0 ata - dad cannot control verbal outburst. (level day)
24) 3/09/2011 – 2.0 ata (level day)
25) 3/10/2011 (iced in, no HBOT. Jumped on for horsey ride and said got ya)
26) 3/11/2011 (iced in, no HBOT.)
27) 3/13/2011 (good day)
28) 3/14/2011 – 2.0 ata (bad in chamber, pee still stinks)
29) 3/15/2011 – 2.0 ata (in chamber said “almost done. Five more minutes.”)
30) 3/16/2011 – 2.0 ata (less babbling each day.)
31) 3/17/2011 – 2.0 ata (looking at people more each day.)
32) 3/18/2011 – 2.0 ata (Pointed to door and said, “R** poop outside.” Wanted me to let him out. Reading all color words correctly. Playing with magnets on fridge and spelling words out. He asked me to write seven people from DVD on marker board and pointed to and told me all names correctly.)
33) 3/19/2011 (Opened door without anyone telling him to when I came home and said “hi daddy.” Dropped a lot of papers on ground and said, “somebody broke that.” Asks for paper and markers daily.
34) 3/20/2011 (Playing good with R** and L*** and helped with burning leaves outside.
35) 3/21/2011 (iced in, no HBOT No yelling out hardly at all.)
36) 3/22/2011 – 2.0 ata
37) 3/28/2011 – 2.0 ata T-JC doing well! No yelling!
38) 3/29/2011 – 2.0 ata
39) 3/30/2011 – 2.0 ata T-JC calmer, less yelling, more eye contact
40) 4/01/2011– 2.0 ata T-JC doing well
41) 4/04/2011 – 2.0 ata
42) 4/05/2011 – 2.0 ata
43) 4/06/2011 – 2.0 ata
44) 4/07/2011 – 2.0 ata
45) 4/08/2011 – 2.0 ata
46) 4/11/2011 – 2.0 ata
47) 4/12/2011 – 2.0 ata
48) 4/13/2011 – 2.0 ata
49) 4/14/2011 – 2.0 ata
50) 4/15/2011 – 2.0 ata
51) 4/18/2011 – 2.0 ata

52) 4/19/2011 – 2.0 ata
53) 4/20/2011 – 2.0 ata
54) 4/21/2011 – 2.0 ata
55) 4/22/2011 – 2.0 ata

T-SC

Dive Log documented notes and observations:

1) 1/31/2011 - didn't relax until half-point of dive. Only to 1.4 ata
2) 2/01/2011 - More relaxed 2.0 ata
3) 2/03/2011 - 2.0 ata
4) 2/04/2011 - 2.0 ata
5) 2/07/2011 - 2.0 ata
6) 2/08/2011 – 2.0 ata
7) 2/09/2011 - 2.0 ata
8) 2/10/2011 - stop for pressure in ears – dive at 1.75 ata
9) 2/11/2011 - 1.75 ata
10) 2/14/2011 – T-SC more attentive and alert – to 2.0ata
11) 2/15/2011 - 2.0 ata
12) 2/16/2011 - stopped for ears to 2.0 ata
13) 2/17/2011 – T-SC more attentive and relaxed – to 2.0 ata
14) 2/18/2011 - 2.0 ata
15) 2/21/2011 - 2.0 ata
16) 2/22/2011 - 2.0 ata
17) 2/23/2011 – T-SC, according to mom, is more focused. 2.0 ata
18) 2/24/2011 - 2.0 ata
19) 2/25/2011 – T-SC with mom, calm. Mom says T-SC pays attention more at home. 2.0 ata
20) 2/29/2011 - 2.0 ata
21) 3/01/2011 - more attention, focus and conversation 2.0 ata
22) 3/02/2011 - 2.0 ata
23) 3/03/2011 - more smiles, focus and conversation 2.0 ata
24) 3/04/2011 - 2.0 ata
25) 3/07/2011 - 2.0 ata. No problem with ears.
26) 3/08/2011 – 2.0 ata Manually clear 3x's then T-SC had to use restroom, brought up 13 minutes early
27) 3/09/2011 - 2.0 ata – no problem
28) 3/10/2011 - 2.0 ata. Dad said she speaking clearer and communicates better
29) 3/11/2011 – 2.0 ata

30) 3/14/2011 – 2.0 ata
31) 3/15/2011 – 2.0 ata
32) 3/16/2011 – 2.0 ata
33) 3/17/2011 – 2.0 ata
34) 3/18/2011 – 2.0 ata
35) 3/21/2011 – 2.0 ata
36) 3/22/2011 – 2.0 ata
37) 3/23/2011 – 2.0 ata
38) 3/25/2011 – 2.0 ata
39) 3/28/2011 – 2.0 ata
40) 3/30/2011 – 2.0 ata

So far, we have observed the following changes in T-SC since she began HBOT:

Increase in independent behavior (saying “no” she doesn’t want to do this or that, she wants to do what she wants), since she never really went through this stage, this is probably a good thing.

Some increase in eye contact, including looking at people while smiling (which she did not really do before)

Increase in focus – she will spend a little longer with things like homework, puzzles, etc (maybe 4-6 minutes)

Willingness to try to figure things out (kind of goes along with increased focus) she will attempt to do things that she was really resistant to trying before like puzzles, singing songs, etc.

She is also showing an interest in new things like computer games – she will play with a computer (she’s had since she was 2, so it’s for very young children) and continue playing the letter game for up to 15 minutes.

Also, as I stated earlier we will be happy to complete any additional surveys after a month or so and I’m sure her teacher will too.

Thanks again for all of your help and advice!

D C, mother

T-AO

Dive Log documented notes and observations:

1) 2/21/2011 - 2.0 ata
2) 2/22/2011 - 2.0 ata
3) 2/23/2011 - 2.0 ata.T- AO relaxed in chamber
4) 2/24/2011 - 2.0 ata Dad says T-AO much calmer at home and less temper
5) 2/25/2011 - 2.0 ata T-AO is relaxed and watched entire movie
6) 2/28/2011 - 2.0 ata Had trouble with descent. Leveled at 3 psi. Dad stated, "able to sleep at night after the very first dive. She was not sleeping before. She slept all night long. No tantrums with her coat. Wanted into chamber. More assertive."
7) 3/01/2011 - 2.0 ata
8) 3/02/2011 - 2.0 ata
9) 3/03/2011 - 2.0 ata – T-AO much calmer, no longer plays rough or climbing the walls. "T-AO is no longer climbing the walls and pulling cabinet doors off the hinges. No longer plays as rough, less bruises on her legs.)
10) 3/04/2011 – T-AO relaxed and watched movie. Dad had trouble w/ears – level to 1.5 ata
11) 3/07/2011 - 2.0 ata – no problems
12) 3/09/2011 – T-AO feeling good! 2.0 ata
13) 3/10/2011 - 2.0 ata
14) 3/11/2011 – 2.0 ata
15) 3/14/2011 – 2.0 ata
16) 3/15/2011 – 2.0 ata
17) 3/16/2011 – 2.0 ata
18) 3/17/2011 – 2.0 ata
19) 3/18/2011 – 2.0 ata
20) 3/21/2011 – 2.0 ata
21) 3/22/2011 – 2.0 ata
22) 3/23/2011 – 2.0 ata
23) 3/24/2011 – 2.0 ata
24) 3/25/2011 – 2.0 ata
25) 3/28/2011 – 2.0 ata
26) 3/30/2011 – 2.0 ata
27) 3/31/2011 – 2.0 ata
28) 4/1/2011 – 2.0 ata

29) 4/4/2011 – 2.0 ata
30) 4/5/2011 – 2.0 ata
31) 4/6/2011 – 2.0 ata. According to mom: T-AO eating and sleeping better. In better mood.
32) 4/8/2011 – 2.0 ata
33) 4/11/2011 – 2.0 ata According to Dad, “her eating is back to normal, sleeping back to normal, no waking up, teacher said she said her name, she has a comprehension of emotion and mimics from the DVD.
34) 4/12/2011 – 2.0 ata
35) 4/13/2011 – 2.0 ata. According to dad, T-AO is taking in her own language.
36) 4/14/2011 – 2.0 ata
37) 4/18/2011 – 2.0 ata. According to dad, is now singing. “She ate 3 pieces of chicken (thighs) and potatoes, her appetite has increased. She is trying to say words. She is saying “so ki” for name. Her very strong personality is coming out. If she wants to do something, she stands firm on it.”
38) 4/19/2011 – 2.0 ata
39) 4/20/2011 – 2.0 ata According to dad, T-AO is mimicking/repeating words that you say.
40) 4/22/2011 – 2.0 ata

S-DR:

Dive Log documented notes and observations:

1) 2/21/2011 - 1.5 ata – congestion/coughing.
2) 2/22/2011 - 1.5 ata – still congested
3) 2/23/2011 - 1.5 ata – still congested
4) 2/24/2011 - 1.75 ata
5) 2/25/2011 – 1.75 ata
6) 2/28/2011 – 1.75 ata
7) 3/01/2011 – 1.75 ata
8) 3/02/2011– 1.75 ata
9) 3/03/2011– 1.75 ata
10) 3/04/2011– 1.75 ata
11) 3/07/2011– 1.75 ata
12) 3/08/2011– 1.75 ata
13) 3/09/2011– 1.75 ata
14) 3/10/2011– 1.75 ata
15) 3/11/2011– 1.75 ata
16) 3/14/2011– 1.75 ata

17) 3/15/2011– 1.75 ata
18) 3/16/2011– 1.75 ata
19) 3/17/2011– 1.75 ata
20) 3/18/2011– 1.75 ata
21) 3/22/2011– 1.75 ata congestion and coughing gone
22) 3/23/2011 – 2.0 ata
23) 3/24/2011– 2.0 ata
24) 3/25/2011– 2.0 ata tech notes S-DR seems to be engaging visually and a little more attentive
25) 3/26/2011– 2.0 ata
26) 3/28/2011– 2.0 ata
27) 3/29/2011– 2.0 ata tech notes: He is more attentive, seems to be more engaging to others here at the clinic. (According to Dad, S-DR has been more relaxed for a week or so. Attending church has been more pleasant as S-DR has been calmer.)
28) 3/30/2011– 2.0 ata
29) 3/31/2011– 2.0 ata
30) 4/01/2011– 2.0 ata
31) 4/04/2011– 2.0 ata
32) 4/05/2011– 2.0 ata
33) 4/06/2011– 2.0 ata
34) 4/07/2011– 2.0 ata
35) 4/08/2011– 2.0 ata
36) 4/11/2011– 2.0 ata
37) 4/12/2011– 2.0 ata
38) 4/13/2011– 2.0 ata
39) 4/14/2011– 2.0 ata
40) 4/15/2011– 2.0 ata

REFERENCES

Allen, G., & Courchesne, E. (2003). Differential effects of developmental cerebellar abnormality on cognitive and motor functions in the cerebellum: An fMRI study of autism. *American Journal of Psychiatry, 160*(2), 262-273.

Agency for Toxic Substances and Disease Registry (ATSDR). (1999). *Toxicological Profile for Mercury*. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Amin-Zaki, L., Elhassani, S., Majeed, M., Clarkson, T., Doherty, R. & Greenwood, M. (1974). Studies of infants postnatally exposed to methylmercury. *Journal of Pediatrics, 85, 81-84.*

Araghi-Niknam, M., & Fatemi, S. H. (2003). Levels of bcl-2 and p53 are altered in superior frontal and cerebellar cortices of autistic subjects. *Cellular and Molecular Neurobiology, 23*(6), 945-952.

Aschner, M., Allen, J. W., Kimelberg, H. K., LoPachin, R. M., & Streit, W. J. (1999). Glial cells in neurotoxicity development. *Annual Review of Pharmacology and Toxicology*, 39, 151–73.

Asperger, H. (1961). Psychopathology of children with coeliac disease. *Ann Paediatr, 197*, 346-351.

Axton, J. H. (1972). Six cases of poisoning after a parenteral organic mercurial compound (merthiolate). *Postgraduate Medical Journal, 48*(561), 417-421.

Baker, J. (2008). Mercury, vaccines, and autism: one controversy, three histories. *American Journal of Public Health,* 98(2) 244-53.

Baskin, D., (2002). Vaccines and the autism epidemic: Reviewing the federal government's track record and charting a course for the future. Committee on government reform, House of Representatives One Hundred Seventh Congress Second Session, Serial Number 107-153 (testimony of David Baskin).

Baskin, D. S., Ngo, H., & Didenko, V. V. (2003). Thimerosal induces DNA breaks, caspase-3 activation, membrane damage, and cell death in cultured human neurons and fibroblasts. *Toxicological Sciences, 74*(2), 361-368.

Bernard, S., Enayati, A., Roger, H., Binstock, T., and Redwood, L. (2003). Toxicology of neruodevelopmental disorders: The role of mercury in the pathogenesis of autism. *Molecular Psychiatry, 7*, S42-S43.

Bigazzi, P. (1994). Autoimmunity and Heavy Metals. *Lupus,* 3:449-453.

Billstedt, E, Gillberg, C. & Gillberg C. (2005). Autism after adolescence: population-based 13- to 22-year follow-up study of 120 individuals with autism diagnosed in childhood. *Journal of Autism and Developmental Disorders*, *35*(3), 351-360.

Boddaert, N., & Zilbovicius, M. (2002). Functional neuroimaging and childhood autism. *Pediatric Radiology, 32*(1), 1-7.

Boerema, I., Kroll, J., Meijne, E., Lokin, E., Kroon, B., & Huiskes, J. (1956). High Atmospheric pressure as an aid to cardiac surgery. Archivum Chirurgicum Neerlandicum. 8,193-211.

Bradstreet, J. (2001) Autism: Why the increased rates? A one year update. Hearing before the Committee on Government Reform: 107th congress. April 25-26, p. 17, Serial No. 107-29.

Brummelkamp, W., Hoenijk, J. & Boerema, I. (1961) Treatment of anaerobic infections (clostridial myostitis) by drenching the tissue with oxygen under high atmospheric pressure. *Surgery*. 49, 299-302.

Burton, D. (2003). Mercury in medicine: Taking unnecessary risks. *A Report Prepared by the Staff of the Subcommittee on Human Rights and Wellness Committee on Government Reform United States House of Representatives Chairman Dan Burton,* May 2003.

Byrd, R. (2002). Report to the legislature on the principal findings from the epidemiology of autism in California: a comprehensive pilot study. *University of California's Medical Investigation of Neurodevelopmental Disorders (M.I.N.D.) Institute.*

Carbone, P. S. (2010). The Medical Home for Children with Autism Spectrum Disorders: Parent and Pediatrician Perspectives. *Journal of autism and developmental disorders*, 40(3), p.317-324.

Castelli, F., Frith, C., Happe, F., & Frith, U. (2002). Autism, Asperger syndrome and brain mechanisms for the attribution of mental states to animated shapes. *Brain, 125*(8), 1839-1849.

Cave, S. (2000) Congress U.S. House of Representatives, Committee on Government Reform. Testimony by Dr. Stephanie Cave. July 18, 2000.

Centers for Disease Control and Prevention (1999) Thimerosal in vaccines: A joint statement of the American Academy of Pediatrics and the Public Health Service, *Morbidity and Mortality Weekly Report* 48(26), 563-565.

Centers for Disease Control and Prevention (2007). Prevalence of autism spectrum disorders: autism and developmental disabilities monitoring network, 14 Sites,

United States, 2002. *Morbidity and Mortality Weekly Report Surveillance Summaries, 56*(1), 12–28.

Choi, B., Lapham, L., Amin-Kaki, L., & Saleem. T. (1978). Abnormal neuronal migration, deranged cerebral cortical organization, and diffuse white matter astrocytosis of human fetal brain: a major effect of methylmercury poisoning in utero. *Journal of Neuropathology & Experimental Neurology, 37, 719-733.*

Churchill-Davidson, I., Sanger, C., & Thomlinson, R. (1955). High pressure oxygen and radiotherapy. *Lancet*, 1, 1091-5.

Clarkson, T. (2002). The three modern faces of mercury. *Environmental Health Perspectives, 110, (1)*, 11-23.

Clarkson, T., Magos, L., & Myers, G. (2003) The toxicology of mercury: Current exposures and clinical manifestations. The New England Journal of Medicine. 349, 1731-7.

Committee on the Toxicological Effects of Methylmercury (2000). Board on Environmental Studies and Toxicology, National Research Council. *Toxicological Effects of Methylmercury*. National Academy of Sciences. Washington, D.C.

Congress (2001) U.S., Washington, D.C., House Committee on Government Reform. Autism: why the increase rates? A one-year update. April 25 and 26, 2001.

Congress (2003). Congressional Record, V. 149, Pt. 9, May 14, 2003.

Courchesne, E., Karns, C. M., Davis, H.R., Ziccardi, R., Carper, R.A., Tigue, Z.D….. Courchesne, R.Y. (2001). Unusual brain growth patterns in early life in patients with autistic disorder: an MRI study. *Neurology,* 57, 245–254.

Crichley, H., Daly, E., Bullmore, E., Williams, S., VanAmelsvoort, T., Robertson, D….Murphy, D (2000). The functional neuroanatomy of social behavior: changes in cerebral blood flow when people with autistic disorder process facial expressions. *Brain, 123*, 2203-12.

Degirmenci, B., Miral, S., Kaya, G. C., Lyilikci, L., Arslan, G., Baykara, A….Durak, H. (2008). Technetium-99m HMPAO brain SPECT in autistic children and their families. *Psychiatry Research*, 162, 236–243.

Department of Developmental Services. (1999). *Changes in the Population of Persons with Autism and Pervasive Developmental Disorders in California's Developmental Services System: 1987 through 1998*. A Report to the Legislature March 1, 1999. Sacramento CA: California Health and Human Services Agency.

Descotes, J.(1986). *Immunotoxicology of Drugs and Chemicals.* New York: Elsevier.

Desmouliere, A., Redard, M., Darby, I., & Gabbiani, G. (1995). Apoptosis mediates the decrease in cellularity during the transition between granulation tissue and scar. *American Journal of Pathology*, 146 (1), 56-66.

Edwards, K., Meade, B., Decker, M., Reed, G., Rennels, M., Steinhoff, M. (1995) Comparison of 13 acellular pertussis vaccines: overview and serologic response. *Pediatrics 96, 548-57.*

Elder, J., Shankar, M., Shuster, J., Theriaque, D., Burns, S., Sherrill, L. (2006) The gluten-free, casein-free diet in autism: Results of a preliminary double blind clinical trial. *Journal of Autism and Developmental Disorders,* 36(3), 413-420.

Fagan, D. G., Pritchard, J. S., Clarkson, T. W., & Greenwood, M. R. (1977). Organ mercury levels in infants with omphaloceles treated with organic mercurial antiseptic. *Archives of Disease in Childhood, 52*(12), 962-964.

Fatemi, S. H., Halt, A. R., Stary, J. M., Realmuto, G. M., & Jalali-Mousavi, M. (2001). Reduction in anti-apoptotic protein bcl-2 in autistic cerebellum. *Neuroreport, 12*(5), 929-933.

Feldmeier, J. (Ed.). (2003). *Hyperbaric oxygen 2003: indications and results*. Kensington, MD: Undersea and Hyperbaric Medicine Society.

Fiasco, B. (2002). The Homeland Security Bill, Washington, D.C.

Filipek P., Accardo P. J., Ashwal, S., Baranek, G.T., Cook, E. H., Dawson, G…..Volkmar, F. R. (2000). Practice parameter: screening and diagnosis of autism. Report of the Quality Standards Subcommittee of the American Academy of Neurology and the Child Neurology Society. *Neurology*, 55(4), 468–79.

Forstrom, L., Hannuksela, M., Kousa, M., & Lehmuskallio, E. (1980). Merthiolate hypersensitivity and vaccination. *Contact Dermatitis, 6*(4), 241-245.

Fournie, G. J., Mas, M., Cautain, B., Savignac, M., Subra, J. F., Pelletier, L.,…Druet, P (2001). Induction of autoimmunity through bystander effects. Lessons from immunological disorders induced by heavy metals. *Journal of Autoimmunity, 16*(3), 319-326.

Fox, P. T., & Raichle, M. E. (1986). Focal physiological uncoupling of cerebral blood flow and oxidative metabolism during somatosensory stimulation in human subjects. *Proceedings of the National Academy of Sciences of the United States of America, 83*(4), 1140-1144.

Furlano, R. I., Anthony, A., Day, R., Brown, A., McGarvey, L., Thomson, M. A….Murch, S., H. (2001). Colonic cd8 and gamma delta t-cell infiltration with epithelial damage in children with autism. *Journal of Pediatrics, 138*(3), 366-372.

Ganz, J., Simpson, R., & Corbin-Newsome, J. (2008). The impact of the Picture Exchange Communication System on requesting and speech development in preschoolers with autism spectrum disorders and similar characteristics. *Research in Autism Spectrum 2:157-169.*

Ganz, Michael. (2007) The lifetime distribution of the incremental societal cost of autism. *Pediatric & Adolescent Medicine*, 161 (4), 343-349.

General recommendations on immunization (2002). *MMWR, 51*(RR02), 1-36.

Geier, D., and Geier, M. (2004). A comparative evaluation of the effects of MMR immunization and mercury doses from thimerosal-containing childhood vaccines on the population prevalence of autism. *Medical Science Monitor*, 10(3),133-139.

Geier, D., Sykes, L., and Geier, M. (2007). A review of thimerosal (Merthiolate) and its ethylmercury breakdown product: Specific historical considerations regarding safety and effectiveness. *Journal of Toxicology and Environment Health, Part B*, 10(8), 575-596.

Gill, A., and Bell, C. (2004). Hyperbaric oxygen: its uses, mechanisms of action and outcomes. *Quarterly Journal of Medicine*, 97:385-395.

Grigg, J. (2004). Environmental toxin: Their impact on children's health. *Archives of Diseases in Childhood, 89:244-250.*

Gosselin, R., Smith, R., & Hodge, H (1984). *Clinical toxicology of commercial products* (5th ed.). New York: Williams & Wilkins.

Gupta, P., Rapin, I., Houroupian, D., Roy, S., Llena, J., & Tandon, P. (1984). Smoldering encephalitis in children. *Neuropediatrics*, 15, 191-197.

Gupta, S., Aggarwal, S., & Heads, C. (1996). Dysregulated immune system in children with autism: Beneficial effects of intravenous immune globulin on autistic characteristics. *Journal of Autism and Developmental Disorders, 26*(4), 439-452.

Guy, J., Gan, J., Selfridge, J., Cobb, S., & Bird, A. (2007). Reversal of neurological defects in a mouse model of Rett syndrome. *Science*, 315, 1143–1147.

Haley, B. (2007) The relationship of the toxic effects of mercury to exacerbation of the medical condition classified as Alzheimer's disease. *Medical Veritas 2, 1510-1524.*

Haley, B. (2005). Mercury toxicity: Genetic susceptibility and synergistic effects. *Medical Veritas 2*, 535-542.

Halsey, N., & Hyman, S. (2001) Measles-Mumps-Rubella vaccine and autistic spectrum disorder: *Report from the new challenges in childhood immunizations conference convened in Oak Brook, Illinois*, June 12-13, 2000.

Harch, P., & McCullough, V. (2007). *The oxygen revolution*. New York: Hatherleigh Press.

Harrington, P., Patrick, P., Edwards, K., and Brand, D. (2006) Parental beliefs about autism: Implications for the treating physician. *Autism*, 10(5) 452–462.

Hashimoto, T., Sasaki, M., Fukumizu, M., Hanaoka, S., Sugai, K., & Matsuda, H. (2000). Single-photon emission computed tomography of the brain in autism: Effect of the developmental level. *Pediatric Neurology, 23*(5), 416-420.

Helt, M., Kelley, E., Kinsbourne, M., Pandey, J., Boorstein, H., Herbert, M., Fein, D. (2008) Can Children with autism recover? If so, how? *Neuropsychology Review,* 18, 339-366.

Hendry, J., DeVito, T., Gelman, N., Densmore, M., Rajakumar, N., Pavlosky, W….Nicolson, R. (2006). White matter abnormalities in autism detected through transverse relaxation time imaging. *Neuroimage, 29*(4), 1049-1057.

Henshaw, N. (1664). Aero-chalinos. Dublin, Dancer.

Herbert, M., & Anderson, M. (2008). An expanding spectrum of autism models: From fixed developmental defects to reversible functional impairments. *Autism: Current theories and evidence.* Totowa, NJ: Humana.

Hornig, M., Chian, D., & Lipkin, W. I. (2004). Neurotoxic effects of postnatal thimerosal are mouse strain dependent. *Molecular Psychiatry, 9*(9), 833-845.

House of Representatives. (2002). *Vaccines and the autism epidemic: Reviewing the federal government's track record and charting a course for the future*. Second Session. 435.

Howson, C. P., Howe, C. J., & Fineberg, H. V. (1991). *Adverse effects of pertussis and rubella vaccines : A report of the committee to review the adverse consequences of pertussis and rubella vaccines*. Institute of Medicine (U.S.). Committee to Review the Adverse Consequences of Pertussis and Rubella Vaccines.Washington, D.C., National Academy Press.

Hunt, T. (1988). The physiology of wound healing. Annals of Emergency Medicine, 17:1265-73.

James, S., Slikker, W., Melnyk, S., New, E., Pogribna, M., & Jernigan, S. (2005). Thimerosal neurotoxicity is associated with glutathione depletion: Protection with glutathione precursors. *Neurotoxicology, 26*(1), 1-8.

James, S., Rose, S., Melynk, S., Jernigan, S., Blossom, S., Pavliv, O., and Gaylor, D. (2009). Cellular and mitochondrial glutathione redox imbalance in lymphoblastoid cells derived from children with autism. *The Journal of the Federation of American Socieities for Experimental Biology, 23(8), 2374-2383.*

Jepson, B. (2007) *Changing the course of autism: A scientific approach for parents and physicians*. Bolder: Sentient Publications.

Just, M. A., Cherkassky, V. L., Keller, T. A., & Minshew, N. J. (2004). Cortical activation and synchronization during sentence comprehension in high-functioning autism: Evidence of underconnectivity. *Brain, 127*(Pt 8), 1811-1821.

Kanner, L. (1943). Autistic disturbances of affective contact. *Nervous Child,* 217-250.

Kanner, L and Eisenberg, L. (1956) Early infantile autism 1943-1955*. American Journal of Orthopsychiatry*, 26 (3), 556-66.

Kawashima, H., Mori, T., Kawashima, Y., Yakekuma, K., Wakefield, A. (2000) Detection and sequencing of measles virus from peripheral mononuclear cells from patients with inflammatory bowel disease and autism. *Digest Disease and Sciences*, 45(4), 723-9.

Kern, J. (2003) Purkinje cell vulnerability and autism: a possible etiological connection. *Brain & Development*, 25, 377-382.

King, M. and Bearman, P. (2009) Diagnostic changes and the increased prevalence of autism. *International Journal of Epidemiology*, 38, 1224-1234.

Kirby, D. Evidence of Harm. New York: St. Martin's Press: 2005.

Knighton, D., Halliday, B., & Hunt, T. (1984) Oxygen as an antibiotic: the effect of inspired oxygen on infection, 119:199-204.

Knighton, D., Silver, I., and Hunt, T. (1981) Regulation of wound-healing angiogenesis-effect of oxygen gradients and inspired oxygen concentration. Surgery 90, 262-70.

Kravchenko, A. T., Sovetova, G. P., & Chebotareva, S. V. (1982). Evaluation of the toxic action of prophylactic and therapeutic preparations on cell cultures of different types and origin: The cytotoxic action of adsorbed DPT vaccine and its components on cells of the continuous L132 line. *Zh Mikrobiol Epidemiol Immunobiol,* (5), 53-57.

Kravchenko, A. T., Dzagurov, S. G., & Chervonskaia, G. P. (1983). Evaluation of the toxic action of prophylactic and therapeutic preparations on cell cultures: The detection of toxic properties in medical biological preparations by the degree of cell damage in the L132 continuous cell line. *Zh Mikrobiol Epidemiol Immunobiol* (3), 87-92.

Kravchenko, A. T., Chervonskaia, G. P., & Mironova, L. L. (1986). Use of a diploid cell line for detecting the toxic components in medical immunobiological preparations. *Bulletin of Experimental Biology and Medicine, 101*(4), 489-491

Leach, R. M., Rees, P. J., & Wilmshurst, P. (1998). Hyperbaric oxygen therapy. *British Medical Journal, 317*(7166), 1140-1143.

Letter (July 22, 1935) Director, Biological Laboratories of Pitman-Moore Company to W.A. Jamieson, Director, Biological Division, Eli Lilly & Company. Subcommittee on Human Rights and Wellness, Government Reform Committee. Mercury in Medicine Report, Washington, D.C. Congressional Record, May 21, 2003: E1011-30.

Levin, M. (2005, February 8). '91 memo warned of mercury in shots*. The Los Angeles Times*. Retrieved from http://www.lattimes.com/business/la-fi-vaccine8feb08,0,624328.story?coll=la-home-headlines.

Levin, M. (2004, April 02) U.S. won't alert parents, doctors on mercury in flu shots for kids. *The Los Angeles Times*, Retrieved from http://articles.latimes.com/2004/apr/02/business/fi-vaccine2.

Levinson, D. (2010) Department of Health and Human Services: Office of Inspector General entitled, "*Challenges to FDA's Ability to Monitor and Inspect Foreign Clinical Trials.*"

Lord, C., Pickles, A., McLennan, J., Rutter, M., Bregman, J., Folstein, S….Minshew, N. (1997) Diagnosing autism: Analyses of data from the autism diagnostic interview. *Journal of Autism and Developmental Disorders, 27(5), 501-517.*

Lucier, G. (2001). Comparative Toxicity of Ethyl and Methyl Mercury. In a presentation to the Institute of Medicine Immunization Safety Review Committee, July 2, 1001.

Margos, L. (2001). Comparative Toxicity of Ethyl and Methyl Mercury. In a presentation to the Institute of Medicine Immunization Safety Review Committee, July 2, 1001.

Magos, L., Brown, A. W., Sparrow, S., Bailey, E., Snowden, R. T., & Skipp, W. R. (1985). The comparative toxicology of ethyl- and methylmercury. *Archives of Toxicology, 57*(4), 260-267.

Marx, R., Ehler, W., Tayapongsak, P. & Pierce L. (1990) Relationship of oxygen dose to angiogenesis induction in irradiated tissue. *American Journal of Surgery,* 160, 394-7.

Maugh, T. (2002, October 18) ‘Sobering’ State Report Calls Autism an Epidemic. *Los Angeles Time. http://articles.latimes.com/2002/oct/18/local/me-autism18.*

McClannahan L. E., & Krantz P.J. (1993). On systems analysis in autism intervention programs. *Journal of Applied Behavior Analysis*. 26(4), 589–96.

McGeer, P. (1995). The inflammatory response system of brain: implications for therapy of Alzheimer and other neurodegenerative diseases. *Brain Research*, 21(2), 195-218.

Mukhtarova, N. D. (1977). Late sequelae of nervous system pathology caused by the action of low concentrations of ethyl mercury chloride. *Gig Tr Prof Zabol* (3), 4-7.

Muller, R. A., Behen, M. E., Rothermel, R. D., Chugani, D. C., Muzik, O., Mangner, T. J., Chugani, H. (1999). Brain mapping of language and auditory perception in high-functioning autistic adults: A pet study. *Journal of Autism and Developmental Disorders, 29*(1), 19-31.

Munford, R., Pugin, J. (2001). Normal responses to injury prevent systemic inflammation and can be immunosuppressive. *American Journal of Respiratory and Critical Care Medicine*, 163(2), 316-321.

National Research Council (U.S.) (2000). Committee on the Toxicological Effects of Methylmercury. *Toxicological effects of methylmercury*. Washington, DC: National Academy Press.

Nelson, E. A., & Gottshall, R. Y. (1967). Enhanced toxicity for mice of pertussis vaccines when preserved with merthiolate. *Applied Microbiology, 15*(3), 590-593.

Ohnishi, T., Matsuda, H., Hashimoto, T., Kunihiro, T., Nishikawa, M., Uema, T., Sasaki, M. (2000). Abnormal regional cerebral blood flow in childhood autism. *Brain, 123 (Pt 9)*, 1838-1844.

Olmstead, D., and Blaxill, M. (2010). *The Age of Autism*. Thomas Dunne books, New York.

Ozonoff, S., South, M., Miller, J. (2000) DSM-IV defined Asperger Syndrome: Cognitive, behavioral and early history differentiation from high-functioning autism. 4 (1), 29-46.

Park, A. (2008). How safe are vaccines? *Time Magazine,* Wednesday, May 21, 2008.

Peterson, R., and Rumack, B. (1978). Pharmacokinetics of acetaminophen in children. *Pediatrics, 62:5s, 877-879.*

Pierce, K., Haist, F., Sedaghat, F., & Courchesne, E. (2004). The brain response to personally familiar faces in autism: Findings of fusiform activity and beyond. *Brain, 127*(Pt 12), 2703-2716.

Plioplys, A. V., Greaves, A., Kazemi, K., & Silverman, E. (1994). Lymphocyte function in autism and Rett syndrome. *Neuropsychobiology, 29*(1), 12-16.

Pollard, K. M., Pearson, D. L., Hultman, P., Deane, T. N., Lindh, U., & Kono, D. H. (2001). Xenobiotic acceleration of idiopathic systemic autoimmunity in lupus-prone bxsb mice. *Environmental Health Perspective, 109*(1), 27-33.

Powell, H. and Jamieson, W. (1931). Merthiolate as a germicide. *American Journal of Hygiene*, 13:296-310.

Public Health Services, (1999). U.S. Department of Health and Human Services, American Academy of Pedicatrics, Morbidity and Mortality Weekly Report, 1999, 48, 563-564.

Qvarnstrom, J., Lambertsson, L., Havarinasab, S., Hultman, P., & Frech, W. (2003). Determination of methylmercury, ethylmercury, and inorganic mercury in mouse tissues, following administration of thimerosal, by species-specific isotope dilution gc-inductively coupled plasma-ms. *Analytical Chemistry, 75*(16), 4120-4124.

Rimland, B. (1964). *Infantile autism; the syndrome and its implications for a neural theory of behavior*. New York: Appleton-Century-Crofts.

Rimland, B. (2000). The autism epidemic, vaccinations, and mercury. *Journal of Nutritional & Environmental Medicine, 10, 261-266.*

Rimland, B. (2000). Autism Increase: Research needed on the vaccine connection. (Testimony of Bernard Rimland). Before House Committee on Government Reform. April 6, 2000.

Rimland, B. (2006). Psychologist researcher into autism who overturned the theory that it was a reaction to bad parenting. *Autism Research Institute, November 2006, 28.*

Rock, A. (2004) Toxic tipping point: Are the CDC, the FDA, and other health agencies covering up evidence that a mercury preservative in children's vaccines cause a rise in autism? *Mother Jones. March/April.*

Rossignol, D., Rossignol, L., James, S., Melnyk, S., and Mumper, E. (2007) *The effects of hyperbaric oxygen therapy on oxidative stress, inflammation, and symptoms in children with autism: an open-label pilot study. Biomedical Central Pediatrics* 7, 36-49.

Roylance, F., & Cohn, Meredith. (2001, June6). Parents often driven to alternative autism treatments. *The Post and Courier.* Retreived from: http://www.postandcourier.com/news/2011/jun/06/parents-often-driven-to-alternative-autism/.

Rutter, M. (1978) Diagnosis and definition in autism: A reappraisal of concepts and treatment. New York: Plenum.

Salle, AJ (1936). Comparison of resistance of bacteria and embryonic tissue to germicidal substances. I. Merthiolate. *Proceedings of the Society for Experimental Biology and Medicine,* 32, 665-667.

Sanfeliu, C., Sebastia, J., & Ki, S. U. (2001). Methylmercury neurotoxicity in cultures of human neurons, astrocytes, neuroblastoma cells. *Neurotoxicology, 22*(3), 317-327.

Scheuermann, B., Webber, J., Boutot A., Goodwin, M. (2003). Problems with personnel and preparation in autism spectrum disorders. *Focus on Autism and Other Developmental Disabilities,* 18, 197-206.

Shah K. (2001). What do medical students know about autism? *Autism* 5(2), 127–33.

Singh, V. K. (1996). Plasma increase of interleukin-12 and interferon-gamma. Pathological significance in autism. *Journal of Neuroimmunology, 66*(1-2), 143-145.

Singh, V. K., & Jensen, R. L. (2003). Elevated levels of measles antibodies in children with autism. *Pediatric Neurology, 28*(4), 292-294.

Singh, V. K., Lin, S. X., Newell, E., & Nelson, C. (2002). Abnormal measles-mumps-rubella antibodies and cns autoimmunity in children with autism. *Journal of Biomedical Science, 9*(4), 359-364.

Smith, G., and Sharp, G. (1962). Treatment of coal gas poisoning with oxygen at two atospheres pressure. *Lancet.* 1, 816-19.

Sorensen, F., Larsen, J., Eide, R., & Schionning, J. (2000) Neuron loss in cerebellar cortex of rats exposed to mercury vapor: a stereogical study. *Acta Neuropathologica,* 100, 95-100.

Stahmer, A. C., & Mandell, D. S. (2007). State infant/toddler program policies for eligibility and services provision for young children with autism. *Administrative Policy for Mental Health,* 34(1):29–37.

Stejskal, J., & Stejskal, V. D. (1999). The role of metals in autoimmunity and the link to neuroendocrinology. *Neuro-Endocrinology Letters, 20*(6), 351-364.

Stratton, K., Wilson, C., McCormick, M. (2002). Immunization safety review: Multiple immunizations and immune dysfunction. National Academy Press: Washington, DC.

Stubbs, E. G., & Crawford, M. L. (1977). Depressed lymphocyte responsiveness in autistic children. *Journal of Autism and Child Schizophrenia, 7*(1), 49-55.

Swann, J. “Food and Drug Administration,” in A Historical Guide to the US Government, ed. George Thomas Kurian (New York: Oxford University Press, 1998), 248–254.

Taras, H., Potts-Datema, W. (2005). Chronic health conditions and student performance at school. *The Journal of School Health*, 75(7), 255-267.

Tibbles P, & Edelsberg, J. (1996). Hyperbaric oxygen therapy. New England Journal of Medicine, 334,1642-8.

Uhlmann, V., Martin, C. M., Sheils, O., Pilkington, L., Silva, I., Killalea, A….O'Leary, J. (2002). Potential viral pathogenic mechanism for new variant inflammatory bowel disease. *Molecular Pathology, 55*(2), 84-90.

University of California's Medical Investigation of Neurodevelopmental Disorders (M.I.N.D.) Institute (2003). *Austitic specturm disorders: Changes in the California caseload: An update 1999 through 2002*. Report to the Legislature of California. http://www.dds.ca.gov/Autism/docs/AutismReport2003.pdf

Vargas, D. L., Nascimbene, C., Krishnan, C., Zimmerman, A. W., & Pardo, C. A. (2005). Neuroglial activation and neuroinflammation in the brain of patients with autism. *Annals of Neurology, 57*(1), 67-81.

Verstraeten, T., Davis, R., and DeStefano, F., Lieu, T. A., Rhodes, P. H., Black, S., B….Chen, R., T. (2003) Safety of thimerosal-containing vaccines: a two-phased study of computerized health maintenance organization databases. *Pediatrics.* 112, 1039-48.

Verstraeten, T. (2004). Thimerosal, the Centers for Disease Control and Prevention, and GlaxoSmithKline. *Pediatrics 113:932.*

Wakefield, A. J., Ashwood, P., Limb, K., & Anthony, A. (2005). The significance of ileo-colonic lymphoid nodular hyperplasia in children with autistic spectrum disorder. *European Journal of Gastroenterology and Hepatology, 17*(8), 827-836.

Wakefield, A., Murch, S. H., Anthony, A., Linnell, J., Casson, D. M., Malik, M….Walker-Smith, J (1998). Ileal-lymphoid-nodular hyperplasia, non-specific colitis, and pervasive developmental disorder in children. *Lancet, 351*(9103), 637-641.

Waiter, G., Williams, J., Murray, A., Gilchrist, A., Perrett, D., and Whiten, A., (2005) Structural white matter deficits in high-functioning individuals with autistic spectrum disorder: a voxel-based investigation. *NeuroImage 24, 455-461.*

Walker SJ, Hepner K, Segal J, Krigsman A.(2006) Persistent ileal measles virus in a large cohort of regressive autistic children with ileocolitis and lymphonodular hyperplasia: Revisitation of an earlier study. PS-3.30 International Meeting for Autism Research (IMFAR) Montreal, Canada, June 1-3, 2006

Walker SJ, Lobenhofer, EK, Klein E, Wakefield, AJ, Hewitson L. (2008) Microarray analysis of GI tissue in a macaque model of the effects of infant vaccination. P-157.16 International Meeting for Autism Research (IMFAR) London, England, May 15-17, 2008.

Warren, R. P., Foster, A., & Margaretten, N. C. (1987). Reduced natural killer cell activity in autism. *Journal of the American Academy of Child Adolescent Psychiatry, 26*(3), 333-335.

Westphal, G. A., Asgari, S., Schulz, T. G., Bunger, J., Muller, M., & Hallier, E. (2003). Thimerosal induces micronuclei in the cytochalasin b block micronucleus test with human lymphocytes. *Archives Toxicology, 77*(1), 50-55.

White, E., and Smith, C. (2002). Theme issue on scientific research in education. *Educational Researcher.* 31 (8), 3-29.

Wilcox, J., Tsuang, M. T., Ledger, E., Algeo, J., & Schnurr, T. (2002). Brain perfusion in autism varies with age. *Neuropsychobiology, 46*(1), 13-16.

Wing, L. Asperger's syndrome: A clinical account. *Psychological Medicine,* 11(1), 115-129.

Winkler, D. and Haley, B. FDA meeting in Silver Springs, Maryland, July 27, 2004. Mislabeling and misrepresentation of ingredients in vaccinations which are to be licensed by the FDA.

WHO Expert Committee on Biological Standardization Thirtieth Report. (1979). General considerations for combined vaccines. Who Technical Report Series, 638, 100.

Yarbrough, O., & Behnke, A. (1939) Treatment of compressed air illness utilizing oxygen. Journal of Industrial Hygiene Toxicology. 21:213-18.

Yeo, J., McKenzie, B., Hindwood, B., and Kidman, A. (1976) Treatment of paraplegic sheet with hyperbaric oxygen. *The Medical Journal of Australia*, 1(15), 538-40.

Zerrate, M., Pletnikov, M., Connors, S., Vargas, D. L., Seidler, F., Zimmerman, A. (2007). Neuroinflammation and behavioral abnormalities after neonatal terbutaline treatment in rats: Implications for autism. *The Journal of Pharmacology and Experimental Theraputics, 322, (*1), 16-22.

Zilbovicius, M., Boddaert, N., Belin, P., Poline, J. B., Remy, P., Mangin, J…. Samson, Y. (2000). Temporal lobe dysfunction in childhood autism: A PET study. The *American Journal of Psychiatry, 157*(12), 1988-1993.

ABSTRACT

OBSERVATIONAL STUDY OF CHILDREN WITH AUTISM WHO HAVE PARTICIPATED IN HYPERBARIC OXGEN THERAPY

by

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Autism is the fastest growing disability ever. With the growth comes a lot of questions as to the etiologies and treatment of this condition, often putting parents, schools, and traditional medical personnel at odds with what treatments have efficacy. As the popularity of alternative treatments increase, so does the need for research.

Hyperbaric oxygen therapy is one alternative treatment parents are seeking for their child with autism. When one looks at the science behind hyperbaric oxygen therapy and the physical condition of a child with autism the rationale behind the treatment becomes clear. Research has shown that children with autism have decreased cerebral blood flow, neurological and gastrointestinal inflammation, reduction of purkinje cells, poor immune systems, increase of heavy metals, and deficits with their myelination. When these conditions are compared to the benefits one receives in hyperbarics a correlation is noted, and an understanding of why a child functioning improves.

This research was a study of five children with school diagnosis of autism that were doing hyperbaric oxygen therapy. Both the parents and the child's teacher filled out a pre and post evaluation of the child using ATEC evaluation tool. The evaluation tool assessed improvements in the area of speech/language/communication, sociability, sensory/cognitive awareness, health/physical/behavior of a child with autism.The results were assessed with the SPSS (Statistical Package for the Social Sciences Personal Computer) software using t-test with Paired Samples Statistics data analysis to compare the pretest and post test scores.

All areas showed improvements. In speech/language/communication the parents reported a 6.33 percentage of improvements and the teachers reported a 10.34 percentage of improvements. In sociability the parents reported a 10.53 percentage of improvements and the teachers reported a 3.96 percentage of improvements. In sensory/cognitive awareness the parents reported a 4.11 percentage of improvements and the teachers reported a 14.29 percentage of improvements. Lastly, in health/physical/behavior the parents reported a 17.61 percentage of improvements and the teachers reported a 10.22 percentage of improvements.

Overall, the study concluded that further research with a larger sample size is warranted to see if hyperbaric oxygen therapy can help benefit children with autism.

Key words: autism, hyperbaric oxygen therapy, alternative therapy, complementary therapy

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