

A Hypothesis and Additional Evidence that Mercury May be an Etiological Factor in Schizophrenia

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Abstract

Schizophrenia is a devastating mental health disorder of unknown origin, with no cure and no realistic promise of a cure writes Susan Naylor, Ph.D of the National Institute of Mental Health. There are more than 2 million people in the United States and Canada that suffer from schizophrenia. About 1% of the world's population is afflicted. In the United States, where 60% of people who have their first experience of schizophrenia decline so rapidly that they depend on disability benefits one year later. People with schizophrenia have difficulty caring for themselves in all areas of life and have particularly difficulties taking their prescribed medications. Conventional anti-psychotic medicines do not slow or stop its natural progression. Symptoms are relieved. These medicines cause both acute and chronic neurological impairment. Approximately 10% of schizophrenics commit suicide.

Keywords: Mercury • Schizophrenia • Amalgam

Introduction

The author of this paper had a study published on his research involving the removal of mercury dental fillings (amalgam) in eight schizophrenic patients [1,2]. The amalgam contains 50% mercury. Sibley's earlier research had found that mercury from dental amalgams was causing a number of mental health problem when compared to a control group in young adults without mercury amalgams. Significant symptoms included depression, anxiety, irritability, and anger [3]. Another study found when amalgams were removed; the symptoms improved or disappeared [4].

The greatest exposure to mercury, which is one of the most toxic substances there is, comes from the dental amalgam according to the World Health Organization [5]. Mercury vapors are continuously being released by the amalgam and then inhaled. It travels to the lungs and then enters the blood stream. The mercury travels to the brain and becomes ionized and entrapped for up to several decades

In the schizophrenia study [3], following mercury amalgam removal, the study found that significant improvements were found in psychological tests that included the Minnesota Multiphasic Personality Inventory-2 (MMPI-2), the Millon Clinical Multiaxial Inventory-II (MCMI-II), and the Symptom Check List-90 (SCL-90). Some of the many significant improvements included depression, schizotypal characteristics, irritability, anti-social behavior, paranoia, anger, psychopathic deviate, social disorders, anxiety disorders, and thought disorders to name a few.

As a result of that study, it appeared that mercury could be causing schizophrenia. The present study examined all the symptoms and physiological changes of schizophrenia found in the book *The Encyclopedia of Schizophrenia and Other Psychotic Disorders* to determine if mercury could be related to these changes and symptoms. The study found nearly all could be explained by mercury toxicity.

Methodology

An excellent book written by Richard Noll, Ph.D., and whose foreword was written by Susan Naylor, Ph.D., was used for the primary reference of

identifying the symptoms and physiology of schizophrenia. It was entitled *The Encyclopedia of Schizophrenia and Other Psychotic Disorders* [1]. Each of the findings was cross referenced with scientific articles on mercury found on PubMed, the most complete compilation of scientific papers.

Results

A. hallmark symptoms

1. Affective disturbances: This is one of the "Four A's," which is a fundamental symptom. This disturbance is the inability of schizophrenics to feel and/or express the full range of human emotions (1).

Mercury: Geir, et al, found a significant relationship between mercury exposure from Thimerosal, a mercury preservative found in childhood vaccines, and the subsequent risk of an emotional disturbance diagnosis [6].

2. Ambivalence: Ambivalence is the presence of two contradictory drives, tendencies, emotions, or thoughts that are aimed at the same person, object, or goal [1].

Mercury: Depression is a hallmark symptom of mercury toxicity, and many schizophrenics are depressed. It is known that many depressed patients have intense ambivalent feelings [3].

3. Association disturbances: This symptom is when single images or whole combinations may be rendered ineffective. Thinking operates with no or insufficient connection with the main idea. Thinking becomes confused and bizarre [1].

Mercury: The effects of mercury on the central nervous system was studied on chlor-alkali workers exposed to mercury (N=89) who were compared to a control group. The scores for confusion were significantly higher in the mercury exposure group [7].

4. Autism: This symptom refers to the unresponsiveness to one's environment, making it seem like they are in a "world of their own [1]."

Mercury: A review of 91 studies examined the potential relationship between mercury and autism. It found that 74% of the studies suggested a risk factor for autism by mercury, suggesting mercury could be the cause [8].

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B. symptoms of schizophrenia

1. Aboulia: Aboulia is a disorder of the will. It is characterized by the inability to exert the will. It is thought to be caused by the abnormal functioning of the frontal lobe.

Mercury: There was nothing in the literature that directly related mercury with aboulia. It is known that mercury can affect the frontal lobe [1].

2. Attention Deficit Disorder (ADD) psychosis: This diagnosis is often given to children who are hyperactive and dyslexic. It is thought that 10% of schizophrenics may be misdiagnosed, and instead have ADD psychosis [9,10].

Mercury: Hair mercury was studied in 35 ADD children compared to a control. The ADD children had significantly higher levels of hair mercury.

3. Anxiety: Anxiety is described as a feeling of uneasiness, apprehension, or dread. Schizophrenics commonly report anxiety [1]

Mercury: 64 dentists who had been exposed to mercury were compared to a control group. The dentists had significantly higher anxiety and memory disturbances than the control [11]. Another study found workers who gilded shrines in Islamic cities suffered anxiety and loss of memory [12].

4. Apathy: This symptom is described as “uncaring” or a “lack of interest” in the self or world. It is commonly found in schizophrenics [1].

Mercury: Chronic occupational exposure to mercury is called occupational mercurialism syndrome. Apathy is one of the symptoms [13].

5. Asthenic type schizophrenia: This type of schizophrenic is excessively thin. There is a clear biological affinity between the psychic disposition of schizophrenia and bodily disposition characteristic [1].

Mercury: A study was conducted on mercury production workers who were found to have asthenic (emotional lability) disorders [14].

6. Asyndetic thinking: This is the apparent lack of causal linkage of connectedness between elements in the language of schizophrenics [1].

Mercury: Nothing in the literature directly related mercury with asyndetic thinking. Autism is characterized by impairment of language. Studies have shown an association between mercury and autism [15].

7. Attention disorder: This is an almost universal characteristic of schizophrenia, which is the inability to focus attention on a thought, feeling, or object [1].

Mercury: 35 children between the ages of 6 and 8 were diagnosed with attention deficit disorder and were compared to a control. Hair mercury levels were significantly higher in the attention disorder group [10].

8. Auditory hallucinations: These are hallucinations of sound. Hearing voices is the most common type of hallucination [1].

Mercury: Exposure to mercury induces changes in the central nervous system which can cause hallucinations [16].

9. Blocking thoughts: This is a common symptom of schizophrenia where a person has an abrupt loss of their train of thought. It is described as a sudden loss of all thought and feeling [1]. Mercury: Workers in a chlor-alkali plant who were exposed to mercury vapor had significant disturbances with short-term memory loss, difficulty in concentrating for tasks that required attention and thinking [17].

10. Cognitive dysmetria: This schizophrenic patient has difficulty prioritizing, processing, and responding to information. It is thought to be a disturbance in the neural circuits of the prefrontal region of the frontal lobe, the thalamus, and cerebellum [1].

Mercury: Mercury can affect this part of the brain and cause cognitive impairment [18].

11. Short term memory: Many studies have found deficits in the working memory of schizophrenics, a type of short term memory [1].

Mercury: Memory loss is a hallmark symptom of mercury toxicity [5].

12. Anhedonia: This symptom is the chronic inability to express pleasure. It can be found in affective disturbance schizophrenia. It is a mood disorder [1].

Mercury: Anhedonia can occur in depression, a common symptom in schizophrenia. A hallmark symptom of mercury toxicity is depression [18].

13. Diminished intellect: Type II schizophrenics have diminished intellectual ability.

Mercury: Cognitive disorders in subjects with chronic mercury intoxication includes poor intellect [18].

14. Social drive: Type II schizophrenia patients have diminished social drive [1].

Mercury: Schizophrenics who had their mercury amalgams removed had significantly less social avoidance ($P=0.036$) and significantly less social introversion ($P=0.013$). Mouse studies found mercury chloride impaired social behavior [2].

15. Delusions, nihilistic: This delusion is commonly found in schizophrenia when the patient believes he or she does not exist [1].

Delusions, Persecutory: This delusion is commonly found in paranoid schizophrenia. It is the delusion that the psychotic individual is being singled out [1].

Delusion, Somatic: This is a delusion about the structure of functioning of one's body. An example would be a male schizophrenic patient believing he is pregnant [1].

Mercury: Evidence suggests that delusional neurotransmission is caused by dysfunction of nicotinic cholinergic neurotransmission. Mercury is known to modulate nicotinic-acetylcholine receptors [19,20].

16. Depression: Depression is a feature of affective disorder schizophrenia [1].

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region of the frontal lobe and subcortical nuclei of the thalamus is disturbed [1].

Mercury: Patients with chronic mercury intoxication have marked cognitive disorder including poor associative thinking [18].

18. Easily distracted: This is when a person's attention seems to be easily diverted to unimportant or irrelevant events. It is extreme in schizophrenia [1].

Mercury: Chronic mercury intoxication can result in disorders of concentration of attention and associative thinking [18-20].

19. Echolia: This is when there is a spontaneous repetition of words and phrases of others, as if the listening is an echo of the speaker's speech. This symptom is found in schizophrenia and autism [1].

Mercury: Autism has been linked to mercury toxicity. Echolia has been associated with aphasia, which is linked to poor short-term memory that has been linked to mercury toxicity [21].

20. Epilepsy: Temporal lobe epilepsy often resembles schizophrenia. About 17% of people with temporal lobe epilepsy display symptoms of schizophrenia [1].

Mercury: One study found a patient exposed to mercury developed early onset dementia and epilepsy [22].

21. Eye movement disorder: Some researchers consider this symptom should be a biological marker of schizophrenia. It is found in 50% to 80% of schizophrenics. It involves a lack of smooth pursuit eye movement [1].

Mercury: Eye movements studies were conducted on Cree Indians in Quebec who were exposed to methyl mercury. Their eye movements were significantly poorer compared to a control group [23].

22. Somatic passivity: The schizophrenic patient experiences oneself as the reluctant recipient of body sensations [1].

Mercury: Mercury can cause delusions [20].

23. Thought withdrawal: The patient believes their thoughts are being taken out of his or her mind by some external force [1].

Mercury: Mercury can cause delusions [20] and hallucinations. [8].

24. Thought insertion: The patient believes their thoughts are being magically transferred into the minds of others [1].

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25. Hallucinations: Hallucinations are a common symptom in schizophrenia. It is an event that is experienced as a sensory perception but is not real [1].

Mercury: Interference with the transmission of sensory signals along the visual and auditory has been implicated in the pathogenesis of hallucinations. One study found mercury in different combinations of cell types in the lateral and medial nuclei. The researchers hypothesized that mercury's induced impairment of the function of the geniculate nuclei could play a part in visual and auditory hallucinations [24]. Mercury is known to cause hallucinations [8].

26. Illogical thinking: This is the expression of thoughts that contain obvious inconsistencies and internal logical contradictions found in schizophrenia [1].

Mercury: Chronic mercury poisoning causes cognitive disorders such as poor associative thinking and poor intellect [18].

27. Incoherence: This term refers to a person's speech marked by illogical thinking, with excessive use of incomplete sentences or abrupt changes in the topic of conversation. It is common in schizophrenia [1].

Mercury: One of the symptoms of mercury toxicity is impairment of speech and thought process [25].

28. Language abnormality: One of the most distinctive signs of schizophrenia is a disturbance in language and the use of non-existent words [1].

Mercury: Studies have shown that methylmercury exposure can result in lower expressive language scores and speech impairment [26].

29. Mortality suicide: Schizophrenia is a life-shortening disease. Suicide has been the leading cause of death, with between 10% and 13% committing suicide [1].

Mercury: One of mercury's common symptoms is depression [3].

30. Similar course as Multiple Sclerosis (MS): There are many similarities between MS and schizophrenia including age of onset and their peaks [exacerbations]. The incidence for both is greater in the northern hemisphere [1].

Mercury: Several studies have linked multiple sclerosis to mercury from dental fillings [27].

31. Olfactory hallucinations: These are hallucinations of smell [1].

Mercury: Mercury affects the olfactory nerve and can cause hallucinations [8, 24].

32. Paranoia: This symptom is when a person maintains a delusion that is usually persecutory or grandiose in nature [1].

Mercury: Studies suggest dysfunctional cholinergic neurotransmitters may cause delusion with a focus on nicotinic receptors. Mercury is known to affect the nicotinic cholinergic neurotransmitter system and can affect the receptor sites [20].

33. Smoking: People with schizophrenia smoke a great deal. One study found 88% of schizophrenics smoke [1].

Mercury: Research has found that subjects with mercury amalgams smoke significantly more than subjects without amalgams. There was a direct correlation between number of amalgams. Another study compared 119 subjects without amalgams to 115 subjects with amalgams. Smoking was 250% more prevalent in the amalgam group [P=0.0016]. It is known that smoking increases dopamine [28, 29].

34. Substance abuse: About one half of schizophrenics abuse alcohol or drugs [1].

Mercury: A health study was done on 235 individuals who worked in a Brazilian gold mine and were exposed to mercury. 62.4% were heavy drinkers and 70.3% were smokers [28, 29].

35. Visual hallucinations: Visual hallucinations are more prevalent in non-paranoid schizophrenia [1].

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C. physiology and pathology

1. Enlarged third ventricle: The schizophrenia brain has an enlarged third ventricle.

Mercury: Patients with Minamata disease caused by methylmercury poisoning were found to have an enlarged fourth ventricle of the brain [30].

2. Decreased cortical volume: Many autopsies have shown smaller and lighter brains of people with schizophrenia [1].

Mercury: Methylmercury exposure can lead to lesions in the cerebellum resulting in necrosis and lysis of neurons causing cerebral atrophy, which can lead to smaller brain volume [31].

3. Reduced temporal lobe and hippocampus volume: The temporal lobe and hippocampus lose disproportionately more volume than other areas of the brain [1].

Mercury: Low doses of mercury chloride in rat studies found cytotoxicity that led to cell death by apoptosis with oxidative stress in the hippocampus

[32].

4. Decreased volume of the thalamus: The thalamus is a major relay center for nerve conductivity. It is smaller and lighter than normal in the schizophrenic brain [1].

Mercury: Elemental mercury vapor exposure in rats found that neurons in the thalamus contained heavy accumulation of mercury. Other studies found that methylmercury caused neuronal damage in the brain and thalamus [33].

5. Gray matter: In schizophrenia, gray matter is affected in volume loss of brain rather than white matter [1].

Mercury: Methylmercury causes neurotoxicity in humans. Lesions in the cerebral and cerebellum gray matter consists of necrosis and lysis of neurons [31].

6. Disturbed brain function: Brain imaging [PET, SPECHT, and MRI] has shown wide spread disturbances of brain function [1].

Mercury: EEG testing was done on 41 chlor-alkalai workers who had been exposed to mercury vapor. In the computerized EEG, the exposed workers had significantly slower and more attenuated EEG results compared to the control [34].

7. Creatine Kinase (CK): Elevated levels of the enzyme creatine kinase seems to be elevated during acute psychotic phases of schizophrenia [1].

Mercury: Mercury can activate kinase pathways [35].

8. Smaller N Acetyl Aspartate (NAA): Schizophrenics have a smaller than normal regional NAA chemical signal indicating nerve damage [1].

Mercury: Cinnabar, which contains mercury sulfide, was found to decrease NAA levels in Wistar rats [36].

9. EEG, P3 or P300 amplitude decrease: There is a decrease in the amplitude of the P3 or P300 peak of the EEG in schizophrenia [1].

Mercury: This decrease has been found in Alzheimer's disease, multiple sclerosis, and Parkinson's disease, all which have been associated with mercury toxicity. A 59 year old man who had chronic mercury poisoning had a prolonged lateral P300 [37].

10. Monamine Oxidase (MAO): Many studies have shown decreased levels of MAO in blood platelets of schizophrenia. MAO regulates biogenic amine concentrations in the brain.

Mercury: Studies have shown a significant negative association between platelet MAO-B activity and mercury in the blood [P=0.029] of fish [38].

11. Dopamine Beta Hydroxylase (DBH): DBH has decreased activity in the blood and cerebrospinal fluid of schizophrenics [1].

Mercury: A negative correlation was found between total mercury and dopamine D-2 receptors in the brain of wild mink [39].

12. Cardiovascular hypoplasia: Autopsy studies have found smaller hearts and a hypoplasia throughout the vascular system [1].

Mercury: Nothing in the literature could be found regarding mercury and cardiovascular hypoplasia. One study of fetal type Minamata disease [methylmercury poisoning] found degenerative changes of blood vessels [40]. It does raise the question if the small heart could be a result of fetal mercury exposure. Mercury exposure from a mother's amalgams has been found in the fetus. Some speculate that early-stage schizophrenia could originate in the fetal stage.

13. Indolamines: This is a group of biogenic amines that includes serotonin, which have been implicated in schizophrenia, bipolar disorders, and depression [1].

Mercury: Monamine oxidase regulates biogenic amine concentrations in the brain, and mercury in the blood has a negative correlation with MAO B activity in platelets [38].

14. **Limbic system:** This area of the brain is implicated in schizophrenia. It includes the hippocampus, amygdala, hypothalamus, and olfactory lobes [1].

Mercury: The neurotoxicity and pathology of organic mercury involves toxic changes in the limbic system [41].

15 Norepinephrine: Some studies have found an increased level of norepinephrine in the brain, blood, and cerebrospinal fluid of schizophrenics [1].

Mercury: Mercury and other heavy metals inactivate COMT, which then increases serum and urinary norepinephrine [42].

D. genetic

1. Genetic transmission: Despite more than 70 years of the study of genetics in schizophrenia, the pattern of the transmission of the disease from family member to family member is unknown [1].

Mercury: Mercury is known to cause DNA damage [43].

2. Genetic markers: Studies have found many weak linkages to schizophrenia with chromosomes 6, 8, 22, and X being the most promising. There are no certain genetic markers [1].

Mercury: Mercury can affect DNA [43].

E. theories on etiology of schizophrenia

1. Biochemical theory: Schizophrenia is caused by a metabolic toxin [1].

Mercury: Mercury is a metabolic toxin.

2. Overactive dopamine theory: This theory believes an overactive dopamine system may be an etiological factor [1].

Mercury: Mercury and other heavy metal can activate COMT, which increases urinary and serum dopamine levels [42].

3. Monamine oxidase theory: MAO is a common degrader of enzymes such as dopamine, serotonin, and norepinephrine [1].

Mercury: Many studies have found a decrease in levels of MAO in blood platelets that correlate negatively with mercury [38].

4. Amino acid neurotransmitters theory: The amino acid neurotransmitters of gamma amino butyric acid [GABA] and glutamate are excitatory neurotransmitters that may be involved in schizophrenia [1].

Mercury: Methylmercury causes oxidative stress that results in neurotoxicity by inhibiting glutamate uptake in astrocytes. Mouse studies found methylmercury resulted in a decrease uptake of GABA by the dorsal root ganglia compared to a control [44].

5. Biogenic amines theory: Abnormalities in the structure, production, and transmission of biogenic compounds may cause schizophrenia. The three primary groups are cytocholamines [such as dopamine], the indolamines [such as serotonin], and histamines which are involved in neurochemistry [1].

Mercury: Mercury is known to reduce acetylcholine, affect dopamine receptors, inhibit binding of serotonin to brain receptors, and stimulate uptake of histamine cerebral endothelial cells [5].

6. Enzyme disorder theory: This theory believes an elevation of creatinine kinase (CK) or decreased levels of MAO or decreased activity of dopamine-beta-hydroxylase or involvement of GABA and glutamic acid are responsible for schizophrenia [1].

Mercury: Mercury is known to affect all these enzymes [5].

7. Environmental causes: After a century of research, no one is certain of an environmental cause [1].

Mercury: How about mercury from dental amalgams? The answer may be right under our nose.

8. Taracein: Taracein is found in IgG and acts as an antibody against antigens in the limbic system. It was thought it might be a possible etiology of schizophrenia causing autoimmunity [1].

Mercury: Mercury is known to cause autoimmune reactions. Mercuric chloride can induce an autoimmune response and elevate IgG [45].

F. epidemiology

1. Age of onset: The first major sign of schizophrenia occurs during adolescence. The average age of onset is 30. Late onset occurs after 45 [1].

Mercury: Mercury amalgams are placed in children. The mercury vapors are inhaled and enter the blood stream and then cross the blood brain barrier, and the mercury becomes entrapped for decades causing damage to the brain [5].

2. Africa: The prevalence of schizophrenia is quite low in Africa [1].

Mercury: The lakes across tropical Africa have low levels of mercury resulting in low levels found in fish [45,46].

3. Blacks: In the United States the occurrence of schizophrenia is 1.5 X greater in blacks than whites, suggesting an environmental problem [1].

Mercury: African Americans have an Alzheimer's disease rate 2X higher than whites. Alzheimer's disease has been associated with mercury [5].

4. Alzheimer's disease: The prevalence of Alzheimer's disease is more common in schizophrenia [1].

Mercury: If mercury is associated with Alzheimer's disease, it could explain why AD occurs more in schizophrenia [5].

5. Canada: Schizophrenia is more prevalent in Canada than the United States [1].

Mercury: Mercury is inflammatory, and vitamin D is anti-inflammatory. Vitamin D in the body

can be produced by sunshine. This is the sunshine hypothesis. There is nothing in the literature regarding mercury and vitamin D. There is also more Alzheimer's disease that occurs in northern latitudes, and Alzheimer's disease patients have lower levels of vitamin D [5].

6. Childhood: The onset of schizophrenia before the age of 13 is very rare. If it [5] occurs, scientists believe it may be due to an environmental factor during the fetal stage [1].

Mercury: Mercury from a mother's fillings can enter the fetus during pregnancy [46,47].

7. Croatia: Some parts of Croatia in Yugoslavia have some of the highest prevalence rates of schizophrenia in the world as well as bipolar disorders [that have also been connected to mercury] [1].

Mercury: Nothing in the literature was found to explain this. A study of 80,445 subjects found 464 individuals were diagnosed as having schizophrenia. Schizophrenia was higher where emigration rates are high and lower where immigration rates are high [48].

8. Rates in the U.S., Asia, and Europe: Rates of schizophrenia is 3.4 per 1000 in south London. Scotland has a higher rate than England. Western Ireland has a rate of 1 in 25. Scandinavians have a rate three times higher than the U.S. In the U.S. the rate is 1 to 4.7 per 1,000. In Japan, the rate is 2.3 per 1,000 [1].

Mercury: The sunshine hypothesis and vitamin D may explain some of this. More fish is consumed in western Ireland and Scandinavia, which contains mercury. The British Isles are not known for their good teeth, and they probably have more amalgams.

9. Winter: Schizophrenia is disproportionately higher in those people born in winter [1].

Mercury: Nothing in the literature can explain this. If it is a fetal

connection and mercury is coming from the mother's amalgams, perhaps mothers may have lower vitamin D levels in the blood because of less sunshine in the winter. Vitamin D is anti-inflammatory.

10. Gender: Men are three times more likely than women to suffer from schizophrenia.

Men have more functional brain abnormalities. There is no scientific explanation for this [1].

Mercury: Are men exposed to mercury more than women from eating more fish, occupational exposure, or perhaps larger dental fillings?

11. High risk: Children with one schizophrenic parent have a life time risk of 12% to develop schizophrenia. Children with two schizophrenic parents have a 35% to 46% greater risk. 85% to 90% of schizophrenics do not have a schizophrenic parent [1].

Mercury: Perhaps there is a genetic connection. Mercury can disrupt DNA. People with apolipoprotein protein e 4 have a higher risk of developing Alzheimer's disease. Apolipoprotein e2 can more easily rid the cell of mercury because it has two cysteines, while APOE e4 cannot do this because it has no cysteine [5, 43].

12. India: The rate of schizophrenia in India is 2.2 to 5.6 per 1,000 people. A greater risk is found in higher socioeconomic groups [1].

Mercury: Perhaps the higher socioeconomic group is exposed to mercury through more vaccinations and more dental care.

13. Italy: Italy has the lowest hospitalization rate for schizophrenia compared to other countries. The rate in southern Europe is much lower than northern Europe [1].

Mercury: There is more sunshine in southern Europe, and perhaps the sunshine hypothesis can explain this with more vitamin D. Mercury is inflammatory, and vitamin D is anti-inflammatory.

14. Poland: Schizophrenia rates are higher in Poland than most countries. The Swedish immigrants to Poland have higher rates [1].

Mercury: Is it the sunshine/vitamin D hypothesis that explains this?

15. Late onset: Patients who develop schizophrenia after 40 are more often female than males. They have more instances of hearing loss and eye disease and paranoid characteristics [1].

Mercury: Is it a hormone reason? Mercury is known to affect female hormones.

Discussion

Evidence has been presented that mercury may be an etiological factor in schizophrenia. Mercury is a persistent bio-accumulative, neurotoxic metal that can accumulate in the brain. Since industrialization, mercury in the air and water has increased by 3-to 5-fold [49], and between 1977 and 2002, mercury has increased in fish 4-to5-fold. Mercury in fish increases by about four percent every year.

The half-life of mercury in the brain is from several years to decades [50]. The World Health Organization rates mercury as one of the ten most dangerous chemicals to public health. A study on autopsied brains found that mercury concentrations in the occipital region increased with age [51]. Mercury exposure in humans is mainly derived from dental amalgams, fish consumption, and mercury based vaccines. According to the World Health Organization, the greatest exposure comes from dental amalgams [52], which are continuously releasing mercury vapors that enter the blood stream and then the brain where it becomes ionized and entrapped. The chemical form of mercury in fish already has reacted with molecules like cysteine or selenium so may not be quite as toxic. Mercury vapor seems to be more toxic than unreacted methyl mercury found in fish according to rat studies. Mercury has been shown to cause blood-brain damage, and once damaged; toxins can enter the brain with great ease.

Supporting the hypothesis, a study found schizophrenia symptoms significantly improved following amalgam removal as measured by standardized tests following amalgam removal on eight schizophrenics [2]. Another study on bipolar disorders found symptoms improved significantly following amalgam removal compared to a control [53-58].

Conclusion

There have been many studies in the literature that have associated mental health symptoms with mercury. Subjects with mercury dental amalgams have significantly more mental health problems than a control group without amalgams. All symptoms and pathological and physiological changes that occur in Alzheimer's disease can be explained by mercury toxicity. Subjects with bipolar disorder significantly improved following amalgam removal. Most changes in multiple sclerosis can be explained by mercury toxicity. When multiple sclerosis subjects had their amalgams removed, their mental health improved significantly. This paper has shown that nearly all symptoms and physiological changes that occur in schizophrenia can be explained by mercury toxicity. An earlier study found when schizophrenic patients had their amalgams removed, their schizophrenic symptoms significantly improved. Mercury has also been associated with autism, which may be associated with thimerosal, the mercury preservative found in vaccines. Perhaps it is time to ban mercury in dental fillings and vaccines, as too many people have suffered from this dreadful toxin.

References

1. Noll, Richard. "The Encyclopedia of Schizophrenia and other psychotic disorders." *Facts on File Publishing* (2009).
2. Siblerud, Robert L, John Motl, and Eldon Kienholz. "Psychometric Evidence that Dental Amalgam Mercury may be an Etiological Factor in Schizophrenia." *J of Orthomolecular Medicine* 14(1999): 201-209.
3. Siblerud, Robert. "The Relationship between Mercury from Dental Amalgam and Mental Health." *Am J Psychotherapy* (1989).
4. Siblerud, R. "Health Effects After Dental Amalgam Removal." *J of Orthomolecular Med* 5(1990).
5. Siblerud Robert, Mutter J, Moore E, Nauman J, and Walach H. "A Hypothesis and Evidence that Mercury may be an Etiological Factor in Alzheimer's Disease." *Int J of Environ Res and Public Health* 16(2019): 5152.
6. Geier, David A, Janet K Kern, Kristin G Homme, and Mark R Geier. "Thimerosal Exposure and Disturbance of Emotions Specific to Childhood and Adolescence: A Case-Control Study in the Vaccine Safety Datalink (VSD) Database." *Brain injury* 31(2017): 272-278.
7. Langworth, J, Almvist, O, Soderman, E, et al. "Effects of occupational exposure to mercury vapor on the central nervous system." *Br J Int Med* 49(1992).
8. Kern, Janet K, David A Geier, Lisa K Sykes, and Boyd E Haley, et al. "The Relationship between Mercury and Autism: A Comprehensive Review and Discussion." *J Trace Elem Med Biol* 37 (2016): 8-24.
9. Guida, Natascia, Mascolo G, Cuomo O. "MC 1568 Inhibits Thimerosal - Induced Apoptosis Cell Death by Preventing #DAC 4 Up-Regulation in Neuronal Cells and Rat Prefrontal Cortex." *Toxicol Sci* 154(2016): 227-240.
10. Tabatadze, T, Kherkheulidze M, Kandelakai E. "Attention Deficit Hyperactivity Disorder and Hair Heavy and Trace Element Concentration. Is There a Link?" *Georgian MedNews* 284(2018): 88-92.
11. Chaari, Neila, Saber Chebel, Irtyah Merchaoui, and Abdelhamid Kerkeni, et al. "Neuropsychological Effects of Mercury Exposure Among Dentists in Monastir City." *Inflamm Allergy Drug Discou* 9(2015): 151-158.
12. Vahabzadeh, Mahdi and Balali Mood M. "Occupational Metallic Mercury Poisoning in Gilders." *Int J Occup Environ Med* 7(2016): 116.
13. Marcilia de Araujo Medrado Fais. "Chronic Occupational-Metallic Mercurialism." *Rev Saude Public* 37(2003).

14. Kudaeva, V, Dyakousch A, Katamanova V. "Clinical and Biochemical Characteristics of Disorders of the Nervous System and the Risks of Common Pathological Syndrome in Mercury Production Workers." *Gig Sanit* 94(2015).
15. Kern, Jenet, Geier David, Sykes K Lisa, and Haley BAL. "The Relationship between Mercury and Autism: A Comprehensive Review and Discussion." *J Trace Elem Med Biol* 37(2016): 8-24.
16. Azevedo, Bruna F, Furieri L, Pecanha F, and Wiggers GA, et al. "Toxic Effects of Mercury on the Cardiovascular and Central Nervous System." *J Biomed Biotechnol* (2012):949048.
17. Pranjie, N, Sinanovic O, Karmehic J. "Assessment of Neuropsychological Effects of Mercury Vapor Poisoning in Chloral-Alkali Plant Workers." *Bosn J Basic Med Sci* 2(2002):1-2.
18. Katamanova, EV, Shevchenko O, Lakman O. "Cognitive Disorders with Chronic Mercury Intoxication." *Med Tr Prom Ekol* 4(2014): 7-12.
19. Lambert C, DaSilva S, Ceniti A, and Rizvi S. "Anhedonia in Depression and Schizophrenia: A Trans-Diagnostic Challenge." *CNS Neurosci Ther* 24(2018).
20. Caton, Michael, Enrique LM Ochoa, and Francisco J Barrantes. "The Role of Nicotinic Cholinergic Neurotransmission in Delusional Thinking." *NPJ Schizophrenia* 6(2020): 1-12.
21. Ota, Shoko, Kaino S, Morita E. "Echolia in Patients with Primary Progressive Aphasia." *Eur J Neurol* 11(2020).
22. Zellner, Tobias, Nicolas Zellner, Norbert Felgenhauer, and Florian Eyer. "Dementia, Epilepsy and Polyneuropathy in a Mercury-Exposed Patient: Investigation, Identification of an Obscure Source and Treatment." *BMJ Case Rep* 28(2016): bcr2016216835.
23. Beuter, Anne, and Roderick Edwards. "Effect of Chronic Exposure to Methylmercury on Eye Movements in Cree Subjects." *Int Arch Occup Environ Health* 77 (2004): 97-107.
24. Pamphlett, Roger, Stephen Kum Jew, Philip A Doble, and David P Bishop. "Elemental Imaging Shows Mercury in Cells of the Human Lateral and Medial Geniculate Nuclei." *PLoS one* 15 (2020): e0231870.
25. Kishi, R. "The Mercury Workers Study Group. Subjective Symptoms and Neurobehavioral Performances of Ex-Mercury Miners at an Average of 18 Years After the Cessation of Chronic Exposure to Mercury Vapor." *Environ Res* 62 (1993): 289-302.
26. Hsi, Hsing Cheng, Chuen Bin Jiang, Tzu-Hsuan Yang, and Ling-Chu Chien. "The Neurological Effects of Prenatal and Postnatal Mercury/Methylmercury Exposure on Three-Year-Old Children in Taiwan." *Chemosphere* 100 (2014): 71-76.
27. Siblerud, Robert L, and Eldon Kienholz. "Evidence that Mercury from Silver Dental Fillings may Be an Etiological Factor in Multiple Sclerosis." *Sci of the Tot Environ* 142(1994): 191-205.
28. Siblerud, R, Kienholz, E, and Motl, J. "Evidence that Mercury from Silver Dental Fillings may be an Etiological Factor in Smoking." *Toxicology letters* 68(1993).
29. Corbett, C, Khouri M, Costa A. "Health evaluation of gold miners in mercury-containing village in South Pelada, Para Brazil." *Arch Environ Occup Health* 62(3), 2007.
30. Matsumoto, S, Okajima, Tlnayoshi. "Minamata Disease Demonstrated by Computer Tomography." *Neuroradiology*, 30(1988).
31. Mottet, N Karel, Shaw C, and Burbacher T. "Health Risks from Increases in Methylmercury Exposure." *Environ Health Perspect* 63(1985): 133-140.
32. Aragao, W, Teixeira, F, Faundes, N. "Hippocampal dysfunction provoked by mercury chloride exposure: Evaluation of cognitive impairment and nature of cell death." *Oxid Med Cell Longev* 11(2018).
33. Kakita, Akiyoshi, Koichi Wakabayashi, Mu Su, and Mineshi Sakamoto, et al. "Distinct Pattern of Neuronal Degeneration in the Fetal Rat Brain Induced by Consecutive Transplacental Administration of Methylmercury." *Brain Res* 859(2000): 233-239.
34. Piikivi, Leena, and U Tolonen. "EEG Findings in Chlor-Alkali Workers Subjected to Low Long Term Exposure to Mercury Vapour." *Br J Ind Med* 46, no. 6 (1989): 370-375.
35. Fujimura, Masatake, Fusako Usuki, Masumi Sawada, and Akihiko Takashima. "Methylmercury Induces Neuropathological Changes with Tau Hyperphosphorylation Mainly through the Activation of the C-Jun-N-Terminal Kinase Pathway in the Cerebral Cortex, But not in the Hippocampus of the Mouse Brain." *Neurotoxicology* 30 (2009): 1000-1007.
36. Wei, Lai, Rong Xue, Panpan Zhang, Yijie Wu, Xiaojing Li, and Fengkui Pei. "1H NMR-Based Metabolomics and Neurotoxicity Study of Cerebrum And Cerebellum in Rats Treated with Cinnabar, A Traditional Chinese Medicine." *Omics* (2015): 490-498.
37. Shikata E, Mochizuki Y, Oishi M, and Takasu T Rinsho Shinkeigakku. "A Case of Chronic Inorganic Mercury Poisoning with Progressive Intentional Tremor and Prolonged Latency of P300, Rinsho Shinkeigaku." 38(1998).
38. Shikata, E, Y Mochizuki, M Oishi, and T Takasu. "A case of chronic inorganic mercury poisoning with progressive intentional tremor and remarkably prolonged latency of P300." *Clin neur* 38(1998): 1064-1066.
39. Stamler, Christopher John, Nadia Abdelouhab, Claire Vanier, Donna Mergler, and Hing Man Chan. "Relationship between Platelet Monoamine Oxidase-B (MAO-B) Activity and Mercury Exposure in Fish Consumers from The Lake St. Pierre Region Of Que, Canada." *Neurotoxicology* 27(2006): 429-436.
40. Scheuhammer, Anton M, and M George Cherian. "Effects of Heavy Metal Cations, Sulfhydryl Reagents and Other Chemical Agents on Striatal D2 Dopamine Receptors." *Biochemical Pharmacol* 34(1985): 3405-3413.
41. Oka, Tomoko, Matsukura Makoto, Okamoto Miwako, and Noriaki Harada et al. "Autonomic Nervous Functions in Fetal Type Minamata Disease patients: Assessment of Heart Rate Variability." *Tohoku J Exp Med* 198(2002).
42. Chang, Louis W. "The Neurotoxicology and Pathology of Organomercury, Organolead, and Organotin ." *J Toxicol Sci* 15 (1990): 125-151.
43. Houston, Mark C. "The Role of Mercury and Cadmium Heavy Metals in Vascular Disease, Hypertension, Coronary Heart Disease, and Myocardial Infarction." *Altern Ther Health Med* 132 (2007): S128-S133.
44. Falluel Morel, Anthony, Katie Sokolowski, Helene M Sisti, and Xiaofeng Zhou, et al. "Developmental Mercury Exposure Elicits Acute Hippocampal Cell Death, Reductions in Neurogenesis, and Severe Learning Deficits During Puberty." *J Neurochem* 103(2007): 1968-1981.
45. Kumamoto, Toshihide, Nobuyoshi Fukuhara, Tadashi Miyatake, and Kazuaki Araki, et al. "Experimental Neuropathy Induced by Methyl Mercury Compounds: Autoradiographic Study of GABA Uptake by Dorsal Root Ganglia." *Eur Neurol* 25 (1986): 269-277.
46. Hansson, Monika, Mounira Djerbi, Hodjattallah Rabbani, and Håkan Mellstedt, et al. "Exposure to Mercury Chloride during the Induction Phase and after the Onset of Collagen-induced Arthritis Enhances Immune/Autoimmune Responses and Exacerbates the Disease in DBA/1mice." *Immunology* 114(2005): 428-437.
47. Black, Frank J, Thethela Bokhutlo, Aaron Somoxa, and Mothusi Maethamako, et al. "The Tropical African Mercury Anomaly: lower than Expected Mercury Concentrations in Fish and Human Hair." *Sci Total Environ* 409(2011): 1967-1975.
48. Mortazavi, Gh, M Haghani, N Rastegarian, S Zarei, and SMJ Mortazavi. "Increased Release of Mercury from Dental Amalgam Fillings due to Maternal Exposure to Electromagnetic Fields as a Possible Mechanism for the High Rates of Autism in the Offspring." *J of Biomed Phys* 6(2016): 41.
49. Folnegovic, Z. and Folnegovic-Smalc, V. "Schizophrenia in Croatia: Interregional Differences in Prevalence and a Comment on Incidence." *J Epidemiology Community Health* 46(1992).
50. Drevnick, Paul E, Lamborg CH, and Horgan MJ. "Increase in Mercury in Pacific Yellow Fin Tuna." *Environ Toxicol Chem* 34(2015).
51. Rooney, James PK. "The Retention Time of inorganic Mercury in the Brain—A Systematic Review of the Evidence." *Toxicol Pharm* 274 (2014): 425-435.
52. Weiner, Jan Axel, and Magnus Nylander. "The Relationship between Mercury Concentration in Human organs and Different Predictor Variables." *Aci Total Environ* 138(1993): 101-115.
53. Organization WHO. Health risks of heavy metals from long-range transboundary air-pollution. WHO, Regional Office for Europe, Copenhagen, Denmark, 2007.

54. Harris, Hugh H, Pickering, IJ, and George, GN. "The Chemical Form of Mercury in Fish." *Science* 301(2003).
55. Takahashi, Tetsuya, Masatake Fujimura, Misaki Koyama, and Masato Kanazawa, et al. "Methylmercury causes Blood-Brain Barrier Damage in Rats Via Upregulation of Vascular Endothelial Growth Factor Expression." *PLoS One* 12 (2017): e0170623.
56. Siblerud, Robert L, Motl J, Kienholz E. "Psychometric Evidence that Dental Amalgam Mercury may be an Etiological Factor in Manic Depression." *J of Orthomolecular Medicine* 13(1998).
57. Siblerud, Robert, and Joachim Mutter. "A Hypothesis and Additional Evidence that Mercury may be an Etiological Factor in Multiple Sclerosis." *J of Multiple Sclerosis* 7 (2020): 01-07.
58. Siblerud, Robert L. "A Comparison of Mental Health of Multiple Sclerosis Patients with Silver/Mercury Dental Fillings and those with Fillings Removed." *Psychological reports* 70(1992): 1139-1151.

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