Overdosed:
Fluoride, Copper
and Alzheimer’s Disease

Minimizing ingestion of these two common substances may prove to be a simple and effective way to help prevent Alzheimer’s disease

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The same issue has a companion report co-written with George J. Brewer, MD:

“Too Much Copper, Too Little Zinc, and Cognitive Deterioration in Alzheimer’s Disease” (excerpt on page 27)

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# Overdosed: Fluoride, Copper and Alzheimer’s Disease

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Overdosed: Fluoride, Copper and Alzheimer’s Disease

“Alzheimer’s disease is an illness that is 100% incurable and 100% fatal. It attacks rich and poor, white-collar and blue, and women and men, without regard to party. A degenerative disease, it steadily robs its victims of memory, judgment and dignity, leaves them unable to care for themselves and destroys their brain and their identity – often depleting their caregivers and families both emotionally and financially.”

This sober assessment is part of Sandra Day O’Connor’s 2010 call for a national Apollo-like program to stop Alzheimer’s by the end of this decade. Three years later, the Alzheimer’s Association says there is still no way to prevent or even slow the progression of this dreadful disease.

This report suggests otherwise. Minimizing ingestion of two common substances – fluoride and copper – may well prove to be a simple and effective way to help prevent Alzheimer’s disease.

Sleep Disruption and Alzheimer’s Disease

The greatest universal risk factor for Alzheimer’s disease is age, especially because sleep quality decreases with age. Distinct sleep problems appear in Alzheimer’s disease. Clinicians report abnormal excitement at bedtime (sun-downing), increased awakenings and sleep fragmentation, reduced slow-wave sleep, and slower EEG frequencies. “It is very clear that animals’ circadian systems begin to deteriorate as they age,” says UCLA Chancellor Gene Block, professor of biobehavioral and physiological sciences. “Humans have enormous problems with the quality of their sleep as they age.”

Circadian rhythms govern most aspects of physiology and behavior in mammals, including sleep-wake cycles. These rhythms are generated by the suprachiasmatic nucleus (SCN), the master circadian pacemaker located in the hypothalamus. Disruptions in the SCN lead to disrupted sleep, as well as dysfunction in memory, the cardiovascular system, and the body’s metabolism and immune response.

The brain’s pineal gland is the central structure in the circadian system that produces the hormone melatonin at night under the control of the SCN. Secretion levels of melatonin are decreased in aging and more severely reduced in Alzheimer’s disease. Studies indicate that a dysfunction of pineal melatonin synthesis by the SCN is responsible for disrupted circadian rhythms taking place as early as the very first preclinical stages of Alzheimer’s.

Older adults with insomnia have a greater risk of Alzheimer’s disease (AD), and recent evidence suggests that circadian dysregulation and sleep disruption are not just a consequence of AD, but play roles in the development of this neurodegenerative disorder.

In 2011, researchers at Washington University School of Medicine (WUSM) reported a mechanism for how inadequate sleep increases the risk of Alzheimer’s disease. They discovered a circadian rhythm to amyloid removal. In the spinal fluid of healthy young people, levels of amyloid-beta rise and fall in a daily pattern that echoes the sleep cycle. However, in older adults with amyloid-beta plaques in their brains, “the ebb and flow is eradicated, and amyloid-beta levels are close to constant.” Inadequate sleep seems to be disrupting clearance of amyloid-beta from the brain through the spinal fluid, a process that normally occurs when the brain is relatively inactive during sleep.

In 2013, WUSM researchers confirmed their earlier observations that sleep is disrupted in people who likely have early AD, but don’t yet have the memory loss or other cognitive problems characteristic of full-blown AD. Participants with preclinical AD had poorer sleep efficiency than people without markers of AD. On average, those with preclinical disease spent less time asleep while in bed at night and also napped more often. The worst sleepers were five times more likely to have preclinical AD compared with good sleepers. A vicious cycle: AD disrupts sleep, and lack of sleep promotes AD. (See addendum on page 12.)
Pineal Calcification and Fluorosis
Researchers used computed tomography to examine the pineal glands in 279 memory clinic outpatients (AD: 155; other dementia: 25; mild cognitive impairment: 33; depression: 66) and 37 age-matched controls. In patients with AD, the degree of pineal calcification was significantly higher than in patients with other types of dementia, with depression, or in controls – indicating reduction in melatonin production and its circadian properties.12

The fact that pineal calcification is significantly higher in patients with Alzheimer’s disease should be a wake-up call to researchers, because the National Research Council (NRC) reported in 2006: “As with other calcifying tissues, the pineal gland can accumulate fluoride. Fluoride has been shown to be present in the pineal glands of older people (14-875 mg of fluoride per kg of gland in persons aged 72-100 years), with the fluoride concentrations being positively related to the calcium concentrations in the pineal gland.”13

The pineal gland is not protected by the blood-brain barrier and is therefore exposed to fluoride in the bloodstream. Animal research by Jennifer Luke, PhD, showed that “fluoride is associated with depressed pineal melatonin synthesis.”14

Luke’s human research revealed: “By old age, the human pineal gland has readily accumulated fluoride and its fluoride/calcium ratio is higher than bone.” The pineal gland is a mineralizing tissue. Its calcified concretions are composed of hydroxyapatite similar to that in bone and teeth. The aged pineal gland contains about the same amount of fluoride as teeth (300 mg F/kg). Fluoride may also accumulate in a child's pineal gland, because significant amounts of calcification have been demonstrated in the pineals from young children.15

The NRC concluded, “Fluoride is likely to cause decreased melatonin production and to have other effects on normal pineal function, which in turn could contribute to a variety of effects in humans. Actual effects in any individual depend on age, sex, and probably other factors although at present the mechanisms are not fully understood.”13 The NRC said, “No studies are available that specifically address the effect of fluoride exposure on pineal function or melatonin production in humans ...” Seven years later, not a single such study has been published, although more than 700 studies involving “fluorosis” have.

The term “pineal fluorosis” does not yet exist, but there is evidence of fluorosis in other soft tissues. PET/CT scans show that vascular calcification and fluoride uptake are significantly correlated in most arterial walls. In coronary arteries, there was a significant association between presence of fluoride uptake and history of cardiovascular events.16 Fluoridation of drinking water at 1.5mg/L “dramatically increased the incipient aortic calcification observed in rats with experimental chronic kidney disease.”16a A mechanism of vascular pathology may be fluoride’s ability to induce “dramatic endothelial cell barrier dysfunction.”17

We still don’t know to what extent decreased melatonin production is caused by fluoride in the pineal gland. We do know melatonin is highly protective against fluoride-induced damage. Recent studies of human blood cells show that melatonin significantly reduces the frequency of primary DNA damage induced by the genotoxicity of fluoride.18 Melatonin also demonstrated a significant decline in fluoride-induced hemolysis (breakdown of red blood cells).19

Animal studies show that pineal proteins and melatonin can protect against fluoride-induced neurotoxicity through mechanisms involving enhancement of the antioxidant defense system.20 Pineal proteins significantly protect the activity of a crucial nervous system enzyme, acetylcholinesterase, from adverse changes induced by fluoride.21 (See page 11: Alzheimer’s disease death rates and water fluoridation rates.)

Fluoride Risks To Young and Old
More people drink artificially fluoridated water in the US alone, than in the rest of the world combined.22 Because fluoride permeates America’s food-and-beverage chain, people can receive a substantial amount of fluoride from soft drinks, juice, beer, and processed foods.23 The average for children 2 to 5 years old is about 37%, but some children receive as much as 85% of their dietary fluoride from solid foods.24
Children and seniors are also at risk from swallowing fluoride in toothpaste. A brush full of toothpaste contains 1 to 2 mg of fluoride. It’s estimated that children may ingest up to 40% of their toothpaste. Adults with a well-developed spitting reflex swallow less than 10%. Swallowing disorders, however, are common in the elderly (from 7% to 22%) and dramatically increase to 40 to 50% in older individuals who reside in longterm care facilities.

Circadian-rhythm sleep disorders may affect between 20 to 30% of young children, but for those with neurodevelopmental disabilities, the prevalence tends to be much greater: about 86% of children aged up to 6 years suffer from severe sleep problems if they have learning disabilities. There is increasing evidence that chronic sleep loss can lead to neuronal and cognitive loss in children, although this is generally unrecognized by the medical profession and the public.

We don’t really know if sleep disruption is merely a symptom or is also a causative factor of neurodevelopmental disabilities as it is for neurodegeneration. We do know that the EPA’s Neurotoxicology Division has found “substantial evidence” that fluoride is toxic “to the developing mammalian nervous system.”

Fluoride is a risk factor for anemia, and anemia is associated with the risk for dementia. Because anemia is common in the elderly, an 11-year study compared anemia and dementia in 2,552 older adults between the ages of 70-79. The research found that people who had anemia at the start of the study had a nearly 41% higher risk of developing dementia than those who were not anemic.

**Copper and Melatonin**

Melatonin is not only vital to the regulation of circadian rhythms, but is also a potent antioxidant. For example, the effective antioxidant dose of melatonin to protect the liver from oxidative stress during malaria is 20 times lower than that of vitamin C and vitamin E. Melatonin is also neuroprotective against copper-mediated free radical damage.

In a 2001 study that administered copper daily to Wistar rats for a six-week period, copper significantly reduced the activity of N-acetyltransferase, an enzyme in their pineal glands needed to produce melatonin from serotonin. When melatonin was coadministered, it prevented copper from inhibiting the enzyme.

Research suggests “a potential role of rhythmic copper metabolism in pineal and/or retina circadian function.” A 2012 study measured the copper and zinc levels in the serum and hair of 126 adult women. Less sleep was significantly associated with higher copper levels in their hair. Other research found elevated levels of copper in the cerebrospinal fluid of women compared to men with Alzheimer’s.

Serum copper levels rise with age, and high copper/zinc ratios are linked with multiple-cause mortality in the elderly. A 2012 study of 144 frail elderly men identified “specific deficits associated with high copper/zinc ratios that span multiple organ systems – supporting earlier studies showing that serum copper levels and the copper/zinc ratio may serve as useful predictive biomarkers for poor health in the elderly.”

**Copper and DNA Damage**

Two factors are consistently associated with neurodegenerative disorders: DNA damage by reactive oxygen species and excessive levels of copper and iron in regions of the brain associated with the particular disorder. In 2010, the first study to examine genome integrity and its relation to these metals found a “clear correlation between copper and iron levels versus DNA strand breaks in aging brain regions.” Researchers assessed copper, iron, and zinc levels in the hippocampus and frontal cortex of normal brains in three age groups. As one progressed from Group I (under 40) to Group III (over 61) – especially from Group II (41-60) to III – levels of copper and iron were significantly elevated, while zinc was significantly depleted.

The researchers note that the accumulated DNA fragmentation could be due to decreased DNA repair capacity. Although our DNA is constantly being damaged, complex mechanisms continuously assess and repair our genetic material thousands of times a day in every cell in our bodies.
In 2011, researchers at University of Texas Medical Branch at Galveston discovered how copper and iron act as a “double-edged sword.” Not only do these metals induce oxidative damage, but they also inhibit the DNA repair process. Iron and copper significantly interfere with the activity of two enzymes that normally would quickly repair DNA damage. “Our results show that by inhibiting NEIL1 and NEIL2, iron and copper play an important role in the accumulation of DNA damage in neurodegenerative diseases,” said lead author Muralidhar Hegde. “We have found multiple toxic mechanisms linking elevated iron and copper levels in the brain and extensive DNA damage.”

Neuroplasticity, Long-Term Potentiation, and Copper

Another reason why age is the greatest universal risk factor for Alzheimer’s disease is because the biological capacity for neuroplasticity decreases with age. Plasticity – derived from the Greek word meaning molded or formed – is the fundamental ability of the brain to change in response to experience. Plasticity is the process of modifying the number and strength of connections between neurons that give the brain its structural capacity to learn and remember, to control behavior, and to recover from injury.

Recent studies have shed light on the role of sleep in synaptic plasticity. Evidence suggests that sleep creates a heightened state of plasticity, which may be essential for the consolidation and optimization of synaptic circuits to retain salient memory traces. Neuroplasticity is impaired in patients with Alzheimer’s disease compared to controls. A breakdown of brain plasticity also characterizes the late stages of mild cognitive impairment (MCI), usually a precursor to Alzheimer’s.

A key mechanism of neuroplasticity is long-term potentiation (LTP), the process of memory formation at the molecular level. LTP produces the synaptic changes necessary to acquire and store new information. LTP occurs in the hippocampus and is required for adult learning. In Alzheimer’s, dementia severity correlates strongly with decreased synapse density in the hippocampus and cortex.

Inhibition of LTP by copper has been well established, but the exact mechanism is poorly understood. In animal studies, electrophysiological tests on hippocampal slices indicated absence of LTP in rats that chronically consumed copper dissolved in water, compared to rats who did not consume copper. The research showed that copper reduces synaptic sensitivity and represents “a significant disturbance in the plasticity phenomenon associated with learning and memory.” A 2011 mouse study showed that “copper inhibited NMDA receptor-independent LTP in the CA3 region of the mouse hippocampus.”

Copper and NMDA Receptors

Long-term potentiation requires activation of N-methyl D-aspartate (NMDA) receptors, key neurotransmitter receptors that also regulate neuronal death. NMDA receptors are crucial to learning and memory, and dysregulation of the NMDA receptor is a key underlying mechanism of neurodegenerative disease.

The NMDA receptor is unusually complex. It is regulated by the excitatory neurotransmitter glutamate, but is also voltage-sensitive. Homeostasis in the glutamatergic system is crucial. Both hypo- and hyperactivity leads to dysfunction. The influence of copper on cortical glutamatergic transmission has been extensively demonstrated at a synaptic level. A pilot study suggested that a higher level of body copper reserve parallels lower cortical glutamatergic responsiveness.

When released into neural synapses, copper damps down the activity of NMDA receptors whose high activity causes excitotoxic cell death. Too much copper, however, inhibits NMDA receptor activity. Animal studies on hippocampal neurons showed that exogenously applied copper can be a potent inhibitor of NMDA receptor-mediated responses and that low concentrations of copper can selectively reduce NMDA-mediated potentials and synaptic plasticity, thus inhibiting long-term potentiation in the CA1 region of the rodent hippocampus.

NMDA receptors are also the principal glutamate receptors central to the photic signaling that mediates the effect of light on resetting the brain’s circadian pacemaker in the SCN.
**Copper and Neurodegeneration**
Both alpha-synuclein and huntingtin are copper-binding proteins, and both have been associated with NMDA receptor-mediated neuronal toxicity. This raises the possibility of copper modulation of NMDA receptors as a unifying theme in many neurodegenerative disorders.\(^{56-58}\)

Alpha-synuclein is commonly found in the brain, but aberrant accumulation can form the insoluble aggregates implicated in several neurodegenerative diseases. Researchers at the University of Bath have explored how the combination of copper and alpha-synuclein may cause neurodegeneration.\(^{59}\) In 2010, they found that a reduction in cellular copper resulted in a great decrease in large aggregates of alpha-synuclein in cells.\(^{60}\)

Researchers in Korea reported that copper was the most effective metal ion affecting alpha-synuclein to form aggregates. They concluded, “Abnormal copper homoeostasis could be considered as one of the risk factors for the development of disorders such as Alzheimer’s or Parkinson’s disease.”\(^{61}\) In 2011, North Carolina State University scientists showed how copper induces misfolding in the alpha-synuclein protein, which they propose is an initial event in the formation of Lewy bodies and thus in Parkinson’s disease pathogenesis.\(^{62}\)

**Copper Particulate Matters**
Another factor coincident with our modern epidemic of dementia is the worsening environmental problem of copper pollution. For example, 530,000 pounds of copper from human activity entered San Francisco Bay in 2003. An estimated 70,000 to 318,000 pounds of copper pollute Puget Sound each year. About a third of this copper comes from the brake pads of motor vehicles.\(^{63}\)

Brake pads contain as much as 25% copper. Each time drivers apply their brakes, tiny particles of copper are released from the pads. Tests show that “full stop” braking produces the highest number and concentrations of fine particles and nanoparticles. Some exposure occurs even when brakes are not being applied. Elevated copper levels in the air have been measured in traffic, including inside vehicles.\(^{64}\) High levels of copper were also found in a parking garage.\(^{65}\)

California and Washington have already passed laws to greatly reduce the copper content in brake pads (by 2023), because copper is toxic to aquatic life, including plankton, the base of the aquatic food chain. In regions of the Mediterranean Sea, significant declines in phytoplankton biomass have been detected after atmospheric aerosol events characterized by high copper concentrations.\(^{66}\)

Copper is known to interfere with the normal function of the peripheral olfactory nervous system of fish. When juvenile coho salmon were exposed to low levels of dissolved copper (5-20 ppb for 3 hours), they became unresponsive to their chemosensory environment and were significantly less likely to survive an attack.\(^{67}\)

Human studies show that long-term exposure to traffic-related particulate matter impairs cognitive function in the elderly and is associated with significantly worse cognitive decline in older women.\(^{68,69}\)

Depending on their characteristics, air toxicants can reach the brain through several pathways. The effects of pollution on the brain then manifest as neuroinflammation, oxidative stress, and neurodegeneration.\(^{70}\)

A decade of compelling epidemiological and experimental research led by Lilian Calderón-Garcidueñas, MD, PhD, has found that particulate matter can reach the brain by uptake through olfactory neurons, and that the olfactory bulb neuropathology associated with urban exposures is very similar to the early stages of Alzheimer’s and Parkinson's diseases.\(^{71,72}\) “Exposure to air pollution causes neuroinflammation, an altered brain innate immune response, and accumulation of Abeta42 and alpha-synuclein starting in childhood.”\(^{73}\)

What’s more, the researchers’ data suggest that “air pollution moderates the association between ApoE genotype and neurodegenerative changes ... An ApoE4 carrier residing in a highly polluted environment...”\(^{74}\)
will have an acceleration of neurodegenerative changes towards AD." The increased risk of Alzheimer’s
disease for ApoE4 genotypes may relate to the inability of ApoE4 to bind copper and remove it from
the brain. (See below: “The Genetic Factor” section in the report co-written with George J. Brewer, MD.)

Calderón-Garcidueñas points out that in 2012, more than 74 million people in the United States were
being exposed to concentrations of fine particulate matter above the health standard set in 2006. In 2013, the
EPA lowered that threshold 20%, so now many more people are being exposed to air pollution particulates that likely play a key role in the development of neuroinflammation and neurodegeneration.

Other sources of olfactory exposure to copper are pressure-treated lumber (whose copper content was
boosted substantially in 2004) and “high-copper amalgam” dental fillings whose copper content jumped from below 6% to 12-30% in 1962. An Israeli company recently began marketing clothing, pillowcases, and even respiratory face masks impregnated with very small particles of copper oxide.

Alzheimer’s Disease Prevention Is Possible

For more than six years, Dr. George Brewer has continued to publish well-reasoned wake-up calls about
our dementia epidemic’s association with our chronic consumption of unprecedented high levels of
inorganic copper. (His latest report, “Too Much Copper, Too Little Zinc, and Cognitive Deterioration in
Alzheimer’s Disease,” is in this issue of the Townsend Letter, p. 52)

Brewer has responded to critics, yet has received little support from the scientific-journal community,
even though major copper/AD researchers acknowledge that something is disturbing copper homeostasis.
For example, Ashley I. Bush, MD, PhD, says, “Brain homeostasis of transition metals is severely
disturbed in Alzheimer’s disease,” and “The AD-affected brain suffers from metallostatics, or fatigue of
metal trafficking, resulting in redistribution of metals into inappropriate compartments.” Even the
International Copper Association’s researcher concluded, “More research is urgently required to
understand why there is an apparent disturbance in metal homeostasis in AD.”

In his comprehensive 2009 review, (“Copper in Alzheimer’s disease: too much or too little?”), Joseph F.
Quinn, MD, concluded, “Disordered copper metabolism is not likely to be the primary cause of AD ... however, copper may modulate the primary mechanisms in AD.” In his subsequent 2010 study (with
Brewer), Quinn concluded, “Our data suggests that controlled lowering of systemic copper may achieve
anti-amyloid effects if initiated early in the disease process.”

How early in the disease process should preventive measures be initiated? As soon as possible. We
already know that biochemical harbingers of Alzheimer’s are present 15 to 20 years before any of its
currently recognized symptoms become apparent. No doubt the disease begins even sooner, especially for
people who have the ApoE4 gene. In a brain-imaging study of young adults (ages 20-35), fMRI scans
showed visible differences in the brains of those with ApoE4, compared to others. There was
hyperactivity in their hippocampi. Even when these ApoE4 carriers weren’t doing anything, their
hippocampi were working harder than it was in those without ApoE4.

ApoE4 increases the risk for sleep disordered breathing, including obstructive sleep apnea/hypopnea in
individuals under age 65. A significant portion of sleep-disordered breathing is associated with ApoE4
in the general population. Breathing disorders during sleep affect pineal function.

“Sleep apnea skyrockets in the elderly, and this fact hasn’t been given the attention it deserves by the sleep
world or the Alzheimer’s world,” says Ricardo S. Osorio, MD. His 2013 research found an association
between sleep disordered breathing (SDB) with hippocampal atrophy and other biomarkers of AD in
cognitively normal elders (with a BMI below 25). In 2015, Osorio et al. confirmed that the presence of
SDB was associated with an earlier age at cognitive decline. “Treatment of SDB may delay progression of
cognitive impairment.”

An estimated 77 million Americans carry an ApoE4 gene, and most don’t know they have this risk factor.
If you inherit a single ApoE4 from one parent, your AD risk triples. If you inherit a double dose of ApoE4
from both parents, your risk rises by ten times or more. Also, someone who has a first-degree relative
with Alzheimer’s disease (especially a mother) is four to ten times more likely to develop the disease compared to people with no family history.

**History Repeats Itself**

Benjamin Franklin wrote to a colleague in 1786 about a case of lead poisoning in Europe wherein a whole family was afflicted by drinking rain water from their leaded roof: “This had been drunk several years without mischief; but some young trees planted near the house growing up above the roof, and shedding the leaves upon it, it was supposed that an acid in those leaves had corroded the lead they covered and furnished the water of that with its baneful particles and qualities.”

This problem that Franklin described more than two centuries ago is being repeated in our time. Similar to how acidic leaves leached lead from the roof into the rain water that the family drank, caustic chemicals added to modern tap water are leaching lead and copper from metallic plumbing into the water we consume.

Research presented at a 2005 Drinking Water Symposium points to copper pipe failure caused by the use of chloramines in California’s water systems. Chloramines are compounds containing a mixture of chlorine and ammonia that extend the disinfecting power of chlorine in drinking water. Chloramine treatment, however, may cause pinhole leaks in the copper tubing carrying the water. Chloramines may be producing what EPA calls “aggressive” water with an ability to leach out the minerals, metals or other materials from whatever it touches or passes over.86

According to corrosion expert Marc A. Edwards, Professor of Civil & Environmental Engineering at Virginia Tech, “Copper corrosion by-product release to potable water is a complex function of pipe age, water quality, stagnation time, and type of phosphate inhibitor.”87 He says, “A wide range of factors are involved, including natural organic matter, pH, alkalinity, sulfides and other dissolved materials in water. In some cases, particularly bad combinations of these components can cause a new copper pipe to leak in as little as two weeks.”88

Copper pipes are not the only source of copper that contaminates drinking water. Another is brass plumbing fixtures, because brass is about two-thirds copper. Water enters most homes through brass water meters and back-flow valves, travels through brass elbows and shutoff valves, then flows out of brass faucets. Also, millions of families have water wells equipped with brass-bearing submersible pumps.

**Fluoridation Chemicals Leach Copper into Drinking Water**

Disinfection and fluoridation chemicals have been added to the tap water that hundreds of millions of people have been drinking their entire lives. Unbelievable as it seems for a society that prides itself on science, no one had looked at brass corrosion caused by combinations of these corrosive chemicals prior to a landmark 2007 study by the nonprofit Environmental Quality Institute at the University of North Carolina in Asheville.

This well-designed study found that when fluosilicic acid (the chemical most often used to fluoridate drinking water) is combined with disinfection chemicals, it worsened the leaching of lead from brass elbows and brass water meters. The researchers note, “Chlorine is known to corrode brass, releasing lead from plumbing devices. It is known that chloramines and chlorine in different ratios with ammonia mobilize copper from brass, which we have found also enhances elution of lead from leaded brass alloys.”89

The study’s abstract concludes: “Over the first test week ... lead concentrations nearly doubled (from about 100 ppb to nearly 200), but when fluosilicic acid was also included, lead concentrations spiked to over 900 ppb. Lead concentrations from the chlorine-based waters appeared to be decreasing over the study period, while for the chloramines + ammonia + fluosilicic acid combination, lead concentrations seemed to be increasing with time.”89
Although increased copper levels were not measured, what happened was that as more copper was leached from the brass, more lead became available for corrosion. The researchers explain:

In brass, “lead alloyed with copper is not molecularly distributed, as in a solid solution. Discrete lead nodules are embedded in a copper matrix. Agents that attack copper are likely to foster lead mobility, adding significantly to lead (probably particulate) in drinking water. ... This may help to explain the Washington, DC experience that homes with only brass as a possible source of lead, not only had high water lead, but were also experiencing serious pitting of copper pipe.”89 (The District of Columbia's drinking water is treated with both chloramines and fluoridation chemicals.)

The researchers conclude that several factors can produce more corrosion than either of the disinfectants or fluoridating agents alone:

“One such factor is that fluosilicic acid, the most widely used fluoridating agent, is a good solvent for lead. Another is that chlorine, ammonia, and chloramine are all hostile to copper in that they induce copper stress cracking and/or can dissolve it. A third factor is that ammonia added to chlorine to produce chloramine will also react with fluosilicic acid to produce ammonium fluosilicate, an established solvent for copper alloys.”89

Related research showed that in communities where fluosilicic acid is added to the drinking water, the “prevalence of children with elevated blood lead (PbB > 10 micrograms/dL) is about double that in non-fluoridated communities.”90 Co-exposure to lead and fluoride may have a synergistic effect. In rats exposed to low levels of lead, fluoride consistently increased lead concentrations in their blood and calcified tissues. Conversely, lead exacerbated dental fluorosis in these rodents.91,92

Evidence of Copper and Lead Leaching from Fluoridation
Westby, Wisconsin (1990): Fluoride equipment malfunctioned and caused the fluoride to surge to 150 ppm, instead of the intended 1 ppm. The fluoride corroded copper off the pipes in area homes. The Westby Council stopped fluoridating its water.93

North Branford, Connecticut (1988): When excess hydrofluorosilicic acid was diverted to a 127-home community water supply for 12 hours, fluoride levels peaked at 51 ppm. Water acidification caused copper to leach from the domestic plumbing, raising copper levels to 25 to 41 ppm.94 (The EPA’s maximum contaminant level goal for copper is 1.3 ppm.)

See page 10: data showing higher copper levels in fluoridated Salem compared to unfluoridated Portland.

As the Environmental Quality Institute study suggests, when copper is leached from brass, so is lead. Several cities have reported increased lead levels in their drinking water because of fluoridation:

Tacoma, Washington (1992): The city had to shut down the fluoridation equipment because fluoride had eaten the pipes. The municipal water had approximately 32 ppb lead, but after fluoridation stopped, the lead level dropped to 17 ppb. When the equipment was fixed, the lead level shot right back up to 32 ppb. The city discontinued the use of fluoride, and the lead level again dropped.95

Thurmont, Maryland (1994): Lead levels in town water decreased significantly after town officials stopped adding fluoride. Thurmont then voted to officially ban the use of fluoride.96

Lebanon, Oregon (2005): The town’s tap water contained more lead after fluoridation began in 2001. “City Administrator John Hitt said that adding fluoride apparently changed the water chemistry enough to cause more lead to be leached from pipes in some houses dating from before the 1960s.”97

When New York City’s fluoridation treatment was shut down for 3 to 4 months, there was approximately a 20% decrease in the lead concentrations in city water.98
What To Do?
Over thousands of generations, humans have evolved to require only minute amounts of copper obtained from food. The body contains only 5/1000 of an ounce of copper. Copper is a micronutrient essential to life – especially to brain function – but copper can also be neurotoxic. That’s why special copper ‘chaperone’ proteins have evolved to safely transport this important but dangerous metal through the interior of the cell to specific sites where it’s needed. Now, however, seniors in developed nations have for much of their lives been chronically consuming abnormally high amounts of inorganic copper – especially in vitamin/mineral supplements and tap water.

As for fluoride, humans have no nutritional need for it. In fact, nature has evolved to protect infants from fluoride. Even when a mother’s dietary intake of fluoride is high, fluoride levels in her breast milk remain low. Nursing infants also have a similar natural protection against another toxin, lead.

On the one hand, it’s mind boggling. The neurochemistry of copper and the broad toxicity of fluoride are extremely complex. On the other hand, it’s quite simple. For decades we’ve been overdosing on copper and fluoride – and now dementia is epidemic. We must do something, now. Even if we could simply postpone the onset of Alzheimer’s disease by five years, a large share of nursing home beds in the United States would empty.

A logical preventive strategy is obvious. Stop consuming copper in multivitamins and in drinking water, especially fluoridated water and the beverages made with it. Make sure elderly family members do the same. (Eye formulas with high amounts of copper are often recommended for seniors.) Use fluoride-free toothpaste. Minimize exposure to pollution from heavy traffic.

Human societies have always relied on guidance from their elders, whose wisdom comes from a lifetime of experience and memory. If we continue to tolerate the devastation of our elders’ minds, our society cannot thrive. If we fail to prevent the early deterioration of our leaders’ minds, we may not even survive.

We must not allow the gift of consciousness to fade while we wait around for profit-centered interests to create a “cure.” The human brain is the most complex structure in the known universe. Attempts to pharmodulate neurochemistry are guaranteed to have unexpected, dire consequences.

Our levels of fluoride and copper consumption must return to what they were before 1945, when our current plague of dementia was only a horror story in the minds of science-fiction writers.
Copper levels in Salem, Oregon’s fluoridated water average 2 times higher than in Portland, Oregon's unfluoridated water.

<table>
<thead>
<tr>
<th>Sample Year</th>
<th>Copper Levels (ppm)</th>
<th>Sample Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portland</td>
<td></td>
<td>Salem</td>
</tr>
<tr>
<td>Unfluoridated</td>
<td>0.500</td>
<td>Fluoridated</td>
</tr>
<tr>
<td>2013</td>
<td>0.270</td>
<td>2013</td>
</tr>
<tr>
<td>2012</td>
<td>0.340</td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>0.270</td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>0.340</td>
<td></td>
</tr>
<tr>
<td>2009</td>
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<td></td>
</tr>
<tr>
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<tr>
<td>2000</td>
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<td>2000</td>
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<tr>
<td>2000</td>
<td>0.620</td>
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<tr>
<td>2000</td>
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</tr>
<tr>
<td>2000</td>
<td>0.660</td>
<td>1.170</td>
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</tbody>
</table>

Averages: 0.385 ppm 0.783 ppm

2014 water reports:
- Portland: www.portlandoregon.gov/water/article/450920
- Salem: www.cityofsalem.net/Departments/PublicWorks/Operati

Similarly, during the past several years in New York state, copper levels in Newburgh’s fluoridated water averaged more than four times higher than in Kingston’s unfluoridated water (0.280 vs 0.065 ppm).
### Alzheimer's Disease Death Rates and Water Fluoridation Rates in the United States (2010)

<table>
<thead>
<tr>
<th>State</th>
<th>Percentage of US population on community water systems receiving fluoridated water in 2010</th>
<th>2010 Alzheimer's age-adjusted death rate per 100,000 population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hawaii</td>
<td>10.8</td>
<td>10.5</td>
</tr>
<tr>
<td>New Jersey</td>
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<td>Kansas</td>
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<td>Delaware</td>
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<td>South Carolina</td>
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<td>North Carolina</td>
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<td>Ohio</td>
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<td>Wisconsin</td>
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<tr>
<td>Kentucky</td>
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</tbody>
</table>

The Alzheimer’s disease death rate averaged 10% higher in the 22 states fluoridated at 80% or more, compared to the 28 states fluoridated less than 80%.

The Alzheimer’s disease death rate averaged 20% higher in the 10 most fluoridated states compared to the 10 least.

The Copper Lobby

The International Copper Association (ICA) website has everything you’d ever want to know about copper, except for any mention of copper’s toxicity. The ICA funds studies and gives out the Copper Award, a prize worth 50,000 euros. In 2010, it went to two German professors, Drs. Gerd Multhaup and Thomas Bayer.104

In their ICA-funded 2008 clinical study (“Intake of copper has no effect on cognition in patients with mild Alzheimer’s disease”), Multhaup, Bayer, Kessler, et al report that “patients who took the copper supplementation, up to 8 mg daily, showed neither improvement nor progression of Alzheimer’s disease.” From this, they concluded that “the long-term oral intake of 8 mg copper can be excluded as a risk factor for Alzheimer’s disease.”105

The ICA celebrated this “good news for copper,” but their conclusion is dubious, as George J. Brewer, MD, points out:

“These patients did not improve cognition either! The hypothesis underlying the study was that AD patients were copper deficient, and copper therapy would be efficacious. Thus, the study was a negative one in terms of its underlying hypothesis. However, because the patients did not get worse, the authors turned their conclusion around, and concluded copper administration was not harmful.

“As to why the patients did not get worse given our hypothesis about the role of copper toxicity, there are problems with this study leading to many possible explanations. Copper orotate is relatively insoluble, and perhaps very little was absorbed. No copper parameters were measured in the patients, so there is no information on absorption. It is possible that maximum effects from exogenous copper were already occurring, and that more exogenous copper therefore had no additional effect. Finally, AD is a slowly progressive disease, and these were mild patients. Perhaps the observation period was not long enough to affect the cognitive tests being carried out.”74

Joseph F. Quinn, MD, concluded in his 2009 review (“Copper in Alzheimer’s disease: too much or too little?”) that the Bayer, Multhaup, et al “copper supplementation trial used an unusual copper salt, copper orotate, and did not measure any markers to show that body copper was actually changed. ... Its publication as a negative outcome likely marks the end of the development of a copper supplementation strategy for AD.”78

Quinn’s prediction has turned out to be accurate. What’s more, Copper Award-winner Multhaup went on to find that dietary supplements of copper ions worsen eye damage (in Drosophila) caused by Aβ42, the most neurotoxic and aggregation-prone form of amyloid-beta.106

Note: in their 2003 study funded by the ICA, Bayer and Multhaup reported suppressed AD pathology in transgenic mice given water with 250 mg/liter of copper.107 The opposite was reported in 2009 by other researchers who also did a study with transgenic mice treated with 250 mg/liter of copper in water, but who instead found “that chronic copper exposure accelerates not only amyloid pathology but also tau pathology in a mouse model of AD.”108
Evidence Mounts for Connection Between Sleep and Dementia

• A neuroimaging study published in the October 2013 issue of *JAMA Neurology* found that shorter sleep duration and lower sleep quality are both associated with greater buildup of toxic amyloid-beta proteins in the brain.\(^{109}\)

• Another study published in the October 2013 issue of *Science* reveals that the brain’s unique method of clearing away toxins responsible for Alzheimer’s disease and other neurological disorders – dubbed the glymphatic system – is almost 10-fold more active during sleep. What’s more, cells in the brain shrink by 60% during sleep! This contraction creates more space between the cells and allows cerebral spinal fluid to flush waste into the circulatory system and, ultimately, the liver.\(^{110}\)

“Sleep changes the cellular structure of the brain. It appears to be a completely different state,” said Maiken Nedergaard, MD, DMSc, co-director of the Center for Translational Neuromedicine at the University of Rochester Medical Center in New York, and a leader of the study.

The researchers also observed that the hormone noradrenaline is less active in sleep and speculate that noradrenaline may serve as a “master regulator” controlling the contraction and expansion of the brain’s cells during sleep-wake cycles. When drugs were used to block noradrenaline in mice, it induced unconsciousness and increased brain fluid flow and the space between cells.\(^{111}\) In contrast, sodium fluoride has been shown to increase noradrenaline in the brain’s hippocampus and neocortex.\(^{112}\)

• In March 2014, a pre-clinical study found that sleep disturbance acts as a trigger that accelerates the pathological process of tau becoming phosphorylated and irreversibly damaging the synaptic connection. “We can conclude from this study that chronic sleep disturbance is an environmental risk factor for Alzheimer’s disease,” Domenico Praticò, professor of pharmacology and microbiology/immunology in Temple's School of Medicine.\(^{113}\)

• June 2015: “Poor sleep linked to toxic buildup of Alzheimer’s protein, memory loss. Berkeley neuroscientists connect a deficit of restorative slumber to an accumulation of beta-amyloid.”\(^{113b}\)

• October 2016: How Does Our Brain Get Rid Of Toxins? Neuroscientist Jeff Iliff. TED Radio Hour.\(^{113c}\)

Amyloid-Beta and Long-Term Potentiation in the Olfactory System

Loss of the sense of smell is one of the earliest symptoms of Alzheimer’s disease. In 2011, researchers at Case Western Reserve University School of Medicine showed that amyloid-beta plaque builds up in the brain’s olfactory system first. Just a tiny amount of this toxic protein (too little to be seen on today’s brain scans) causes smell loss in mouse models.

“This shows the unique vulnerability of the olfactory system to the pathogenesis of Alzheimer’s disease,” said lead investigator Daniel Wesson, PhD. “The evidence indicates we can use the sense of smell to determine if someone may get Alzheimer’s disease, and use changes in sense of smell to begin treatments, instead of waiting until someone has issues learning and remembering.”\(^{114}\)

In 2009, other Case Western neuroscientists were the first to discover that the olfactory bulb does in fact have long-term potentiation (LTP) and that “NMDA receptors are required for LTP at proximal synapses.”\(^{115}\)

Free-Copper Predicts Alzheimer’s Disease

March 2014: A new study found that free copper in the serum of someone with mild cognitive impairment was predictive of developing Alzheimer’s disease. Those with higher levels of free copper had a conversion rate three times higher than those with lower levels.

Among the several evaluated parameters, including iron and APOE genotype, the only significant predictor of developing Alzheimer’s disease was the free copper level in blood.\(^{116}\)
May 2014: George Brewer’s long-time warning to avoid copper in supplements is now one of the seven “guidelines for Alzheimer’s prevention” recommended by international researchers, including copper experts (Ashley Bush and Rosanna Squitti) and Neal Barnard, MD, founder of Physicians Committee for Responsible Medicine.\textsuperscript{117}
References: Overdosed: Fluoride, Copper and Alzheimer’s Disease

(All links accessed June 10, 2015)


45. Li S, Jin M, Koeglsperger T, et al. Soluble Aβ oligomers inhibit long-term potentiation through a mechanism involving excessive activation of extrasynaptic NR2B-containing NMDA receptors. *Journal of Neuroscience,* 4 May 2011;31(18):6627-6638. www.jneurosci.org/content/31/18/6627.full


73c. Borkow G et al. Improvement of facial skin characteristics using copper oxide containing


74. Brewer GJ. Issues raised involving the copper hypotheses in the causation of Alzheimer’s disease. *Int

www.ncbi.nlm.nih.gov/pubmed/22635102


77. Danzeisen R, Bush AI, Bayer TA, Multhaup G, Kaden D. Disturbed copper bioavailability in

78. Quinn JF, Crane S, Harris CJ, Wadsworth TL. Copper in Alzheimer’s disease: too much or too little?

www.ncbi.nlm.nih.gov/pmc/articles/PMC2940947

80. Gallagher L. Young adults at future risk of Alzheimer’s have different brain activity, says study.

81. O’Hara R, Luzon A, Hubbard J, Zeitzer JM.. Sleep apnea, apolipoprotein epsilon 4 allele, and TBI:

82. Gottlieb DJ, DeStefano AL, Foley DJ, et al. APOE epsilon4 is associated with obstructive sleep
www.ncbi.nlm.nih.gov/pubmed/15326239

83. Kadotani H, Kadotani T, Young T, et al. Association between apolipoprotein E epsilon4 and sleep-
www.ncbi.nlm.nih.gov/pubmed/11401610


98. Personal communication from the Environmental Quality Institute, the lab that tested NYC water. February 6, 2008.

100. Connett P, Beck J, Micklem HS. The case against fluoride: how hazardous waste ended up in our drinking water and the bad science and powerful politics that keep it there. Chelsea Green Publishing; 2010:121-122.


102. void


Too Much Copper, Too Little Zinc, and Cognitive Deterioration in Alzheimer’s Disease

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Too Much Copper, Too Little Zinc, and Cognitive Deterioration in Alzheimer’s Disease

George J. Brewer, MD, and John D. MacArthur

Excerpt

The full report is available at: www.townsendletter.com/Oct2013/copper1013.html

Inorganic Copper Toxicity as a Major Factor in the AD Epidemic

Scientists these days like to talk about the complexity of AD. They formulate drugs or agents designed to lessen the amyloid-beta burden in the brain or to attack biochemical aspects of the neurofibrillary tangles. One of us (GJB) has long suggested there is a simpler line of attack: prevent AD by eliminating ingestion of inorganic copper. 12-20 This concept, however, has yet to enter the conversation of the scientific community. In one review21, the authors rejected the hypothesis by saying that it was unlikely that something as simple as a dietary ingredient could explain a disease as complex as AD. These authors did not read the papers carefully. It is not simply dietary copper ingestion that is involved, but the ingestion of inorganic copper. Organic copper is food copper. It is tightly bound to food proteins, is metabolized by the liver, and is safe. Inorganic copper is a simple salt of copper, the kind put in nutritional supplements or leached into drinking water. Some of this inorganic copper bypasses the liver and adds directly to the “free copper” pool of the blood, and is unsafe...

An epiphany in our thinking about this occurred in 2003 with research published by Sparks and Schreurs. 22 They found that addition of as little as 0.12 ppm copper to the distilled drinking water in the rabbit model of AD greatly enhanced both the AD-type brain pathology and impaired the cognitive abilities of the animals. In their 2006 follow-up study, when they added copper to the drinking water of beagles and mice, it produced significantly enhanced brain levels of amyloid-beta in these animals, too. Their research data “suggest that water quality may have a significant influence on disease progression and amyloid-beta neuropathology in Alzheimer’s disease.”23 Their work was replicated in 2007 by Deane and Zlokovic who compared mice that drank distilled water to mice that drank water containing 0.12 ppm of copper. The copper-consuming mice had one-third more amyloid-beta in their brains and about twice as much copper in the cells lining the blood vessels of their brains than did the mice that drank distilled water. They also had one-third fewer LRP molecules in those blood vessels. The brain can remove amyloid-beta, thanks to a molecule called LRP (low-density lipoprotein receptor-related protein) that escorts it out of the brain and into the body for elimination. Using human cells, the research team discovered that copper damages LRP to such an extent that it stops working.24 For reference, the U.S. EPA allows 1.3 ppm copper in human drinking water, over 10 times the amount found toxic in animal AD models.

Regarding the brain toxicity of inorganic copper in supplement pills, Morris et al25 have shown in a population study that those in the highest quintile of copper intake (and whose diets were high in saturated and trans fats) lost cognition at six times the rate of other groups. There was “a strong dose-response association with higher copper dose in vitamin supplements” and cognitive decline in the high-fat group.

Current data show that the percentage of the U.S. population who take at least one multivitamin/multimineral product increased from 30% in 1988 to 39% in 2006.26 Most of these supplements contain copper ...

Free copper is the part of blood copper not covalently bound to ceruloplasmin (Cp). Depending on the way Cp is measured, the free copper is 5% to 35% of total blood copper. When inorganic copper is consumed, it largely bypasses the liver and enters the free copper pool of the blood directly where it is available to cause toxicity, such as the generation of reactive oxygen species.
Squitti et al have shown that the free blood copper is significantly elevated in AD patients compared to age matched controls. This group has also shown that the level of free blood copper correlates negatively with cognition in AD (the higher the free copper, the poorer the cognition) and is a predictor of the degree of future cognition loss (the higher the free copper, the greater the rate of future cognition loss).

In 2010, they measured levels of free copper in individuals already affected by mild cognitive impairment (MCI) and found “the probability of acquiring MCI increased by about 24% for each free copper unit (µmol/L) increment.”

Evolutionary Perspective
We would like to consider the role of copper toxicity from the broad standpoint of evolution, and to include iron in this discussion, because copper and iron toxicity are very similar. They are both transition elements, which means they are redox active, transitioning between reduced and oxidized states. This property has been used in evolutionary development such that both are absolutely critical to a huge number of necessary metabolic steps, many of which require this redox effect. But this property also makes them both potentially toxic by virtue of generation of oxidant radicals as a byproduct, which if generated in excess, can be very damaging to all sorts of molecules. Indeed, a major theory of aging is that it occurs through gradual oxidant damage.

Looking at the levels of copper and iron in the human from the standpoint of evolution, it is important to understand that evolution promotes fitness, which is measured by success in reproduction. Because copper and iron are so important to life, having adequate stores is important for reproduction. If an individual has extra stores, they are partially protected against adverse events, such as a period of famine, or trauma causing blood loss and a need for increased nutrients to repair wounds. Thus, people with increased stores are favored to reproduce, that is, they are more fit. Extra stores of these metals may cause some toxicity during reproductive years, but this does not affect fitness as long as it doesn’t hamper reproduction. The reproductive years in the human extend to about age 50, and good health in parents during the early lives of children is important in reproductive success.

After age 50, however, toxicities and diseases restricted to the aging population no longer affect reproductive success, so there is no natural selection against such diseases. This includes the toxicities associated with having too high levels of copper and iron (as long as these levels were adequately safe during the reproductive years). Thus, the levels of copper and iron we consider normal and healthy during reproductive years are, in our view, too high after age 50 and contribute unacceptably to diseases of aging, as well as aging itself. Just as iron-free multivitamins are now common, copper-free supplements should be readily available, especially products used by seniors: multivitamins and eye formulas.

Can Other AD Risk Factors be Linked to Inorganic Copper?
The answer is yes. As mentioned earlier, a high-fat diet appears to be a risk factor for AD. Grant has shown that the incidence of AD in various counties correlates positively with the amount of fat in the diet. The AD rabbit model used by Sparks and Schreurs was a cholesterol-fed model (although other models that were not cholesterol- or fat-fed also showed copper toxicity). The studies of Morris et al that showed cognition loss in the highest quintile of copper intake also required a high-fat diet.

To understand the synergy between inorganic copper and fat ingestion, one has to understand that copper toxicity is oxidant in nature. Because of its redox potential, involving the change of copper from one valence state (such as Cu⁺) to another (such as Cu²⁺), copper can generate damaging oxidant radicals. This occurs, for example, when copper binds to amyloid plaques. Copper can also oxidize cholesterol and fat molecules into species that are toxic, particularly to neurons. It is part of our hypothesis that the epidemic of AD is due to not only increased ingestion of inorganic copper, but the concomitant increase in fat intake in developed countries.

Elevated homocysteine levels, a known risk factor for atherosclerosis, is also a risk factor for AD. Copper bound to homocysteine can oxidize cholesterol to a derivative toxic to neurons. Certain alleles of iron management genes, such as hemochromatosis or transferrin, increase the risk for AD. Iron, like copper, is a redox agent capable of generating oxidant radicals, so this fits with the overall oxidant stress hypothesis from increased copper or iron. ...
In considering the possible causal role of copper in AD, it is important to note that all the molecules involved in the brain pathology of AD are binders of copper. The amyloid precursor protein binds copper and this domain reduces Cu$^{++}$ to Cu$^{+}$, which produces oxidative damage. The beta secretase enzyme binds copper. $^{3}$ Beta amyloid binds copper and cholesterol, causing oxidation of cholesterol to 7-OH cholesterol.$^{52,53}$ This molecule is extremely toxic to neurons. The tau protein that forms the neurofibrillary tangles, another unique feature of the AD brain, also binds copper.$^{54}$ Amyloid plaques and neurofibrillary tangles in the AD brain are active producers of oxidant radicals.$^{3}$ This redox activity is abolished by chelation of iron or copper, and is restored with re-addition of copper or iron.$^{3}$ Oxidant damage is a major feature of the AD brain. The copper binding by all these AD-related molecules does not prove that copper is playing a causal role in AD, but it helps draw the net of suspicion tighter around copper.

The Genetic Factor
Currently, the strongest evidence for an increased risk of Alzheimer’s disease is genetic, the ApoE gene. Apo is short for apolipoprotein. It has the letter E because it’s one of a whole series of apolipoproteins – A, B, C, D, and so on. The ApoE gene gets its name from the fact that it’s the part of the blueprint in charge of synthesizing apolipoprotein E, an important component of cholesterol metabolism. In 1999, researchers first clearly demonstrated that human ApoE affects amyloid-beta metabolism, suggesting that “human ApoE particles might somehow remove amyloid out of incipient plaques the way it removes cholesterol out of atherosclerotic plaques in arteries.”$^{55}$

Apolipoprotein E has three versions or alleles: E2, E3, and E4. ApoE2 is associated with a decreased risk of developing Alzheimer’s disease. In contrast, ApoE4 markedly increases risk (and decreases age of onset). Approximately 25% of the population carries at least one copy of the ApoE4 gene, and five percent carries two copies. “If you inherit a single variant of ApoE4 from one parent, your Alzheimer’s risk triples. If you inherit a double dose of ApoE4 from both parents, your risk rises by ten times or more,” says Jean Carper in 100 Simple Things You Can Do to Prevent Alzheimer’s. (#26: Keep Copper and Iron Out of Your Brain).

The increased risk of Alzheimer’s disease for ApoE4 genotypes may relate to the inability of ApoE4 to bind copper and remove it from the brain. ApoE4 has no cysteines in a certain location in the molecule that binds copper if a cysteine is present. In contrast, ApoE2 has two cysteines that bind copper, and ApoE2 is mildly protective against the development of Alzheimer’s disease. Apo E3 is neutral regarding risk, and has one copper-binding site....

Conclusions
The first half of this report, which deals with inorganic copper from drinking water and supplement pills as a causal factor in our epidemic of AD, has to be viewed as a hypothesis. What we have as a main observation is an association between introduction of copper plumbing and increasing prevalence of copper in multivitamins with the AD epidemic. Any statistician will tell you, association does not prove causation. There are, of course, other observations that support the hypothesis. The studies which show that trace amounts of copper added to drinking water greatly enhance AD-like disease in rabbits, mice, and beagles have tested this hypothesis in animals. But animals are not humans. One can’t ethically test a potentially toxic substance by giving it to humans, but Morris et al have come as close as one can get by studying what humans have done to themselves when ingesting a higher copper dose in vitamin supplements. It is a bit hard to visualize what study or studies would provide the definitive test one seeks when evaluating this hypothesis. An epidemiologic study could be done, looking at whether a high proportion of those with AD, compared to age-matched controls, used copper plumbing or consumed copper supplements during their lives, but this would be very difficult.

It is not likely a definitive test of this hypothesis will occur in the next few years, especially because there is no profit motive for a drug company to do so. In the meantime, we draw an analogy to the history of cigarette smoking. Those who took alarm three or four decades ago to the early association of cigarette smoking with lung cancer and heart attacks, and who stopped smoking, gained great benefit when it was later established that the association was causal. We liken the copper situation to the previous cigarette smoking situation. It you believe in a high likelihood that this hypothesis is correct, and therefore decrease ingestion of inorganic copper now, you will benefit greatly if it is correct.
If you wish to take action now, 
the following are our recommendations:

1. **Discard all copper-containing nutritional supplements.**
   Copper deficiency is rare, and most people don’t require supplementary copper, and this type of inorganic copper is dangerous. Special groups of people that may require copper supplementation are those that have had intestinal surgery that removed a part of the small intestine, those with gastric bypass surgery, those using and swallowing large quantities of dental adhesives containing zinc, and those taking a dose of more than 50 mg/day of zinc. All these groups should have their copper levels checked before taking a copper supplement. Everyone else should look carefully at the label of any supplements they take. Nowadays, most multivitamin formulas contain copper, as do eye formulas. ...

AD patients and their families, and those who think they are at risk of developing AD, must decide for themselves whether to take zinc supplements. If they do, particularly if they take a high dose (more than 50 mg/day), it should be done under a physician’s supervision. That physician should be aware of how to monitor for copper deficiency, the main risk from high dose zinc therapy, then lower the zinc dose if that occurs. Also, zinc must be taken between meals, because food substances bind zinc and prevent its effect on blocking copper absorption. To be clear, AD patients taking zinc, should not try to compensate the partial loss of copper absorption by taking supplementary copper, because one intent of zinc therapy is to lower copper.

**Measuring the Free Copper Level in Your Blood**

If you want to evaluate the impact of reducing your copper intake, this can theoretically be done by monitoring your free copper level, which you calculate from your serum copper and serum ceruloplasmin measured in the same blood draw.

Typically, ceruloplasmin is given as mg/dl of serum with a normal range of 20-35. Serum copper is given as micrograms/dl of serum with a normal range of 80-120. Free copper in your blood is calculated by multiplying the ceruloplasmin value by 3 (because there are 3 micrograms of copper per mg of ceruloplasmin), then subtracting that number from the serum copper value. For example, if your ceruloplasmin is 30, multiplied by 3 equals 90. If your serum copper is 100, 100 minus 90 equals 10 micrograms/dl, the free copper level in your blood.

When ceruloplasmin is measured by the immunologic method (the one most used clinically), the normal range of free copper is 5-15 micrograms/dl, but it may be very low or even less than zero. This is acceptable. It simply means the free copper value is low. When ceruloplasmin is measured by the more accurate oxidase method, a normal range of free copper is about 30-35 micrograms/dl. There is some error in these measurements, so they are a somewhat rough approximation of free copper, but as long as the same method is used consistently, you can evaluate your free copper over time.

2. **What about dietary changes – are they recommended?**

The most effective dietary strategy to reduce both copper and iron in the body is to reduce meat intake. Both copper and iron are much more effectively absorbed (more bioavailable) from meat than from vegetable foods. One shouldn’t be confused by our suggestion here to reduce intake of meat copper, which is organic copper and we have called this copper “safe copper.” Our first prohibition is against ingestion of inorganic copper, because some of this copper contributes immediately to enlarging the serum free copper pool. But too much organic copper can also be bad, by slowly building up total body copper, which over time can gradually increase the serum free copper as well. In fact, recent studies have shown that overall health would be improved and mortality reduced if intake of meat by many in the population was lowered.

A large study conducted by NIH and the American Association of Retired Persons found that people who ate about five ounces of red meat per day had a 30% higher mortality than those who averaged about 2/3 of an ounce. Processed meats, which include hot dogs, sausage, and bacon also have an effect. People who ate about 60 grams (2 ounces) of processed meat per day had a 20% higher mortality than those who...
ate about 9-18 grams (about 1/3 to 2/3 ounces)/day. A similar study in Europe confirmed the effects of processed meat on mortality. The effect of higher meat eating on mortality may be due, in part, to the increased copper and iron absorption, which would increase oxidative damage, important to many disease processes besides AD, such as atherosclerosis.

High levels of copper have been detected in U.S. beef. Unlike other countries, the U.S. has not established thresholds for many dangerous substances. A 2010 review by the USDA Inspector General found that meat with harmful residues (dioxin, copper, arsenic, drugs, pesticides) is being distributed. In 2008, when Mexican authorities rejected a shipment of U.S. beef because it contained copper in excess of Mexico’s tolerances, the Food Safety and Inspection Service had no basis to stop distribution of this meat in the U.S.

The U.S. government also allows unregulated residues of copper sulfate on our food. Copper sulfate (pentahydrate) is exempt from the requirement of a tolerance when applied as a bactericide/fungicide on meat, fat, and meat byproducts of cattle and hogs. Copper sulfate is also exempt from the requirement of a tolerance when applied as a fungicide to growing crops or to raw agricultural commodities after harvest. (Copper sulfate is the form of copper used by Sparks and Schreurs in their animal experiments.)

The top crops for copper sulfate use in California in 2009 were (in descending order): rice, wild rice, cherries, oranges, wine grapes, peaches, nectarines, walnuts, almonds, lemons, apricots, and grapefruit. Even certified organic products are allowed to contain ingredients treated with copper sulfate, which is also commonly applied to cocoa for the treatment of black pod disease. This toxic copper remains in the soil for a long time, where it’s a threat to workers as well as to water sources.

3. Test your water for copper.
What copper level is safe? When rabbits consumed a concentration of 0.12 ppm (mg/L) copper in their drinking water, they had enhanced AD-type brain pathology and a decrease in cognition – their ability to carry out tasks. According to the study, these 2.2 kg rabbits consumed between 300 and 600 ml of water per day for a copper dosage of 0.016 to 0.033 mg/kg/day. For a 70 kg human, the equivalent dose would be 1.1 to 2.3 mg of copper per day. But extrapolations from the 10-week rabbit study are confounded by the fact that human water consumption lasts for many decades. What then is a safe concentration of copper in drinking water? We advise as close to zero as possible, but never more than 0.05 ppm (0.05 mg/L). That way, one liter of water would contain no more than 50 micrograms of copper. (Inexpensive copper test strips are available from SenSafe.com.)

If your water copper level is higher than that, you can filter it. A reverse osmosis system is about 99% effective at removing copper, while pitchers that use monthly disposable filters are 85-95% effective. Distilled water has no copper present. Bottled water is an unreliable source, because copper levels may be unknown or vary from lot to lot.

Copper corrosion in drinking water is a complex function of pipe age, water quality, stagnation time, and type of phosphate inhibitor. Disinfectant chemicals used to treat water – chlorine, ammonia, and chloramine – are all hostile to copper in that they induce copper stress cracking and/or can dissolve it. Chloramine will also react with fluorsilicic acid, the most widely-used water fluoridating agent, to produce ammonium fluosilicate, an established solvent for copper alloys.

The Dartmouth Toxic Metals Superfund Research Program advises to use only water from the cold tap for drinking and for preparing food. Run the water until it gets very cold after it has been sitting in the pipes overnight. More copper leaches from hot water. Also, soft water is likely to contain more copper than hard water. Making sure that no electrical appliances are grounded to the plumbing can reduce corrosion of pipes.

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References: Excerpt of
Too Much Copper, Too Little Zinc,
and Cognitive Deterioration in Alzheimer’s Disease

(All links accessed June 10, 2015)


www.ncbi.nlm.nih.gov/pmc/articles/PMC3767519

www.ncbi.nlm.nih.gov/pubmed/16908733

www.cdc.gov/nchs/data/databriefs/db61.pdf


www.ncbi.nlm.nih.gov/pubmed/19122030

www.ncbi.nlm.nih.gov/pubmed/20930297


www.ncbi.nlm.nih.gov/pubmed/16225961


