GUIDANCE TO DEAL WITH THE LEAD POISONING PROBLEM IN THE AFTERTIME

Table of contents

1. SUMMARY

In order to deal with the health hazard that lead will present after the pole shift and associated cataclysms, a review of the actual knowledge on lead and lead poisoning is offered in this article. Only the topics, which appear relevant to the pole shift and the Aftertime, have been developed.

ZetaTalk® indicates that lead poisoning will be a problem after the pole shift. This has triggered a search for solutions and some of them like water distillation and chelation therapy are presented in Troubled Times.

At the present time, the lead poisoning problem is clearly associated with industrialization and many characteristics typical of a third density culture are related to this problem. In accordance to what is reported in ZetaTalk®, it is striking to learn that atmospheric lead is clearly associated with volcanic activity and that a cycle resulting, with time, in lead disappearance from the biosphere, can be deduced from the scientific literature.

In the Aftertime, the lead burden coming from bone demineralization of undernourished survivors will add to the volcanic lead intake. The lead blood level of the population is already so close to the toxic threshold that even well prepared communities could be affected.

To avoid poisoning, lead should be prevented from entering the body. Dust mask can be used to reduce inhalation of lead containing volcanic dust particles. Drinking water will certainly be a major source of lead poisoning and will require to be depleted of lead. Although there are several ways to achieve this, distillation is probably the easiest method. When it is not possible to treat water to remove lead, filtered mineral rich water, containing calcium, magnesium and not acidic is preferable. There are many ways to reduce ingestion of lead from food. Gardening practices and plant selection in outdoors lead contaminated environment can minimize lead incorporation in crops. The addition of organic matter to the soil as well as a pH higher than 6.5, decreases lead incorporation by vegetables. Fruiting crops should be preferred to root crops and leafy vegetables should only be grown inside. Lead concentration in soil will be higher than in plants, therefore, vegetables should be carefully washed before consumption. Animal food tends to have lower lead levels than plants. Lead is more or less incorporated depending on animal species. When eating animals, poultry should be preferred; pigs, goats and rabbits come next, and finally cattle and sheep. Adult animals are also safer, since young animals concentrate more lead than adults. Lead concentrating organs such as bones, liver, kidney, bone marrow, brain and testes should be avoided. Lead in seawater is very dilute and the concentration of lead in seafood should remain low.

An appropriate diet can minimize lead bio-availability. Food rich in vitamin C, iron, calcium, and magnesium reduce lead assimilation. Weeds or plants containing these chemicals can be identified and selected from existing databases. Dietary supplements of these components are a good way to reduce assimilation and to help the body to get rid of absorbed lead. If the first measure to prevent contamination is avoidance of exposure to lead, the second one is to use mineral supplementation. Mineral supplements and vitamins should be stocked and more importantly, natural sources should be identified. Alimentary chelator, either synthetic (EDTA, Succimer) or found in plants (citric acid, oxalic acid) could be used as oral additives to prevent lead poisoning.

Lead blood tests will not be available after the pole shift. Recognition of lead poisoning will essentially be based on the observation of the symptoms. Several forms of treatments will be possible. Provided that the appropriate compounds (such as DMPS and DMSA which are administered orally) have been stocked, chelation therapy will be possible. There are also alternative treatments such as essential metal ions supplementation, heat depuration and homeopathy. Medicinal plants (rich in essential metal ions or natural chelators) might also be effective. Since the body has, to some extent, the ability to get rid of the lead it has assimilated, avoidance of any additional incorporation is the first treatment that should be applied. Ideally,

every individual presenting symptoms of lead poisoning should be treated, especially when life is threatened but to avoid permanent neurological damages, children should be the treated in priority. Some lead poisoning genetically susceptible individuals will also require special attention.

Additional steps to prevent lead contamination, which is always possible in high tech, hydroponics type, food production systems, can be implemented without too much difficulty. In indoor recycling food production systems, lead biosorption using plants or microorganisms can be used to keep the system safe. A plant or microorganism biosensor, also compatible with this kind of food production system is useful to monitor the lead level of the system.

2. INTRODUCTION

Lead (Pb) is rather stable; it hardly dissolves in water unless the water is acidic and/or "soft" (low mineral content). On the contrary to magnesium (Mg), calcium (Ca), zinc (Zn), lead is not an essential metal. Lead does not have any physiological role in the body. Lead poisoning, which has been known since the Antiquity is clearly correlated to industrialization. To various extents, every individual is affected by elevated blood lead level, which is a direct consequence of human activities. When lead is incorporated in the body, it is mainly distributed in the skeleton (94%) where it has a half-life of more than 10 years[i]. Lead can cause long-term damage to the brain, nerves and kidney. Due to the large quantities handled since the industrial era and its extreme toxicity, lead has been recognized as a major hazard. With a brain under development, children are more susceptible than adults to lead poisoning.

According to ZetaTalk®[ii], lead coming from volcanoes emissions will be a serious problem after the pending pole shift. The awareness of the potential danger of volcanic lead for human health brought up in ZetaTalk® has triggered, in Troubled Times[iii], a search for solutions. Some of them such as water distillation and recycling have been proposed in ZetaTalk®.

The purpose of this guide is to provide information on the way to deal with the lead hazard in the context of the Aftertime. It is intended to the survivors of the pole shift, to help them with the lead poisoning problem. Lead is insidious and is a cumulative poison. A better understanding of lead (chemistry, toxicity) and lead poisoning (symptoms, treatment) gained from the actual knowledge can certainly help.

This guide is organized as follow: First, the information provided in Zetatalk® on the lead poisoning problem is recapitulated in the 'Introduction' section. Next, a review of the current knowledge on lead poisoning, which appears relevant to the Aftertime context, is presented in the 'What is known about lead and lead poisoning' section. Finally, solutions are proposed in the 'Lead poisoning & Aftertime' section.

2. 1. Opening remarks

In scientific literature, a common view on a particular subject in not reached easily. This is true for several issues concerning lead and lead poisoning where opposing currents of opinion are present. For instance, some of the mechanisms of lead toxicity, particularly the free radical theory, are still matter of discussion. Other examples of controversy are the beneficial aspect of essential metal ions supplements to reduce lead assimilation and of chelation therapy to prevent cardiovascular diseases[iv]. There are also conflicting reports on whether or not, oral chelators might increase the bio-availability of lead.

In this study of the vast amount of information on lead and lead poisoning available on the Internet and on scientific literature, it was necessary to take position on several of these controversies. In this guide, as often as possible, the references and sources are mentioned. Most of the time, these publications are available on the Internet. So the reader has the possibility to eventually develop different opinions and alternative solutions. These references can also be used as a starting point to get additional information for a better or more specific preparation.

Even with the large amount of information provided in ZetaTalk®, it is still very difficult to get a clear picture of life in the Aftertime. Moreover, the conditions of live will vary greatly from places to places and will also depend on the level of preparation of communities. Since the actual knowledge of lead is discussed in the context of the Aftertime, the choices that are made and the solutions that are proposed in this paper, reflect this fuzziness.

Finally, the amount of information on lead poisoning is so vast that it can only be covered partially. Other readings or a different understanding of the literature on these topics can also lead to different choices.

2. 2. Lead and pole shift cataclysms. What do the Zetas say

Lead poisoning is mentioned several times in ZetaTalk®:

- **Safe Water**[v]

"During the pole shift volcanoes, old and new, will violently explode. The resulting ash will sift down from the upper atmosphere for decades, poisoning ground water. Humans driven to drink this gritty water will find more than grit between their teeth, they will find their nervous system beginning to fail them, their eye sight fading, and their digestive system intolerant of any food they may find. We are speaking here primarily of lead poisoning, which is not a problem man expects from the water nature provides. Lead settles and over eons settles down out of the way, but after a cataclysm the lead heavy mantle has been spewed out over the landscape, most of this vomit in the form of fine billowing dust.

Will the ground water not be safe? Depends. During the cataclysms the ground is heaved and jerked, and any wells or piping will be shattered. In that the ground water is as likely to carry poisons as the surface, having filtered down from the surface, what looks like pure water from underground may be, again, a slow death. Ground water also is subject to contact with the lead heavy mantle, which most often does not make it all the way to the surface during eruptions. If one cannot trust the usual water supply, what to do? Distillation processes or recycling water known to be pure are two approaches likely to provide a steady supply of water. This may seem tedious to those so used to taking fresh, pure water for granted, but those who prepare for the times ahead will not find themselves suddenly without one of life's necessities.

Man dies without air in minutes, without water in days, and without food over weeks. Bread may be the staff of life, but water is life itself!"

- **Polluants**[vi]

"Mankind lives in an uneasy peace with the poisons he has developed. Some of them, such as lead spewed into the air by cars burning leaded fuels or the chloride compounds eating into the ozone layer, seem innocuous until a buildup occurs."

- **Atmosphere Building**[vii]

"Metals washed constantly with a liquid are found in that liquid, thus the concern for lead poisoning when drinking water stands in lead pipes."

- **How to Prepare**[viii]

"Rivers and seas may be poisoned, what with the volcanic dust falling everywhere, so fish tanks fed from algae grown in human sewage will likewise be most abundant."

- **Terror Tactics**[ix]

"Poisoned water has long been a means of wiping out a village, or protecting turf, over the ages. Unsafe water is a factor mankind has had to deal with in any case, as water found standing in ponds or even flowing in streams can carry organisms causing disease or heavy metals such as lead, so most cases of poisoning by water occur naturally, not by the hand of man. Man has poisoned himself, in fact, by using utensils that leach lead, or allowing sewage water to leach into his drinking water, or allowing corporate interests to prevail so that PCBs or other chemical poisons degrade the quality of life of millions to allow the wealthy few to step higher on their perch."

- **Inland Lakes**[x]

"The oceans have resources not available to inland lands, in that the oceans flow around the world. This not only shares nutrients, but dilutes pollution. The oceans are thus able to gain from being positioned under the equator, where kelp can gain maximum sunlight. To the degree that an inland lake is free from volcanic ash, is not dumped excessively so that the water becomes poisoned, and to the degree that the land is under intense sunlight, equatorial preferably, it will flourish. Water has advantages that land does not, after a pole shift. Ash

settles to the bottom, where on land remains on the surface. Water also traps heat, creating a middle ground where temperatures rise and fall slowly. Thus, life in the water can survive a winter, where on land would freeze and starve. Water pools often have nutrients that have drained from the land, during runoff. Where sewage is considered a nuisance by man, it is the basis for much future growth. From death comes life, in nature. Thus, water pools flourish and is only considered a foreign environment by man because he is a land animal.

Water based farming should be considered by survival groups at least to the extent that land based gardening is. Fish often cast off heavy metal pollutants such as lead, and can live without light. Thus, this is a fruitful avenue for survival groups to consider. Inland lakes should be examined based on the following:

1. *Are they downwind from volcanoes, and if so, can they drain or have enough flow such that the pollutants likely to accumulate can dilute and flush out.*
2. *Do they have positive run-off, rich in humus or animal droppings, so that plant life in the lake has something as a nutrient.*
3. *Are they deep enough to encourage circulation necessary for complex life forms, not just slime algae in shallow pools, but crustaceans, etc.*

What flows in, and through, these lakes, such that the lake can be trusted to remain fertile, and will not be poisoned by those upstream."

- **Death Wish**[xi]

"There are children who will be left orphaned, without protection, vulnerable to the worst nightmares. There are those who will wish to stay alive for the safe of their dependents, children or others in poor health or needing them, who will need advice*. What to eat? Where to go? How to distill the water to avoid lead poisoning? Where to get Vitamin C? And what to expect over the next few months? Should they move to the hills or remain along the rivers where fish abound? Should they rebuild a shelter or plan a houseboat to accommodate the rising water? Should they join this group or that, or take to the road? What country or direction is the best direction, if moving is the obvious choice? How long will this last? Will help arrive to rescue them? All these questions are those you can* help *them with."*

- **Nuclear Winter** [xii]

"Depending upon where one is, downwind from volcanoes, the ash will poison the water and soil. This tends to be the immediate effect after a violent *burping, not a lingering effect. However, since violent burping will occur big time during the shift,* all *ash afterwards will carry poisons. Thus, until the rains wash this away, some months at best, drinking water should be distilled. Ground water may carry these poisons for a longer time, depending upon how close to the surface this is, the flow patters, etc. Water in lakes and oceans dilutes, where ground water stagnates. Fish likewise have an ability to* exclude *lead, though do absorb other heavy metals such as Mercury. Likewise, water retains warmth, and algae grows in abundance in places land based plants cannot tolerate. Thus, this resource should be explored, and explored* thoroughly*, prior to the shift, as a real survival technique."*

- **What will Survive**[xiii]

"One should not assume a grim picture of life after the cataclysms. No more birds singing, no more pizza. This is not a true picture. Birds survive, and sing by nature, and we suspect that as cookbooks and ingredients will also survive, there will be pizza. Where there will be a chronic dusk, due to volcanic dust, for at least two decades, life will go on. Not all streams and lakes will be poisonous, but the cautious should plan ahead, and anticipate these occurrences. Safe food and shelter can be arranged, and this does not require great wealth or strength. This requires common sense."

2. 3. Lead poisoning in Troubled Times

Solutions to lead poisoning have been described in Troubles Times[xiv]. These solutions deal with the 'lead testing', the 'chelation therapy' and also with the 'lead free water' problems. In addition, the water distillation process[xv] is presented and a prototype drinking water distillation system is described[xvi].

3. WHAT IS KNOWN ABOUT LEAD AND LEAD POISONING

Much information on lead and lead poisoning can be found in the scientific literature. Below, a short and incomplete review is presented, mainly focusing on the aspects, which appear the most relevant to lead poisoning in the post pole shift era.

3. 1. Historical aspects of lead poisoning

Lead poisoning (also called saturnism or plumbism) has already been observed in Antiquity (lead was used in some cooking utensils, in contact with food). Lead poisoning has been linked to the fall of the Roman Empire. It was sporadically mentioned until the 19th century where it reached epidemic dimensions. Lead poisoning is clearly correlated to industrialization[xvii]. As stated in ZetaTalk®, saturnism has been observed in some regions where lead pipes where used for drinkable water, especially when the water is acidic, which favors the dissolution of lead. With the introduction of tetraethyl lead in gasoline, lead poisoning became a serious environmental pollution problem. Since lead has been restricted from use in gasoline (started in 1972 and completed in 1995), blood lead level in the population has been decreasing (almost fourfold reduction in US children[xviii]). Although lead poisoning has been known from the time of Hippocrates, a specific treatment (chelation therapy) became available only few decades ago. Chelation therapy dates back to 1941, when citric acid was used to treat lead poisoned patients. Ethylenediaminetetraacetic acid (EDTA), a more efficient lead chelator was introduced in the 50's[xix].

3. 2. Lead poisoning and our 3rd density culture

A clear responsibility of industry in lead pollution and consequently in lead poisoning has long been established: *'Lead is perhaps the longest used and best recognized toxic environmental chemical, yet it continued to be used recklessly until only very recently. Lead is thus a lesson in the limitations and strengths of science, human conscience and common sense'*[xx]. In addition, industrial lobbying to maintain the use of lead and to prevent biomedical research in this field is notorious: *'Despite over 100 years' knowledge of the special hazards of lead exposure for young children, it has taken over a century for effective primary prevention to be adopted. Obstacles to primary prevention have included deliberate campaigns by industry to prevent restrictions upon such uses on lead as plumbing, paints, and gasoline additives; influence of industrial support of biomedical research at major US medical schools; lack of appropriate policy mechanisms to identify and control lead exposures; and opposition to investing resources in lead poisoning prevention'*[xviii]. A simplistic view of toxicology where an effect is solely analyzed in term of life or death has also been preventing progress in the lead poisoning field: *'New research on lead toxicity has been stimulated by advances in toxicology and epidemiology as well as by a shift of emphasis in toxicology away from binary outcomes (life/death; 50 percent lethal dose) to grades of function, such as neuropsychological performance, indices of behavior, blood pressure, and kidney function'*[xxi].

Lead exposure, when assessed in bone or teeth has been correlated to high school drop out and also appears as the most reliable predictor of delinquent behavior. Criminality and leaded gasoline consumption peaks coincides. Countries spewing out the highest amount of tetraethyl lead also have the highest crime rate[xxii].

3. 3. Lead and volcanoes

Atmospheric lead coming from volcanoes has indeed been reported by scientists[xxiii,xxiv]. The ratio of lead coming from volcanoes over lead coming from human activities (anthropogenic) is still matter of discussion[xxv,xxvi,xxvii]. Greatly increased concentrations of lead were observed at all altitudes (up to 15 km) for several years after the Fuego and Nevado del Ruiz volcanic eruptions in 1974 and 1985 respectively[xxvi]. The lead fallout measured in a 77 m ice core in Greenland is not constant. The higher lead fallout coincides with high volcanic activity[xxiv].

3. 4. 'Lead cycle'

The lead cycle where lead released during volcanic eruption tends, with time to "*settles down out of the way*" which is mentioned in ZetaTalk®[v] is quite in agreement with the fate of atmospheric lead as it is presently understood. When compared to surface water (3.9 µg/L), lead in seawater is much diluted (0.005 µg/L). Lead tends to concentrate in sediments (20,000 µg/g in river sediments and about 100,000 µg/g in coastal sediments) whereas the average concentration of naturally occurring lead in soil is only 10-30 µg/g.

Water-soluble lead (as lead chloride) has been observed in volcanoes ashes[xxviii,xxix]. Such ashes will leach lead under the effect of rain. Other water-soluble lead compounds such as lead sulfide, oxide or sulfate have been reported in volcanic fumaroles[xxx]. In addition, lead is also carried by running water in an undissolved form (as colloidal particles or larger solid particles of lead carbonate, lead oxide, lead hydroxide, or other lead compounds incorporated in other components of the surface particulate matter from runoff). Atmospheric lead appears to enter the soil as lead sulfate. Since lead sulfate is relatively soluble, it can leach through the soil. Lead may mobilize from soil when lead-bearing soil particles run off to surface waters during heavy rains. Lead may also mobilize from soil to atmosphere by downwind transport of smaller lead-containing soil particles entrained in the prevailing wind[xxxi]. '*When discharged of lead atmosphere declines, lead is slowly removed from the biosphere. An increasing proportion of the circulated lead becomes trapped in compounds that are poorly absorbed by living organisms. While the lead remains at the surface of the earth and in seawater, the amount entering in animals and plants declines rapidly*'[xxxvi]. This 'lead cycle' is summarized in figure 1.

3. 5. Lead and lead salts chemistry

Lead can be found as elemental (metallic) lead (Pb), or as different salts which might be more or less soluble in water, depending on their chemical properties (lead sulfide, phosphate, carbonate, and oxides are insoluble or hardly soluble in water; lead chloride is slightly soluble; lead acetate and nitrate are soluble in water). Another chemical form of lead is organic lead where lead is part of an organic molecule. Lead dissolves reasonably quickly in acid solution. Lead is attacked by water containing air, nitrates, ammonium salts or carbon dioxide[xxxii]. According to ZetaTalk® ('Ocean Life')[xxxiii], after the pole shift, the atmosphere and water will be rich in carbon dioxide, … which might in turn increase the mobilization of lead. In addition, the almost constant rain that the earth will experience after the pole shift ('Rebirth')[xxxiv] will carry atmospheric volcanic particles and wash volcanic ashes also increasing the mobilization of lead (figure 1).

3. 6. Lead toxicity

Several million tons of lead are produced every year. A toxic threshold for children has been established at a blood level around 0.5 µM[xxxv] (~10 µg/dl or 0.1 part per million or 0.1 ppm; 10 µg would be the equivalent of the amount of matter in a pencil point and a dl is 100 ml or approximately the equivalent of ¼ of an Imperial unit measuring cup). In view of the amount of lead generated every year and its high toxicity, lead has long been recognized as a major hazard. As mentioned in ZetaTalk®[vi], lead is a cumulative poison[l] to which we are all exposed, to some degree. In the mid-1990 the average lead blood level in the U.S. population was in the 2-4 µg/dl range. The blood lead levels in pre-Columbian American, has been estimated, based on bone studies, at less than one tenth of the current levels[xxxvi].

Lead is not natural within the body and is not required in the diet. *'The disturbing fact is that the natural levels in human in blood are already very close to that which is considered to be a reasonable toxicological limit, not leaving us with any margin for exposure to lead'*[xxxvii].

- **Why is lead toxic**

To some extend, the biochemical basis of lead poisoning is known[xxxviii]. Any ligand with sulfhydryl groups (-SH, cystein residues in proteins) is vulnerable. Lead is an enzymatic poison; it replaces zinc on heme enzymes and induces a decrease of production of heme. Lead interacts with calcium in the nervous system to impair cognitive development[xxxix]. The mechanism for the central nervous system effects of lead is unclear but involves lead interactions within calcium-mediated intracellular messenger systems and neurotransmission[xl]. Ionic lead (Pb^{2+}) enters the cells via plasma membrane Ca^{2+} channels[xli,xlii].

Another hypothesis on the mechanisms of inorganic lead toxicity is correlated to the generation of free radicals[xliii,xliv,xlv,xlvi,xlvii], very deleterious to the cells and to the body. To counter this toxic effect, antioxidant enzymes are induced in lead exposed individuals, but once the antioxidant capacities of the body are overcome, the harmful effect of lead takes place. This can occur for low concentrations of lead.

- **What chemical form of lead is toxic**

The toxicity of the different chemical salts of lead depends on their solubility and how they are incorporated within the body[xlviii]. Whatever the chemical form in which lead enters the body, it is the dissolved form of lead (ionic form, Pb^{2+}), which competes with essential metal ions (such as Zn^{2+}, Ca^{2+} and Mg^{2+}) for binding to metallo-enzymes (enzymes which require metal ions for activity). In interfering with the activity of these enzymes, it is the ionic form of lead, which is toxic.

One of the worse form of lead, as far as toxicity is concerned, is organic lead (when lead is included in an organic molecule), probably because it is more easily absorbed in the body[xxxviii]. This form of lead should not be a problem in the post pole shift era unless lead is incorporated in organic molecules which are formed above volcanoes and in lighting flashes, as described in ('Manna from Heaven')[xlix].

3. 7. How does lead enter the body

Lead can enter the body mainly through inhalation and through the gastro-intestinal track. Through either route, lead enters the bloodstream and therefore can be distributed to various organs and body tissues (figure 1).

- **Inhalation (vapors and dusts)**

Inhalation of vapors and dusts containing lead is the most dangerous route of entry; lead rapidly reaches the blood stream and is practically completely absorbed. Poisoning occurs upon breathing contaminated soil, dust air or water. Lead dust, fumes or vapors are more easily absorbed from the respiratory tract.

- **Ingestion**

Lead also enters the body through the gastro-intestinal tract. Eating food grown on contaminated soil or food covered with lead-containing dust, eating lead-based paint chips, drinking water that comes from lead pipes or lead soldered fittings are typical routes of lead poisoning.

- **Through the skin**

Inorganic lead is not significantly absorbed though the skin, but organic lead can enter the body though the skin.

- **Through the blood (mother-fetus)**

Lead can cross the placenta barrier; this is a source of lead poisoning for unborn children when their mothers are contaminated. Since lead accumulated in the bones is mobilized during pregnancy, lead poisoning is passed from generation to generation. Women exposed to high level of lead during childhood are therefore more likely to bear children with significant learning disabilities. Lead can also be passed to children from breast milk[l].

3. 8. Bio-availability of lead

'*The bio-availability is the extent to which the metal concerned is transferred from the gastro-intestinal tract to the blood and this depends on the chemical behavior of the element in the gastro-intestinal tract, where the pH may vary from ~2 in the stomach to about pH 8 in the small intestine, where high concentrations of complexing ligands are also present'*[li] Between 50 to 80% of ingested lead (metallic form) is not assimilated and is eliminated in feces. However, due to the acidic conditions of the stomach, small amount of lead is metabolized. It is usually believed that metal ions can cross mucosa in non-ionized form. It is the ionic form of lead (Pb^{2+}) which is captured by chelators and which interferes with enzyme activity. Lead contaminated water (when filtrated) only contains ionic lead. This lead form is readily absorbed in the body. For the same reason, soluble lead salts are particularly toxic. Once in the blood stream, lead is excreted in urine, discharged from gall bladder to feces (degradation of hemoglobin that binds lead), it is also excreted in the skin, hair, nails and in the breath. From the blood stream, it also enters the cells where is interferes with enzyme activity, it also distributes in soft tissues and mainly incorporates in bones (figure 1). Lead containing dust particles when inhaled (it seems that particles smaller than 10 µm are not filtrated in the nose) stay in the lungs and depending on their chemical form dissolve more or less rapidly. Inhaled lead is almost completely assimilated. Again when dissolved, lead can enter the blood stream. The distribution of lead in small particles would maximize, upon ingestion intestinal absorption. Fine particles of lead are attacked by weak acids such as fruit juices, fatty acid in alimentary oil and acetic acid of vinegar.

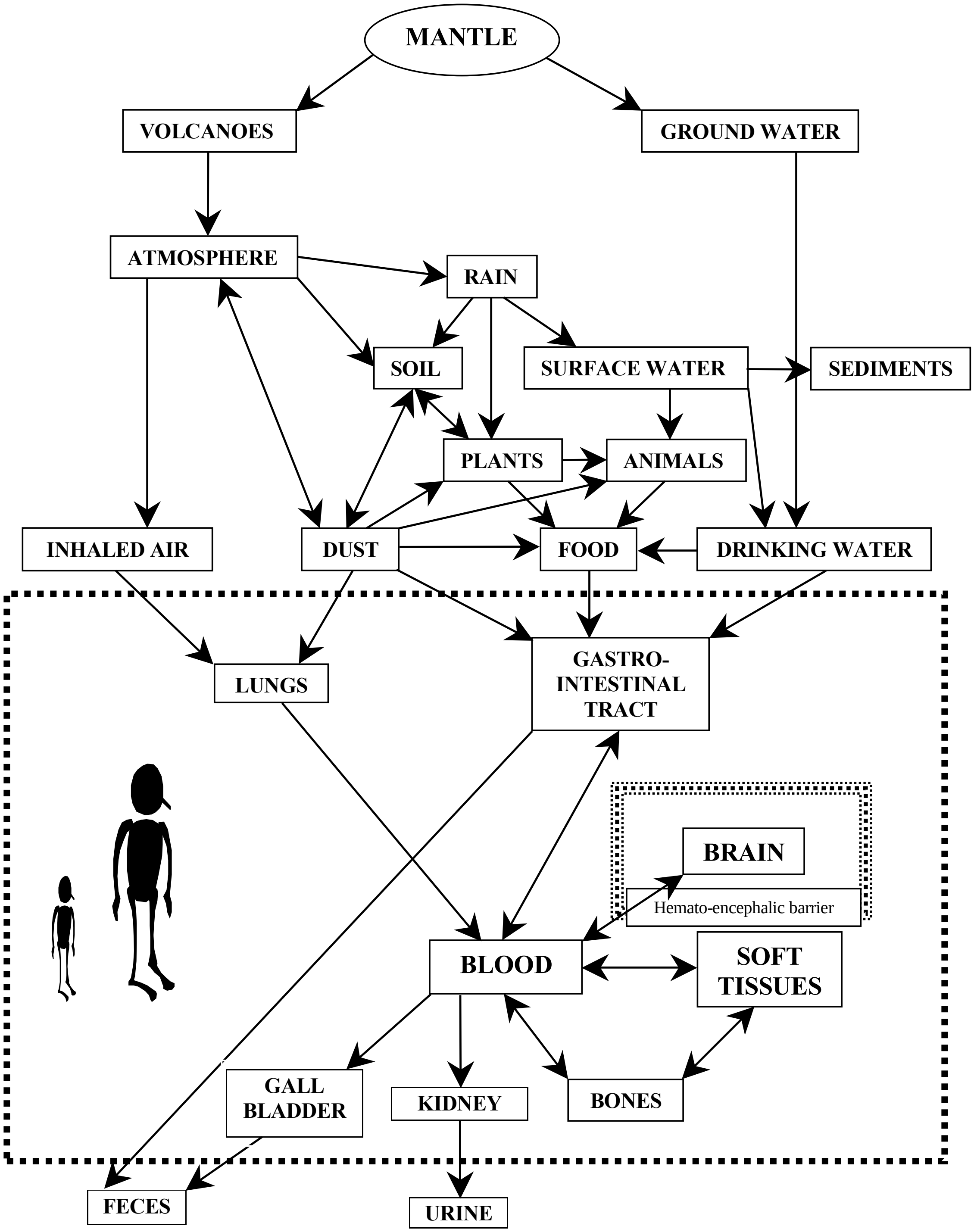

Figure 1: The fate of lead in the Aftertime (adapted from ref. [lii]). This schematic representation describes the pathways of lead in the Aftertime from the heavy mantle to man (dotted rectangle). Lead body distribution and elimination is also shown. The exploding volcanoes will release tremendous amounts of lead containing ashes in the atmosphere. In the addition to the direct lead heavy mantle contamination of ground water, lead containing volcanic ashes will contaminate surface waters. Rain will also carry atmospheric lead and will wash lead from the volcanic ashes on the ground. Plants will be contaminated by lead, upon incorporation from the soil or water and also by atmospheric dusts. Similarly, animals will be contaminated. The sources of potential contaminations of human survivors are water, plant and animal food, soil dusts and 'atmospheric lead'. Once in the blood stream, lead is mainly incorporated in bones. Lead is slowly eliminated in feces and urine.

3. 9. Individual susceptibility to lead

Whereas identical twins seem to have similar response to lead poisoning, some children of the same family (with similar lead exposure) develop more lead poisoning than the others. Since genetic susceptibility differs, some individuals might be significantly more resistant than others[liii,liv]. It seems also that males are more susceptible than females to lead poisoning[lxxxii].

3. 10. Chelation therapy

As documented in Troubled Times[lv], patients are treated with chelators to remove lead from the body. There are parenteral and oral drugs that may be used. The current understanding of the pharmacokinetics of lead and its alteration by chelating agents is rudimentary[lvi]. Treatment of acute poisoning consists of one or more chelating agents.

- **Dimercaprol**

Dimercaprol (Dimercaptopropanol, BAL in oil, British antilewisite) binds with lead and is excreted in urine and bile. It was first developed as an antidote for Lewisite (an arsenical chemical weapon). It can only be given intramuscularly. There is a high incidence of side effects: histamine release, fever… Dimercaprol is commonly combined with EDTA to treat lead encephalopathy.

- **Calcium EDTA**

EDTA binds to lead and is excreted in urine. This agent can be found in a variety of combinations, complexed with calcium, sodium, zinc, … The calcium disodium forms of EDTA which is recommended in the US is $CaNa_2EDTA$ (calcium disodium edetate or calcium disodium versenate). When taken orally (taken by mouth), $CaNa_2EDTA$ has a low availability (less than 5 %). Therefore, for effective treatment, $CaNa_2EDTA$ is administered parenterally and hospitalization is required. Intramuscular injection of $CaNa_2EDTA$ is extremely painful. To avoid severe side effects, $CaNa_2EDTA$ is infused intravenously, slowly during 4 hours in a dilute 0.5 % solution. The usual daily dose is 1,000 mg/m^2 for 5 days. The dose may be repeated every 2 to 5 days as needed. Careful patient monitoring and follow up for kidney and liver function is necessary. The increased excretion of zinc observed upon $CaNa_2EDTA$ injection results in deficiency during prolonged treatment. $CaNa_2EDTA$ is not recommended as the sole chelator to treat patients with the symptoms of encephalopathy.

- **DMSA and DMPS**

These drugs were introduced in 1975 in Western Europe and in USA. They are effective orally. DMSA appears less toxic than DMPS. Both drugs are found to be as effective as $CaNa_2EDTA$[lvii].

DMSA (2,3-meso-dimercaptosuccimic acid, succimer) is a water-soluble analog of dimercaprol, which has the advantage of oral administration. On the contrary to EDTA, succimer can enter the cells and seems more efficient. It minimally enhances iron, zinc and calcium excretion. Unlike $CaNa_2EDTA$, succimer does not precipitate encephalopathy in human patients. Mild gastro-intestinal symptoms, general malaise, hypersensitivity are adverse reactions to succimer. Give DMSA for 5 days at a dose of 10 mg/kg every 8 hours for 5 consecutive days, followed by 2 weeks more therapy at reduced frequency (10 mg/kg every 12 hrs) for a total of 19 days. Additional courses may be given, if necessary, after 2-week interval[lviii]. The 100 mg capsules can be mixed with food or fruit drinks. Succimer has a "rotten egg" sulfur odor.

DMPS (2,3 dimercato-l-propanesulfonic acid sodium salt, dimerval) has received wide attention worldwide. In Europe and in Asia it has become the treatment of choice for most heavy metal intoxications. Patients are treated orally with 250 mg/day for 20 days.

- **Penicillamine**

Penicillamine (D-BB-dimethylcystein, cuprimine, depen) may be given for oral treatment of lead poisoning, but patients might develop side effects such as hypersensitivity, nausea, vomiting. The usual dose is 20 to 30 mg/kg per day and the typical duration of the therapy is 4 to 12 weeks. The overall toxicity profile relegates it to a third-line reagent, indicated only when unacceptable reactions have occurred to succimer and $CaNa_2EDTA$.

3. 11. What is a chelator

"The word chelator is derived from the Greek term for claw. Chelators form a chemical claw around the heavy metals and allow them to be excreted"[liii]. The four carboxilate groups of EDTA, with their negative charges at physiological pH can bind tightly the positively charged lead ions. When lead is complexed or sequestered by a chelator of sufficient affinity, it is no longer available for its targeted enzymes and hence is no longer toxic. The complex formed by lead with EDTA is so stable that it virtually stays in that bound state and is excreted in that form in urine. Not only a chelator is characterized by a metal ion affinity, but also by its selectivity for a particular ion in the presence of other metal ions. The binding of metal ions by a chelator can be viewed as an equilibrium:

Chelator + Metal ion ↔ Chelator bound Metal ion

The amount of bound metal ion (and also the concentration of free metal ion) depends on the affinity constants of the chelator for the metal ion. The higher the affinity, the lower remaining free metal (the toxic form). The affinity of a chelator for different metal ions varies, depending among other things on the size of the metal ion, on the solvatation state of the metal ion and on geometrical aspects of the metal ion coordination. The selectivity of a chelator for a particular metal ion can be defined as the ratio of the affinity of the chelator for the metal ion of interest over the affinity for other metal ions. In the case of lead poisoning, it is interesting to consider the affinity of a chelator in the presence of essential metal ions.

In Table I, the affinity constants of several common chelators for Pb^{2+} are indicated together with the affinity for Mg^{2+} and Ca^{2+}. This table shows that EDTA would bind as much Pb^{2+} as Ca^{2+} or Mg^{2+} even when Pb^{2+} is 10 million fold less concentrated than Ca^{2+} or 1 billion fold less concentrated than Mg^{2+}. The presence of sulfydryl groups such as in cystein in a chelator is probably a factor, which enhances its selectivity for Pb^{2+} versus Ca^{2+} and Mg^{2+}. The affinity constants in Table I come from different kind of experiments performed by different research groups and these values cannot rigorously be compared, they are only indicative. However, they are probably the most reliable values found in the scientific literature for these chelators. Another issue is that they were determined *in vitro* in conditions approaching physiological conditions, however, the real values (in term of affinity and specificity) in the body, in the presence of multiple metal ions might differ substantially.

Table I: Comparison (*in vitro*) of the affinity of different common chelators for Pb^{2+}, Mg^{2+} and Ca^{2+}.

	EDTA	Citric acid	Oxalic acid	Acetic acid	Cystein	Ascorbic acid
Log $K_{(Mg)}$	8.85	3.45	2.76	0.55	NA	0.20
Log $K_{(Ca)}$	10.65	3.45	2.46	0.57	NA	NA
Log $K_{(Pb)}$	18.00	4.44	4.20	2.15	12.300	1.77

These values are taken from Critical stability constants Vol VI (and previous volumes), Martell and Smith[lix]
One unit correspond to one order of difference in affinity for the indicated metal ion

3. 12. Lead Assays

There are several methods to measure lead concentration, based on spectroscopic properties of lead such as 'Inductively Couple Plasma Emission Spectroscopy' (detection limit 42 µg/l) and 'Atomic Absorption Spectroscopy'. These methods are the most commonly used.

There are also biosensor methods, which are based on the response of biological molecules or organisms to lead. A reporter gene system associated to a lead responding element has been used to produce a luminescent bacterial sensor for lead.[lx] A new type of biosensor for the determination of lead ions has recently been described[lxi]. 'It combines the high metal ion selectivity of catalytic DNA with the high sensitivity of fluorescence detection'. The biosensor shows an 80-fold selectivity for Pb^{2+} over other divalent metal ions, and it is sensitive to Pb^{2+} over a 10 nM to 4 µM concentration range. A plant bioassay for Al, Cd, Cu, Pb and Hg has been developed using rice as an indicator species[lxii].

Colorimetric tests are based on the development of color in the presence of lead. As described in Troubled Times[lxiii], where a team has been formed[xiv] on that subject, 'Do-it-yourself kits, are available in hardware stores to test lead in paint and ceramics[lxiv,**lxxiv**]. The detection limit of most commercial lead tests is 0.25 to 0.5 ppm (0.25-0.5 µg per gram, 250-500 µg/l). The current lead level limit in drinking water in the U. S. is 0.015 ppm[xxxvi], these tests are not sensitive enough to determine whether water, food or the environment is safe. However, they can be very useful to recognize heavily lead contaminated alimentary and environmental sources.

One recommendation to the government by the committee on environmental health, 1992 to 1993[lxv], is to promote the development of a better lead test. *'There is a pressing need for a more efficient and less invasive test for lead levels or lead toxicity. The ideal measure could be used routinely on outpatients, be inexpensive, rapid, sensitive, resistant to contamination, and reliable.'*

3. 13. Lead intake in animals

Lead poisoned animals develop the same general symptoms as humans. However, the toxic threshold varies greatly from species to species. Cattle, sheep (lambs), horses, dogs and cats develop symptoms for a daily intake lower than 10 mg/kg of body weight (corresponding to 130 µg/dl in blood). Pigs, goats and rabbits are more resistant, minor signs of poisoning occur at intakes of 60 mg/kg of body weight. Poultry can withstand without symptoms, a daily dietary intake of 100 mg/kg of body weight, an intake of 500 mg/kg of body weight induces serious poisoning[lii]. Similarly to humans, higher percentage of lead is absorbed by young than by adult animals.

4. LEAD POISONING & AFTERTIME

Upon exposure, human body accumulates lead mainly in mineral tissues, with a lifetime of several decades. Under stress, such as malnutrition, demineralization occurs resulting in the mobilization of bone-sequestered lead. This stress might be sufficient, even in the absence of external lead exposure, to poison individuals. In the Aftertime, the lead burden coming from bone demineralization of undernourished survivors will add to the volcanic lead intakes. The lead blood level of the general population is already so close to the toxic threshold that even well prepared communities could be affected.

During the troubled times ahead, the level of preparation of individuals, families and communities will vary greatly. The ideal situation, concerning the lead poisoning problem, is to get, shortly after the pole shift, a shelter (to minimize exposure to lead containing volcanic ashes), a steady food supply from an indoor permaculture system (to avoid lead contamination of food), means to get lead free water (e.g.: distillation), some kind of lead assay and an effective treatment for poisoned individuals (e.g.: chelation therapy). In the worse case, where none of this is available, simple measures (such as water filtration and dust mask) can be used to lower lead exposure. Even in lead contaminated soil, appropriate growing practices and a proper selection of crop can minimize plant incorporation of lead. Similarly, for exposed animals, an appropriate selection of species and body parts used for food can also greatly lower lead ingestion.

Besides the level of preparation, there are also many less controllable parameters that will influences the likelihood for survivors to be poisoned by lead:

- Individual susceptibility. Due to genetic factors, some individuals will be significantly less prone to lead poisoning than other. A wide range of response to lead exposure can be expected, this will only be revealed upon lead exposure.
- The exposition of the living location to volcanic ashes is an important point to take into account for survival. For the people who have the freedom, willingness and opportunity to change location, many advices can be found on the safe location section of ZetaTalk®[lxvi]. The prevalent wind with respect to volcanoes location is another important factor to consider.
- The chemical composition of predominant volcano ashes might also influence considerably the survivors. Some volcanoes might be more deadly than other as far as lead chemicals they spew is concerned.

To help to deal with the lead poisoning problem in the Aftertime, and in addition to physically prepare, it is also important to develop a positive attitude in:

- Gaining knowledge. An analysis of the present knowledge related to lead can be used as a basis to propose solutions and help to deal with the lead poisoning problem in the context of the Aftertime.
- Adapting to new conditions. On many aspects related to lead poisoning, such as avoidance of poisoning, recognition of poisoning and lead poisoning treatment, a trial-error approach will be necessary. Implementing solutions will not only require knowledge, but also adaptability and flexibility.

The measures proposed below are for most of them, common sense. Different alternatives to treat poisoned individuals and to prepare lead free water are described, but the most important message to remember is that avoidance of exposure to lead is the most important prevention!

4. 1. Prevention from poisoning

Avoiding lead from entering the body would prevent poisoning. Getting lead depleted water through distillation is tedious but not difficult. Getting food only from a closed production system is far more difficult and not really realistic. Therefore, means to reduce lead incorporation in the body will have to be used. Even when lead has reached the gastro intestinal tract, an appropriate diet and food selection, the addition of essential mineral and oral chelators are several ways to lower lead bio-availability. An appropriate housing and good hygiene practices can also help in lessening lead exposure.

Since they are particularly sensible to lead poisoning, children, pregnant women and susceptible individuals should be especially protected from lead exposure. In addition, childhood brain impairment caused by lead might not be reversed by drug treatment[lxvii].

4. 1. 1. How to avoid lead from entering the body and to lower lead bio-availability

In the Aftertime, the main probable routes of lead entry will be ingestion and inhalation. Below, some information for a better preparation and measures to minimize lead contamination are described.

- **Atmospheric lead and lead dusts**

Between the main two routes of lead incorporation in the body, inhalation is the most dangerous. Dust mask can be used to reduce exposure to atmospheric volcanic dust particles. They are available in hardware stores. It is certainly wise to stock some. They are cheap now; they might become valuable in the post pole shift era.

- **Lead in water**

During the coming cataclysms and the Aftertime, volcano ashes containing lead will contaminate surface water. Water will certainly be a major source of lead poisoning. In drinking water, the real danger comes from the insidious dissolved lead, which is not removed by filtration and can be present in crystal clear water. The method of chose for lead free water preparation is distillation. Distillation is not difficult; it requires a heating source to boil water. Means to prepare lead free water are described in '4. 4. How to get lead free water'.

Not only should drinking water be distilled, but also water, which is used to wash hands and food and water that is used in food production systems.

If lead free water cannot be found or produced, although this will not remove dissolved lead, filtration or decantation will remove dust-containing lead. If non-purified water has to be used, the less acid water the better, since acidity dissolves more lead. Mineral rich water, containing calcium, magnesium is also safer. It is probably safer to avoid surface water. A lead test kit is certainly very valuable here to determine which water source is the safest.

- **Lead in food**

Ingestion is the other route of lead incorporation; since lead is rather quickly dissolved in acid conditions, avoid lead particles from reaching the stomach. Lead may also contaminate food. Root vegetables take up soil lead and atmospheric lead may fall onto leafy vegetable. Even in heavily contaminated soils the roots do not absorb much lead.

Plants incorporate lead differently and it is hard to predict the amount of lead absorbed by a plant species only based on soil concentration. Several factors influence lead incorporation by the roots: in a soil maintained at a pH level higher than 6.5, lead is relatively unavailable to plants. Since organic compounds bind lead, the addition of organic matter to the soil decreases lead incorporation by vegetables. Even at soil levels above 500 ppm (500 micrograms per gram), most of the risk is from lead contaminated soil or dust deposits on the plants rather than from uptake of lead by the plant[lxviii]. When grown on lead contaminated soil, fruiting crops (tomatoes, peppers, squash, cucumbers, peas, beans, corn, strawberries, apples, etc) incorporate little lead and should be preferred to root crops (such as carrots and radishes). Leafy vegetables (such as lettuce and spinach) should be avoided[lxix]. Leafy vegetable (such as lettuce leaves can store up to seven times more lead than beet roots. Lead that is deposited on leaves does not enter the plants. Vegetables should be carefully washed before consumption. Since water removes only partially lead deposited on plants, it is preferable to add vinegar (1%) or soap (0.5%) to cleaning water. It is important to remove any traces of dirt or dust on the plant parts that are eaten. Indeed, lead concentration in dust or soil is probably much higher than in the plant. It is also preferable to grow vegetables where edible plant parts are protected by leaves such as cabbage or corn[lxx]. Among the main dietary source of lead, grain comes first, since the fibrous seed coat retains mineral, whole grain potentially contains even higher amount of lead. The second alimentary source of lead comes from vegetables. Meats come third. Plants tend to have higher lead levels than animal food[xxxvi].

Animals have physiological mechanisms to get rid of lead, but they also incorporate and concentrate lead in some organs, mainly in bones. When eating animals suspected to be poisoned by lead, if possible, in addition to bones, the following organs should probably be avoided: testes, kidney, bone marrow, brain and liver[lxxi]. However, liver is a good source for many vitamins and should only be rejected when absolutely necessary. If one can assume that some animal species are more resistant than others to lead exposure because they excrete lead more efficiently, poultry should preferably be consumed. Pigs, goats and rabbits come next. Cattle, sheep, horses, should be the last candidates. In addition young animals contains higher percentage of lead than adult animals. Marine organisms concentrate lead by a factor of 100 to 300 times when compared to seawater. However, lead in seawater is very diluted and the concentration of lead in seafood remains low[xxxvi].

Any food in contact with lead particles produced by volcanoes should be carefully cleaned. This should already remove an important source of potential poisoning (this will not remove lead which has been incorporated in food).

4. 1. 2. How to lower lead bio-availability

A good diet can help to minimize lead absorption. Undernourishment favors lead absorption. There are several ways by which appropriate nutrition can help in preventing lead incorporation in the body:

- **Appropriate diet**

A fat rich diet seems to increase lead absorption (since fat rich food will hardly be available after the pole shift, this observation is on the good side). However, low iron[xxxix,lxxii], calcium, magnesium[lxxiii] or vitamin C (ascorbic acid) increases lead blood level and consequently lead poisoning. Food like spinach is rich in iron [lxxiv]. It does not require strong light to grow spinach. Dietary ascorbic acid seems to protect from elevated lead blood level[lxxv] (this is well documented in animals, more speculative in human). Dietary vitamin C is probably a good way to control lead toxicity[lxxvi]. People who consumed alcohol on a daily basis as well as smokers seem to have a higher blood lead concentration[lxxvii]. The consumption of tofu, which has a high calcium content, is associated with low blood lead levels[xxxvi].

In an attempt to identify the most appropriate vegetable diet, the ‘Dr. Duke's Phytochemical and Ethnobotanical Databases’[lxxviii] were searched using several parameters. These vegetables were selected based on their chemical composition in compounds (ascorbic acid, calcium, magnesium, iron, zinc, and lead), which appear relevant in preventing lead poisoning or in treating poisoned patients. The ranking of these vegetables, starting with the one, which appears the most beneficial, is shown in table II.

Table II. Selection of the most appropriate vegetable diet to prevent lead poisoning

Common name	Latin name	Part	Ascorbic acid (ppm)	Calcium (ppm)	Magnesium (ppm)	Iron (ppm)	Zinc (ppm)	Lead (ppm)
Green Bean	*Phaseolus vulgaris*	Fruit	2,389	18,000	18,000	1,050	150	10.5
Lettuce	*Lactuca sativa L.*	Leaf	3,000	19,140	8,700	176	974	6
Spinach	*Spinacia oleracea L.*	Plant	7,595	15,700	11,000	384	185	3
Paprika	*Capsicum annuum L.*	Fruit	20,982	1,956	2,340	286	77	2
Endive	*Cichorium endivia L.*	Leaf	9,302	10,080	2,400	360	146	5
Radish	*Raphanus sativus L.*	Root	6,216	8,570	3,570	189	72	
Cauliflower	*Brassica oleracea var. botrytis L.*	'Flower'	9,300	4,040	2,250	122	97	
Brussel-Sprout	*Brassica oleracea var. gemmifera*	Leaf	6,069	3,177	1,642	136	157	
Carrot	*Daucus carota L.*	Root	775	5,710	1,980	300	79	2
Beet	*Beta vulgaris*	Root	868	4,200	4,200	165	70	4

- **Alimentary chelator**

Alimentary chelator compounds (such as EDTA) work by sequestering lead and consequently avoid assimilation in the body. Since 95% of EDTA taken orally is not absorbed, *per os* administration of $CaNa_2$ EDTA is used when lead is present in the gastro-intestinal tract[lxxix]. One might then suppose that the addition of small amounts of EDTA to contaminated food could sufficiently decrease lead absorption to prevent poisoning. Oxalic acid and citric acid (found in significant amount in rhubarb and citrus, respectively) are also possible alimentary chelators but their effectiveness in preventing lead assimilation is not documented. They might even increase the bio-availability of lead and the acidity of these compounds might increase the dissolution of lead in food. Succimer and amino acids containing sulfur (cysteine and methionine, ...) are used as additive to oral medicine for preventing chronic lead poisoning[lxxx,lxxxi].

- **Essential metal ions and vitamins supplementation**

Food enriched in essential metal ions such as iron, calcium, magnesium and zinc, which can compete with lead for binding to target molecules, can reduce lead assimilation. Calcium seems to determine how much lead is absorbed from the diet. Calcium and lead are similar and compete for binding sites in the intestines[lxxxii].

The processes used to remove lead from water, such as water distillation, will also eliminate essential metal ions. Therefore, when metal ions depleted water is constantly drunk, it might be important to concomitantly use supplementation of essential metal ions (Ca^{2+}, Mg^{2+} and Zn^{2+}) in order to keep the body healthy and not too sensible to environmental lead contamination. In addition, when food consumption decreases, intake of vitamins and minerals can no longer be sufficient, which makes the body vulnerable to lead contamination. Malnutrition and diarrhea are important risk factors of lead poisoning. Currently, in the general population, the intake of magnesium, calcium and zinc is usually too low. One can imagine that this problem is will get worse during the Aftertime, unless specific attention is paid to it.

The first measure to prevent contamination is avoidance of exposure to lead, the second one is to make sure that sufficient amounts of essential minerals are ingested to minimize lead assimilation. Mineral supplements and vitamins should be stocked and natural sources should be identified. One important parameter to take into account in selecting mineral supplements is the balance between the different essential metal ions. An excess of one mineral can reduce the assimilation of the other ones. When used during an extended period of time, a well-balanced multimineral supplement is preferable. Oral administration is the most common way of mineral supplement administration.

The following information on essential minerals and on vitamins[lxxxiii, lxxxiv] can help to identify appropriate sources:

Calcium is found in dairy products. Assimilation of organic calcium supplements such as carbonate, citrate, malate, gluconate or lactate is most efficient. Some supplements contain vitamin D, which is required for calcium assimilation. Calcium intake of the population is often not sufficient. Children, teenagers and pregnant women need a higher intake of calcium. Not more than 2000 mg of calcium (total) should be taken per day because it could affect zinc, magnesium and iron assimilation. It is usually taken in supplement of 400 to 500 mg. In addition to dairy products, mineral water, citrus fruits, cabbage, sardines with bones, broccoli and almonds are good sources for calcium. Oysters shelves and bone powder are sometimes used as mineral supplements but in that case, one has to make sure that they do not contain lead. Shellfish concentrate minerals in the shells and will probably concentrate more lead in the Aftertime. Shells accumulated before industrial times (and also before the pole shift) could be an appropriate source of calcium supplement[xxxvi].

Magnesium supplements are often found in aspartate, carbonate, gluconate, oxyde or sulfate form, but the citrate form is better absorbed. 200 to 600 mg of magnesium supplements can be taken per day. The total magnesium ingested should not be more than about 700 mg per day. Magnesium supplementation often induces diarrhea. Natural sources of magnesium are dry fruits, green vegetables, mineral water and wild rice.

Zinc supplements, taken in excess can interfere with cupper assimilation. Not more than 10-15 mg/day of zinc supplement should be taken. Zinc is found in meat, fish, poultry, eggs, seafood (oysters), cheese, and dry beans. The chemical form of zinc does not influence much its bioavailaility but zinc is better absorbed when coming from meat rather than from plants. The addition of zinc to food decrease diarrhea and boost the immune system.

Iron supplements (Fe^{2+}) in sulfate, fumarate or gluconate forms are often associated to several vitamins and minerals. Usually iron supplements provide 25 mg per day. An excess of iron intake can be toxic. Alimentary iron comes from meat, fish, seafood (oysters) and green vegetable.

Vitamin C in blood is inversely correlated to lead level. Supplements of 200 to 1000 mg per day are usually taken. Ascorbic acid is found in citrus fruits, kiwi, cabbage, broccoli, green leafy vegetables, paprika, cassis and strawberries.

Vitamin D is required for calcium assimilation. Vitamin D is synthesized by the skin when exposed to the sun. In the Aftertime, with a low sunlight and conditions that favor mineral loss, getting sufficient vitamin D will certainly be a matter of concern. Upon vitamin D deficiency, less calcium is absorbed and bone losses increase. In the Aftertime conditions, this would result in an increase of lead assimilation and bone-sequestered lead mobilization. Vitamin C is found in fat fish, eggs and liver.

4. 1. 3. How to minimize lead exposure

- **In food production systems**

The best way to survive under adverse environmental conditions is to enclose oneself in a closed autonomous system where a shelter reduces exposure to lead containing ashes and where food is obtained from indoor gardening. Even in such systems, care should be taken to lower lead exposure. Constant attention has to be paid to prevent lead from reaching the food production chain. One should be aware that poisoned people, especially when treated with chelators would excrete lead in urine and feces, which in entering the recycling loop would in turn contaminate the food production systems. Similarly to the use of EDTA as a treatment for lead poisoned patient, EDTA can also be used to lower metal ions contain of nutritive solutions when an accidental contamination occurs. The plants or microorganisms cultivated in a permaculture process can also be used to monitor the lead contamination level of the system (see 4. 3. Lead Assays in post pole shift era). They also offer the opportunity to remove contaminating lead or metal ions from the system (see 4. 4. How to get lead free water).

- **In housing**

Although in the Aftertime, hygiene might be *'the least of anyone's thoughts'*[lxxxv], lead exposure can be reduced using simple cleanliness measures to avoid carrying volcanic dust in Aftertime housing and bringing lead containing ashes to the mouth through dirty hands. Ingestion of lead containing dust is currently a major source of contamination for children; therefore one might suspect that the problem will be worse in the Aftertime. The only way to protect from this source of contamination is to keep the housing and children as clean as possible.

4. 2. Treatment when contaminated

When prevention is not enough and lead poisoning has occurred, treatment is necessary. In the following paragraphs these questions are addressed in the context of the post pole shift era: once lead poisoning is suspected or recognized, when should a treatment be initiated? What kind of treatment will be available to treat poisoned individuals? Who should be treated first when only finite resources are available? These are tough questions and difficult choices will have to be made. The following paragraphs are intended to help in defining priorities.

4. 2. 1. When should a treatment be initiated

Because it might be the only way to confirm lead poisoning when assays are not available, one should learn to recognize the symptoms of lead poisoning[lxxxvi,xxxii]. Visual disturbances, gastro-intestinal failures and nervous system disorders reported in ZetaTalk®[v], are symptoms which are commonly described. However, the symptoms are not specific (most persons with lead toxicity are not overtly symptomatic[lxxxvii]). Children behavior may be the only indication of lead poisoning. Lead toxic children are often reported as being 'difficult to manage'[lxxxviii].

Depending on resources, treatment should be initiated as soon as recognized. If resources for treatment are scarce, it might only be possible to treat patients with life threatening symptoms or acute poisoning. Life threatening symptoms suggesting encephalopathy are obtundation, headache and persistent vomiting. Whether lead exposure is acute (happens quickly) or chronic (poisoning occurs over weeks or months) the symptoms are slightly different.

The symptoms of lead poisoning are summarized in Table III.

Table III: Lead toxicity symptoms (from 'Case Studies in Environmental Medicine'[lxxxvii])

Mild Toxicity	
	Myaglia or parasthesia
	Mild fatigue
	Irritability
	Lethargy
	Occasional abdominal discomfort
Moderate Toxicity	
	Arthalgia
	General fatigue
	Difficult concentration
	Muscular exhaustibility
	Tremor
	Headache
	Diffuse abdominal pain
	Vomiting
	Weight loss
	Constipation
Severe Toxicity	
	Paresis or paralysis
	Encephalopathy. May abruptly lead to seizures, changes in consciousness, coma and death
	Lead line (blue-black) on gingival tissue
	Colic (intermittent, severe abdominal cramps)

Some symptoms are more specific and more easily recognizable: sweetish metallic taste, burning mouth, severe thirst, unsteady walking style, wrist drop (see picture in reference[liii]) and foot drop[xxi], "lead-line" on gum margin (see picture in reference[liii]). It is very unusual to see a lead line in a child. This purplish line on the gums is rarely seen today, but if present, usually indicates severe and prolonged lead poisoning[lxxxvii].

4. 2. 2. How poisoned individuals could be treated

There are several alternatives to treat lead poisoned patients. In the addition to the effective chelation therapy, essential metal ion supplementation therapy seems to work quite well. Homeopathy, heat depuration and plant therapy, which might be more easily implemented in the pole shift era, can also provide solutions to the problem. The body has the ability to get rid of lead and consequently the first treatment to consider is the avoidance of any additional lead incorporation. The treatments described below can speed up the excretion of lead.

- **Chelation Therapy**

Chelators whose utilization necessitates the hospitalization of the patient, which require intravenous administration or present severe side effects should be avoided. The only chelators (among those which are commonly used at the moment) that fulfill these requirements are succimer and dimerval. Clearly, succimer has the safest spectrum of side effects. Chemet is the Sanofi's brand name for succimer[lxxxix,xc]. The drug produces no harmful side effects but is expensive about $ 400 for a bottle of 100 pills. As often suspected for oral chelators, succimer doesn't seem to increase gastro-intestinal lead absorption during treatment[xci]. Since a complete lead free environment will be difficult to attain in the Aftertime, this property of succimer, together with its oral administration and its minor side effects make of this drug, the best candidate for lead poisoning treatment in the post pole shift era. Chronic lead intoxication is usually treated with oral chelators

An alternative is to use EDTA orally, even if most of it will not reach the blood stream. EDTA is cheaper than succimer and easily available. If EDTA has to be used, take the monocalcium disodium form: $CaNa_2$ EDTA. It is also possible to purchase oral chelation formulas, containing EDTA, cystein and vitamins, which are intended, in lowering heavy metals in the body, to decrease the incidence of heart disease. One example is Life Glow Plus ($150 plus shipping for 4 bottles)[xcii].

A potential problem sometimes reported with chelation agents (particularly when taken orally) is that they can greatly enhance the absorption of lead from gastro-intestinal tract. Therefore, special care should be taken to absolutely avoid lead in food and water of poisoned individuals during treatment. Or treatment should be given on an empty stomach in order to avoid chelation of dietary metals. However, since 95% of EDTA taken orally is not absorbed, *per os* administration of $CaNa_2$ EDTA is used when lead is present in the gastro-intestinal tract.

Since *'The chemical industry will be very hard hit'*[xciii] during the coming cataclysms, the synthesis of the therapeutic chelator molecules which are presently used for lead poisoning treatment will most probably not be possible, unless a community has specifically prepared for this, in acquiring the necessary knowledge, in implementing the synthesis protocols and in assuring adequate sources for the required starting chemicals.

- **Supplementation therapy with essential metal ions**

Toxic metal elimination by mineral substitution is described in Troubled Times[xciv]. On an animal model, oral treatment with magnesium has better effects than intravenous administration of EDTA[xcv]. If this were also observed for humans, mineral supplementation therapy would be an easy way to treat poisoned individuals. This therapy is cheaper, and easier to implement than chelation therapy. Therefore, in addition to chelators, it might be wise to stock mineral supplements containing Mg^{2+}, Ca^{2+}, Zn^{2+}. Mineral supplementation can be used not only to prevent lead assimilation (as described in 4. 1. 2. How to lower lead bio-availability, 'Essential metal ions and vitamins supplementation') but also to treat poisoned individuals.

- **Heat Depuration**

This description of heat depuration can be found on the following web site reference[xcvi]:*'Like chelation therapy, these treatments seek to rid the body of chemicals such as lead, copper, iron, and other toxins. Patients are placed in a sauna heated to as high as 150 degrees Fahrenheit, a temperature which is thought to mobilize the chemicals from deep stores within the body. The treatments are often administered in conjunction with chelation therapy and other forms of detoxification. For example, patients may spend a full day undergoing heat treatments, exercise sessions, a massage, and nutritional therapy counseling.*
Each treatment lasts from 15 to 40 minutes, and 3 or 4 may be given during the course of a day. Advocates say that an average of 20 eight-hour sessions are needed to completely clear the body of toxins.'

The effectiveness of heat depuration in lowering lead blood level or in increasing lead excretion is not documented.

- **Plants**

If plant therapy using wild plants is envisioned in the Aftertime, this requires learning to recognize the local medicinal plants in the vicinity of the survival site. Due to the effect of the shift and cataclysms on vegetation, it is hard to know which of these plants will be present in one's environment after the pole shift. Another alternative is to grow the appropriate medicinal plants. Good books on medicinal plants[xcvii] should be included with the survival items, which are prepared by the people who want to survive to the pole shift. Databases can also be searched for medicinal plant content in calcium, magnesium, zinc, iron, vitamin C, oxalic acid, citric acid, ... Rhubarb (*Rheum Rhabarbarum L. & Rheum Rhaponticum L.*) is rich in oxalic acid, which is a carboxylic chelator that would bind Pb^{2+} with an affinity from 10 to 100 higher than Ca^{2+} or Mg^{2+}. However, when compared to EDTA, the affinity of oxalic acid for Pb^{2+} is very small. Oxalic acid is also present in other common medicinal plants, like *oxalis acetosella L.*, *Rumex Acetosa L.* and spinach. Citric acid, another carboxylic acid, which has been used in the past as a therapeutic chelator of lead is found in lemons and oranges. Citric acid has an affinity for Pb^{2+} similar to oxalic acid but a lower selectivity for this metal ion versus Ca^{2+} or Mg^{2+} (Table I).

When using these plants, care should be taken to absolutely avoid the presence of lead in the gastro-intestinal tract, because it would probably increase the bio-availability of lead. In addition, when grown in the presence of lead these plants would also probably concentrate this metal ion.

Another plant that might be used to treat lead poisoning, is *Equisetum arvense L.* which is rich in minerals and so could work as a supplementation therapy.

It has been suggested, probably due to the high sulfur content that garlic has a role in treating lead poisoning.

- **Homeopathy**

Many occupational medical doctors became convinced of the effectiveness of homeopathy because of the successes they observed with this kind of therapy on metal ions poisoning. Special preparations intended to treat lead poisoning can be found.

4. 2. 3. Who should be treated

Ideally, everybody presenting symptoms of lead poisoning should be treated, especially when life is threatened. However, when resources for treatment are limited, priorities have to be established.

- **Children first**

Children developing nervous system makes them much more susceptible than adults to lead poisoning, particularly under six. The most acute and severe exposure can generate permanent neurological effects and even death. '*In addition, children tend to develop permanent developmental and neurological problems when exposed chronically to lead, whereas many of the symptoms experienced by adults are reversed when exposure is ceased'*[xcviii]. Childhood brain impairment caused by lead might not be reversed by drug treatment. The efficiency of lead absorption from the gastro-intestinal tract is greater in children than in adults[xxxi] (adult humans absorb 10–15% of ingested lead; children absorb up to 50% of ingested lead). Since lead can cross the placenta barrier, unborn children can be poisoned through their mothers. Lead also appears in breast milk, and lead that has been accumulating in bones and stayed dormant for years can cause poisoning at times of increased bone resorption such as pregnancy and lactation[xxi]. Exposure to lead is more dangerous for young and unborn children. Since their neurobehavioral development is impaired even with low level of lead, which often results in a reduced IQ, children (particularly the youngest ones) should especially be protected from lead poisoning (safest food and water should be reserved for them). They should be treated when necessary and as soon as possible.

- **Next, susceptible individuals…**

Poisoned adults with strong symptoms should be nourished with safest food (and safest water). So protect the most genetically susceptible ones (once this has been determined).

4. 3. Lead Assays in post pole shift era

The ability to determine lead concentration in water, food, environment, patient blood and/or urine would certainly help to survive in the Aftertime. Unfortunately, the most common (and reliable) methods to measure lead concentration, based on spectroscopic properties of lead, necessitate expensive equipments. For instance, atomic absorption requires a special spectrophotometer with a lead lamp and an acetylene supply. These lamps are fragile and have a finite lifetime. The protection, use and maintenance of such equipment is not very realistic, for most, during and after the coming cataclysms. The newly developed methods based on the production of a fluorescent or luminescent signal in the presence of lead also depend on delicate detection equipments. Immunodiagnostic tests based on the presence of biomarkers in human patients, which are still under development, appear more robust, but they do not measure lead but the body response to lead poisoning. They cannot be used for lead determination in food, water and the environment. Moreover their efficacy in real conditions has still to be proven. So lead assay in the Aftertime will definitively be a problem since it is already, to some extent, a problem now. Research on lead poisoning, prevention and treatment would be more advanced if a robust and ‘easy to use’ test had had been available.

So what kind of test could be used in the Aftertime to measure the presence and concentration of such an insidious poison in patients, food, water or in the environment?

- **Colorimetric tests.** These tests can detect the presence of lead but cannot be used to determine lead concentration. Since their detection limit of these tests is too high, a negative result on a water sample will not mean that this water is safe. However, these tests do not necessitate special equipments, they are robust and are easily available. Since these tests are available in hardware stores and provided that the shelf live is long enough, it might be wise to get such tests and stock them for the Aftertime. It is also possible to stock the chemicals that are used in this assay, but this would require some research and testing.
- To monitor the lead level in a hydroponic food production, a **biotest** using a sensor such as rice[lxii], or a bacterial or whole cell biosensor could be implemented.
- The observation of the symptoms will probably be the only mean to monitor the lead poisoning status in patients

4. 4. How to get lead free water

Conventional methods for removing metals from wastewaters include chemical precipitation, carbon adsorption, chemical oxidation or reduction, ion exchange, dialysis, electrodialysis filtration, electrochemical treatment, reverse osmosis and evaporation[xxxvii]. Among these processes, the followings are applicable to lead: evaporation, reverse osmosis, ion exchange. Removal of lead from water using living material (in a process known as biosorption) is well documented and is particularly well suited to an hydroponic food production system. In biochemical research laboratories, where heavy metal free water is a necessity, water is often prepared by distillation, membrane filtration, ion exchange and by ‘affinity’ chromatography. Most of the time, a combination of these processes is used to prepare ‘lab grade’ heavy metals free water. Often the ultimate process is an affinity chromatography step where water, already to a large extent depleted of metal ions, is passed through a column filled with a gel to which a chelator is bound.

One difficulty with these different methods is the assessment of their efficiency in the Aftertime. This is related to the lack of a sensitive and robust lead assay and to the very low toxic threshold of lead in water. The loss of efficiency of such systems as chelation on column, ion exchange and reverse osmosis which occurs over time, will be very difficult to assess. For the methods requiring a regeneration cycle, it will be difficult to determine when it is necessary to run this step.

When metal ions depleted water is constantly used, it might be important to concomitantly use supplementation of essential metal ions (Ca^{2+}, Mg^{2+} and Zn^{2+}) in order not to make the body too sensible to environmental lead contamination.

Since water purity is a concern of many, numerous solutions and equipments have been developed. Many solutions to purify water are described in the Internet, as in the following reference[xcix].

- **Distillation**

Processes to get lead free water are well documented in Troubled Times. The simplest way to deplete water from metal ions is distillation, provided that energy to heat up water is available ('Distillation process'[xv] and 'Distilling drinking water'[xvi]). A system as simple as a kettle connected to a pipe (where water can condense) can make up a good distiller.

If distillation happens to be insufficiently effective in removing lead from water (possibly due to a high lead content in the starting aqueous material), it is always possible to run a second step of distillation to get doubled distilled water.

- **Chelation columns ('affinity' chromatography)**

A metal chelation column could be used in the Aftertime to deplete water from lead. A metal chelator is bound to a solid phase (gel), which is used to fill a column. Water can be passed through such a column to remove lead. However, this type of chelating gel is expensive and requires chemicals for regeneration (acid or EDTA). It is a very specialized product, which might not be easy to purchase.

- **Ion exchange**

Ion exchange works in a similar way as chelation on column but instead of a chelating group, a negatively charged molecule is used to capture positively charged lead ions. When compared to chelation on column, it is less specific and less effective, and less expensive. It usually requires salts for regeneration.

- **Filtration (reverse osmosis)**

This method to remove lead from water is described in Troubled Times[c]. Reverse osmosis requires water devoid of insoluble particles to minimize membrane clogging. It also requires enough pressure (pump) to run the system. Much more complicated to run and maintained than distillation or chelation on column.

- **Biosorption**

Biosorption is an alternative way to remove lead from water. '*Alternative metal removal and/or recovery methods based on metal sequestering properties of certain natural materials of biological origin. Certain type of microbial biomass can retain relatively high quantities of metal by "passive' sorption and/or complexation. This is commonly known as biosorption*[xxxvii]'. The principle of the biosorption process is basically a solid-liquid contact. Microorganisms are used to remove heavy metals from water. The microorganisms bind the metals on the surface of their membrane and/or incorporate them in their cytoplasm. Metal sequestration by microbial (bacteria, fungi and algae) cell wall works like an ion exchanger but with a greater capacity. Biosorption consist in passing a heavy metal contaminated solution through a living or not living microorganism biomass, to favor contact, in such devices as batch stirred tanks or continuous flow columns. Running water through coffee grounds is an example of biosorption using dead biological material[ci].

Lead and cadmium are enriched in marine microorganisms by factors of $1.7\ 10^5$ and $1.0\ 10^5$ respectively, relative to the aqueous solute concentrations of these elements in ocean waters. Immobilization and bioaccumulation of lead by bacteria may result in transfer of this metal through the food chain[cii]. Therefore, such a biomass can also be used to deplete water from lead. The use of different sources of biological material to sequester lead is documented:

- **Bacteria:** *Micrococcuc luteus* and *Azotobacter* sp. Cells capable of immobilizing 4.9 and 3.1 10^2 mg of lead per gram of dry cell weight, respectively, have been described[ciii]. Lead binding by cell envelope of a lead resistant strain of *Aeromonas* was observed[civ].
- **Fungi:** The filamenteous fungi *Rhizopus arrhizus* has been shown to sequester a relatively high quantity of lead (0.5 mmol of lead per gram of cells) at pH 4[cv].
- **Algae:** '*There is a high potential for certain algal cells to take up lead quickly and completely from the medium when the metal is supplied at subtoxic levels'*[cvi].
- **Plants**: Alfalfa (*Medicago sativa*) shoots silica-immobilized have been use to remove and recover several metal ions (including lead) from aqueous solutions in a processed called phytofiltration technology[cvii].

The advantage of biosorption as a tool to remove lead from water in the Aftertime context is that no chemicals are required, it can be used for large-scale water purification and since it uses a similar technology and know-how, it can be used concomitantly with hydroponic food production systems. Biosorbents have a low affinity for calcium and magnesium and therefore would deplete drinking water from these essential metal ions to a lesser extend (when compared to other lead depletion systems).

4. 5. Lead and indoor food production

Indoor food production systems, where safe water is recycled, is a good way to avoid lead from reaching the food chain. However, in a heavily contaminated environment, there is always the possibility of lead contamination. In such a system, where the entire food production loop is done in a closed system, a possible entering route for lead is human feces and urine of contaminated individuals. A biosorption compartment in a recycling food production system can be used as a barrier to avoid contamination of the whole system. A biosensor compartment can also be placed before the biosorption compartment. If lead concentration in the system reaches the biosensor threshold, a physical (phenotypic) change of the biosensor would indicate lead contamination. In that case, the biosorption compartment would concentrate and prevent the main food production from being contaminated. The removal of the biomass of the biosorption compartment would eliminate lead from the food production-recycling loop (figure 2). As long as the biosensor does not detect lead, the biosensor and biosorption plants or microorganisms can be used a secondary food source. Instead of a biosorbent, 'chemical' chelators such as EDTA can be used to chetate lead and save food production, but in that case, once the EDTA supply has been consumed it will be very difficult to replace it in the Aftertime.

To get such a food production system working is not easy, but the advantage it can provide goes beyond food supply. Once the know-how to grow plants and microorganisms in a closed system has been gained, the production of chelators, for lead poisoning therapy, by microorganisms can be envisionned (as well as antibiotics). Citric acid is commercially produced from the fungus *Aspergillus niger* where oxalic acid is a byproduct. Both acids (chelators) are separated based on the solubility of their calcium salts (calcium oxalate is precipitated at low temperature whereas calcium citrate is precipitated at much higher temperature, around 100°C).

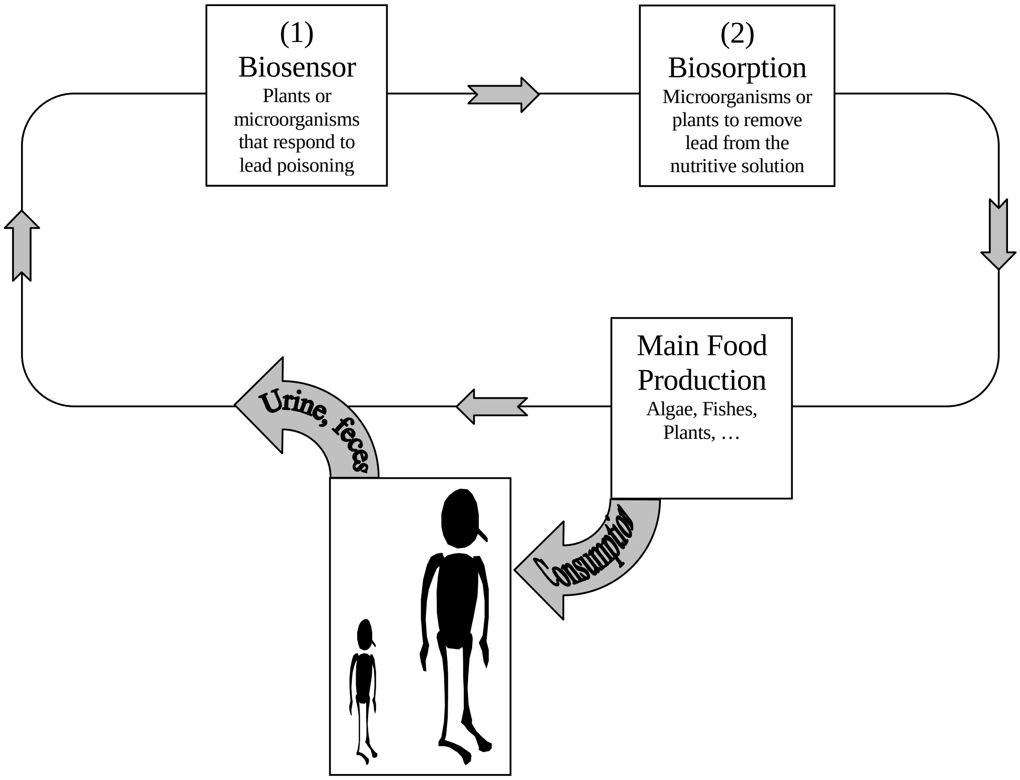

Figure 2: Recycling hydroponic food production system where a biosensor (1) is introduced to monitor the lead level. Following the biosensor, a biosorption step is added (2). Its function is to concentrate lead and protect the food production system. As long as the biosensor does not detect lead, the biosensor and biosorption plants or microorganisms can be used as a secondary food source. If lead enters the system, it would be detected by the biosensor and it would be retained by the biosorption compartment, avoiding the contamination of the main food production system. In that case, the plant or microorganism used in the biosorption compartment would have to be discarded and replaced.

5. CONCLUSIONS

ZetaTalk® describes that during the coming pole shift, volcanoes will spew ashes containing lead, exposing survivors to this toxic element. Human species has survived many pole shifts and will also survive the pending one. Therefore, the lead poisoning problem that accompanies the pole shift is not fatal for human species; it is only one of the parameters (among many others) that have to be taken into account for survival.

Compared to the previous pole shifts, humankind has major advantages in dealing with the lead poisoning problem. First, we know, thanks to ZetaTalk®, that humankind will face such a problem and consequently one can prepare, learn to minimize lead exposure, and seek solutions. Secondly, there are now, effective treatments to remove lead from the body of poisoned individuals. But there are also drawbacks: due to the pollution that industrial age has generated, significant levels of lead are found in the population. Lead is a cumulative poison and its level in blood of human population is such that any additional exposure could be sufficient to exceed the toxic threshold. Moreover, under stress and malnutrition, lead is mobilized from the bones and can poison individuals even in the absence of further lead exposure.

The post pole shift era will require adaptation and even in well-prepared communities, the acquisition of knowledge will facilitate the adaptation to unexpected conditions. It will be possible to deal with the problem of lead poisoning in the post PS era, provided that sufficient knowledge on lead and lead poisoning is gained and that common sense measures are taken. These measures are not necessary high-tech measures; simple actions can be taken to avoid lead poisoning and even to treat contaminated individuals. However, lead is insidious. It has no special taste or smell, it is not directly observable and the assays to determine whether or not someone is contaminated will not be available to most of the survivors. Moreover, it will be difficult to treat severely poisoned individuals (especially when intravenous injection of chelator is required). Since undernourishment favors lead absorption, it is crucial to prevent lead from reaching the gastro-intestinal tract in ingesting lead free water and food; inhalation as a source of lead poisoning will probably be of secondary importance. Most of the measures used to prevent lead contamination and also to treat lead poisoning are probably also effective against other toxic metals such as mercury.

Human body can, to some extend, get rid of lead by itself, provided that the exposure to lead is suppressed. Were human continuously exposed to lead, human species would have selected resistant individuals. However, since the exposure to lead decreases after the pole shifts, the selection pressure of lead also decreases, leading to the current situation with individuals in the population having a wide variety of lead poisoning susceptibility.

Among the measures that can be taken to deal with lead poisoning, some are very easy to implement and do not necessitate much preparation, other are only applicable where an hydroponic food production or permaculture setting has been established. Concretely, the different measures which can be taken to deal with lead poisoning in the Aftertime can be listed starting with the ones which require the least preparation to finish with the ones which are more complicated to implement, as advised in the 'What Mindset'[cviii] page of ZetaTalk: '*You think of the minimum that you will need, not the optimal and how to arrange for it. When you've got the minimum, start adding to that, but* only *when the minimum is addressed. This is where humans fail the most in planning for the shift, and life afterwards. They think of their life* now*, and come down from that. They should start with life with* nothing*, but bugs and sucking dirty water up from the ground with their hands. No clothes. No heat.* Nothing*. Then add what is needed most, and first. Heat, shelter, then food, bugs if need be or weeds, then how to clean your food so you can stop that tummy ache and constant pooping, then how to grow or gather food more* *effectively. Start from that, adding what is needed to clean water and eat food nature will provide, live bugs aplenty, and go from* there*, and you will have a better plan.'*

1. **No preparation.** Even for individuals who do not have the opportunity, the willingness or the time to physically prepare to survive in the Aftertime, gaining knowledge on lead and lead poisoning is a first step. Preparation is only made on an intellectual basis, nonetheless, it is certainly reassuring to gain knowledge on this subject and it certainly prepares to 'move when necessary'. Going from level of preparation1 to level 2 is easy when enough knowledge and emotional preparation has been achieved.
2. **Low level of preparation.** This level of preparation is essentially gathering materials:
   - Dust masks.
   - Lead assays.
   - Therapeutic chelators.
   - Seeds of plants that tend not to accumulate lead when grown outside.
   - Water distillation system.
   - Vitamins and mineral additives.
3. **High level of preparation.** Going form step 2 to 3 is not difficult in the context of a community where resources and expertise are shared and where food is produced indoor. Such a system would provide lead free food. Accidental contamination of the food production system can even be dealt with using biosensors and biosorbents.

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