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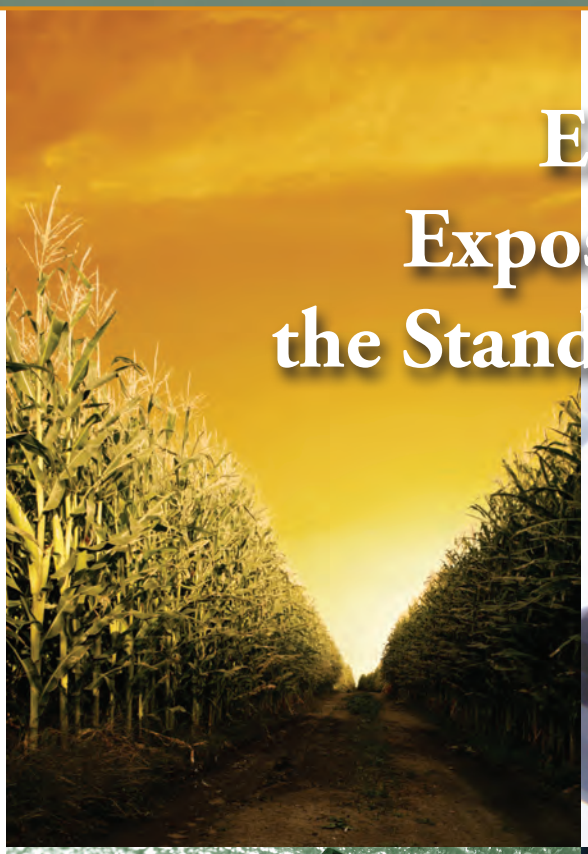
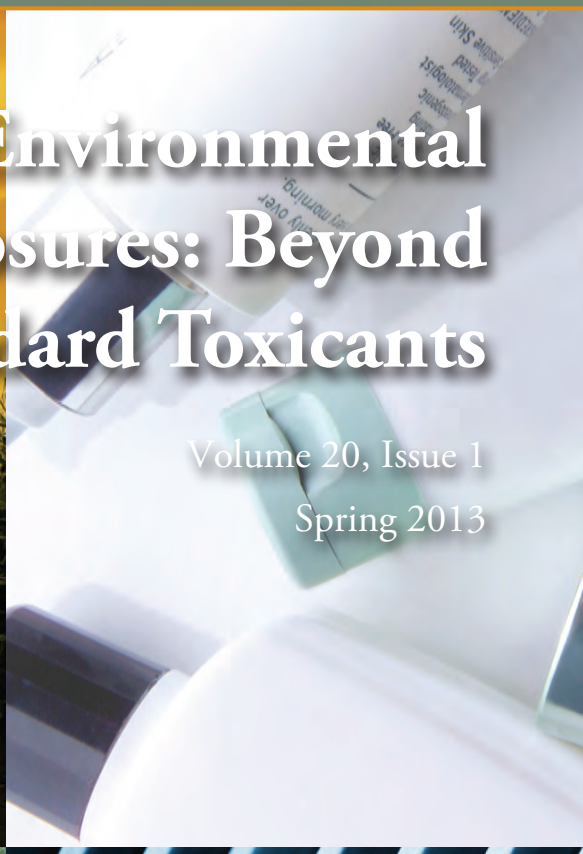
The journal of the Canadian Association of Naturopathic Doctors

Feature Articles





Environmental Exposures: Beyond the Standard Toxicants

Volume 20, Issue 1
Spring 2013

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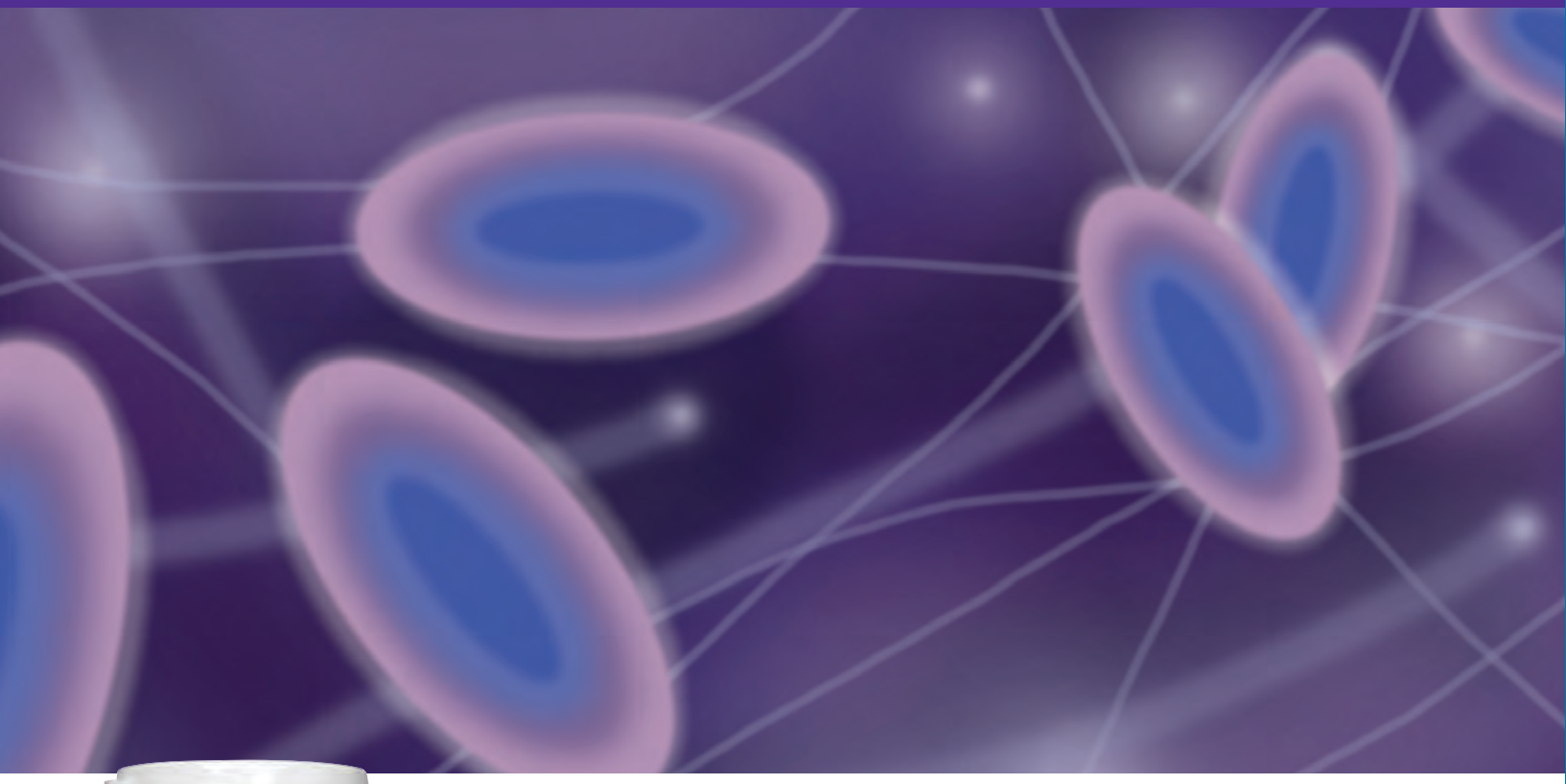

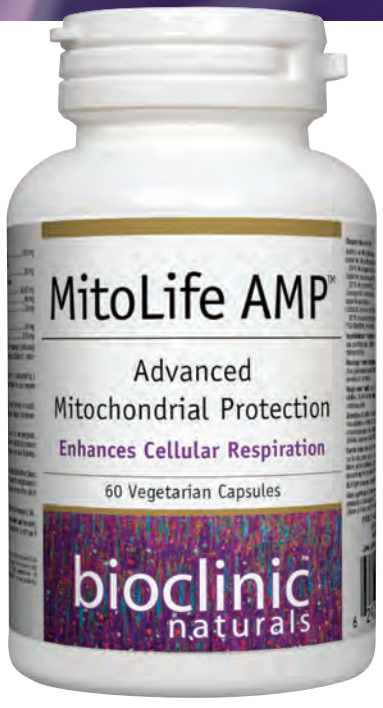

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The *Vital Link* is the professional journal of the Canadian Association of Naturopathic Doctors (CAND). It is published primarily for CAND members and features detailed reviews of specific causal factors: philosophical and research-based papers, clinical practice articles and case reviews, as well as international updates on the profession. The *Vital Link* has an outreach to other health care professions and promotes qualified naturopathic doctors to corporations, insurance companies and the Canadian government.

Forthcoming Themes

Summer 2013 *Health Fusion Edition* – Chronic Inflammatory Disorders
Fall/Winter 2013 Smoking and Health
Spring 2014 Lifestyle and Health

Submissions
When writing for the *Vital Link*, keep in mind its broad readership and outreach to other professions. Your contribution to the *Vital Link* will benefit the naturopathic profession as a whole and provide you with personal professional exposure. Previously unpublished material is preferred. Please contact the managing editor for submission guidelines.

Circulation
The *Vital Link* is published three times per year and is distributed to over 2000 qualified Canadian NDs and students of CNME-accredited naturopathic programs in Canada and the U.S. The *Vital Link* is also distributed to the CAND's corporate members and in our media kit. The journal is available in print and e-formats, by paid subscription.

Advertising
Professional vendors providing NHPD/Health Canada-compliant products or other services to NDs are encouraged to advertise in the *Vital Link*. The CAND's advertising partners enjoy unequalled exposure to qualified Canadian naturopathic doctors.

Naturopathic Notes

Dr. Iva Lloyd, BScH, RPE, ND

The longer I am in practice the more I become aware of how ubiquitous ***environmental toxins*** are and their impacts on health. Environmental toxins don't just include heavy metals and chemicals; they are increasingly present in our food, our homes, and our water and air. Minimizing exposure to these toxins involves detoxifying every aspect of a person's life and environment.

It includes choosing whole, organic, non-GMO foods, chemical-free personal care products and selecting chemical-free household products. It requires a mind-shift that affects every aspect of life and living and making choices based on good health and environmental preservation and sustainability ahead of convenience, comfort and luxury.

This edition of the *Vital Link* explores some specific environmental toxins and how they contribute to disease. Dr. Joe Pizzorno has spoken out against environmental toxins for over thirty-five years and is actively involved in research about the risk of environmental toxins on health. He has also been involved in the development of natural health products that decrease the body's toxic load. We are pleased to feature Joe's editorial, which outlines the history and his perspective on the importance of addressing environmental toxins in a naturopathic practice.

Hands-down, one of the most significant issues today regarding food safety and environmental toxins is that of genetically modified organisms. Claire Robinson, MPhil, researcher and investigative journalist, provides readers with an insightful summary of the current literature and political struggles that surround genetically modified foods and their impact on health.

Personal care products (PCPs) are a daily source of environmental toxins for many people. Naturopathic doctors Jacqueline Cooper, Andrea Maxim and Daisey Kent explore the link between a number of health conditions and the chemicals in conventional PCPs. The research on xenostrogens in PCPs is emphasized as an example of the growing consciousness about the toxins that many mainstream PCPs contain. The article also provides an overview of the main chemicals to avoid and some suggestions for natural, chemical-free options.

Dr. Alexandra Triendl, ND and best-selling author Adria Vasil provide a unique naturopathic guide to healthy household products. They provide a thorough overview of criteria for choosing products, specific ingredients to avoid and make a clear case for the importance of minimizing daily toxin exposure, which as NDs know, is perhaps the simplest and most effective method of decreasing total body burden.

In this issue, we welcome back Dr. Walter Crinnion, a well-known and respected U.S. naturopathic doctor and preeminent environmental medicine expert, who in his article covers the basics of indoor air quality considerations, assessment and improvement.

Toronto-based naturopathic doctor Leslie Solomonian provides a comprehensive look at the heightened vulnerability of children to environmental toxins and strategies to minimize exposure. As toxic exposure is cumulative and children have a great tendency to be affected, fully grasping the importance of addressing childhood exposure prior to disease-manifestation is an important aspect of naturopathic care.

There is no escaping the intense burden of environmental toxins; they are unavoidable and permeate every aspect of our lives. Minimizing our patients' exposure and decreasing their total body burden are our primary goals as naturopathic doctors and the articles in this edition of the *Vital Link* were crafted with this in mind. We are pleased to provide many strategies that you can apply directly and immediately in your practice.

Naturopathic doctors are the experts with respect to recognizing, assessing and addressing the impact of environmental toxins on health and disease. We trust that these articles will augment your growing knowledge base on this important subject.

The next *Vital Link* edition is scheduled to be published right before Health Fusion 2013 (see page 19 for conference details). As such, the focus of our summer issue will be on managing chronic inflammation and pain. We will feature some articles written by selected Health Fusion presenters and two specially-commissioned papers about diet and health that you won't want to miss. We welcome your opinions and questions at any time.

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Four Corners: Association Updates

Canadian Association of Naturopathic Doctors (CAND) *www.cand.ca*

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This will be a busy year for the CAND as we present "Health Fusion: Doctors Connect" in our nation's capital, from June 7 to 9, (see HealthFusion.ca). Be sure to register in time for our Early Bird Deadline of April 15 and as our sessions have a limited capacity, we encourage you to register now to avoid disappointment. We are excited to offer you such a stellar program; please come join us in Ottawa and bring the family!

The CAND continues to represent the naturopathic medical profession at an increasing number of professional conferences, in addition to our day-to-day work. Membership renewal is complete and we are thrilled to be welcoming many new members to the CAND this year, membership now stands at an all time high of over 1,600 naturopathic doctors.

At the federal level, with the assistance of Hill + Knowlton, we continue to lobby on the profession's behalf for GST/HST exemption. With a spring budget looming we have met with Ministry of Finance staff and have a number of meetings scheduled with MPs to garner support for the exemption. We must be realistic and recognize that it will be a challenge to have the exemption included in this first budget as this government is focused on the economy as it continues to decline. However, we will continue to press forward.

We are also engaged with the Health Ministry on access to controlled and/or scheduled substances and have participated in the consultations regarding scheduling of substances now that Schedule F is being repealed. A decision on the structure and processes that will be used for scheduling is expected later this year.

The CAND continues to assist a number of provincial and territorial associations with their government relations work. While more provincial and territorial governments have expressed interest in regulating naturopathic doctors, the process is slow and time consuming. However, with the steadfast determination and diligence of the dedicated NDs involved in government relations, the Profession is moving ever closer to the implementation of effective regulation across Canada.

At our fall Planning Session, the CAND Board of Directors elected a new Executive. We are pleased to announce that your Executive Team for 2013 is:

Chair – Dr. Patricia J. Wales, ND
Vice Chair – Dr. Lowell Greib, ND
Treasurer – Dr. Michael Nowazek, ND
Secretary – Dr. Jilla Kahrobaei, ND

As always, we encourage all naturopathic doctors to get in touch with the CAND with their questions, comments, requests and ideas.

Council on Naturopathic Medical Education (CNME) *www.cnme.org*

The Council on Naturopathic Medical Education (CNME) accredits naturopathic doctoral (ND) programs in Canada and the U.S., and graduation from a CNME-accredited or pre-accredited ND program is a requirement for taking the NPLEX exam and becoming licensed or regulated as a practitioner. Currently, the CNME accredits two ND programs in Canada and five in the U.S. Additionally, the CNME grants approval of postdoctoral residency programs in naturopathic medicine that meet its requirements.

CNME recently issued new editions of its *Handbook of Accreditation* and *Handbook for Naturopathic Medicine Residency Programs*. These handbooks contain the CNME standards, policies and procedures related to the accreditation of ND programs and the approval of residency programs. PDF copies of the handbooks can be downloaded from the CNME website, www.cnme.org.

In 2013, the CNME will be reviewing for reaccreditation the ND programs offered by the following institutions: Boucher Institute of Naturopathic Medicine; Canadian College of Naturopathic Medicine; Bastyr University; University of Bridgeport; and Southwest College of Naturopathic Medicine. ND programs can be reaccredited for a period of up to seven years.

Persistent Organic Pollutants: A Serious Clinical Concern

Dr. Joseph Pizzorno, ND

I am confident all of us are concerned about the ever increasing load of toxins in the environment and how this contributes to our patients' ill health and disease burden. The first lecture I gave when founding Bastyr University in 1978 was entitled, "The Health Effects of Environmental Toxins." This was a frustrating course to teach as I was confident environmental toxin load was a real problem, but there were at the time no useful textbooks.

The academic and research resources were limited to high level exposure such as found in mining and industry and, in fact, explicitly discounted the concept that the chronic low level exposure seen in the general population was clinically relevant. Regular readers of *Integrative Medicine, A Clinician's Journal* will remember that I have addressed the issue of mercury toxicity in previous editorials, accompanied by vigorous Letters-to-the-Editor conversation.

About two years ago after listening to a Jeff Bland, PhD interview on Functional Medicine Update (now called Synthesis by Jeffrey Bland), I was intrigued to hear of new research looking at not just the physiological effects of organic toxins, but also the systemic effects of the total body load of these chemicals. Looking at the research I was excited to see a large body of emerging research and alarmed by the seriousness of the correlations now being seen.

Persistent Organic Pollutants (POPs) Defined

POPs are defined as, "Organic compounds that are resistant to environmental degradation through chemical, biological, and photolytic processes." This resistance to breakdown results in their bioaccumulation in human and animal food chains. These are the pesticides, solvents, industrial chemicals, plasticizers that characterize modern living. In 1995 the WHO defined the "dirty dozen" as "Aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, hexachlorobenzene, mirex, polychlorinated biphenyls, polychlorinated dibenzo-p-dioxins, polychlorinated dibenzofurans, and toxaphene." Since then, many more chemicals have been added: "carcinogenic polycyclic aromatic hydrocarbons, brominated flame-retardants, and some organometallic compounds such as tributyltin.

These organic toxins share specific chemical characteristics:

- Low water solubility
- High lipid solubility (ability to pass through phospholipid membranes and bioaccumulate in fatty tissues)
- Semi-volatility
- High molecular masses (POPs with molecular masses lower than 236 g/mol are less toxic, less persistent in the environment, and have more reversible effects than those with higher molecular masses)
- Frequently halogenated, usually with chlorine (the more chlorine groups a POP has, the more resistant it is to degradation)

A Canadian study found 46 of the 69 POPs measured in virtually everyone.

Health Effects of POPs

The physiological effects of POPs are quite diverse due to their different chemical structures, but perhaps even more so due to their extensive epigenetic effects (note: Dr. Pizzorno is currently writing an article on this, which will be excerpted here in the future). In addition, one of the key systemic effects of total POP exposure is their oxidative load burden, which depletes glutathione (more on this below). The basic types of effects that have been reported in the literature include:

- Endocrine disruption (especially thyroid & sex hormones)
- Blood sugar regulation disruption (interference/mimic insulin)
- Mitochondrial damage
- Inflammatory cytokine upregulation
- Methylation disruption
- Alterations in aryl hydrocarbon nuclear receptor translocator
- Peroxisome proliferator activated receptor (PPAR) agonist
- Stimulation of tumor necrosis factor-α expression

Of perhaps greatest concern are Intrauterine and/or epigenetic and trans-generational effects.

The fetus and children are especially susceptible to the damaging effects of POPs. For example, a ten-fold increase in exposure to organophosphate pesticides doubles the incidence of ADHD.[1] Of even more concern, a child born to women in the top quartile of organophosphate pesticides exposure suffer a 7 point decrease in IQ compared to those with the lowest exposure.[2]

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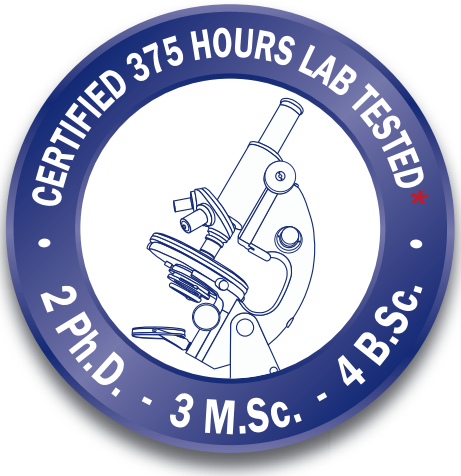

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For adults, many disease associations have been found. Most significant appear to be diabetes/metabolic syndrome, obesity, neurological dysfunction and cardiovascular disease—but be very clear, there are many more disease correlations than I can cover here.

Diabetes. Those in the highest quintile of POP exposure have a remarkable 38-fold increase in the risk of diabetes![3] Of particular interest, in people with undetectable levels of POPs, the typically robust association between obesity and diabetes *was not observed*. POPs contribute to or even cause many of the root causes of impaired glucose regulation, such as insulin resistance, dyslipidemia, inflammation, mitochondrial inhibition, and a decline in pancreatic beta-cell function.[4,5,6] Organochlorine (OC) pesticide serum levels were the most strongly associated with insulin resistance.[7]

Obesity. The correlation between POP exposure and obesity is so strong, they are sometimes called obesogens. In fact, most of the variation in adiposity in prepubertal children can be explained by epigenetics induced by maternal exposure to POPs. The correlation is stronger than commonly-accepted factors such as birth weight and maternal body composition.[8]

Neurological Dysfunction. Children whose mothers were in the highest quintile for exposure organophosphate (OP) pesticides had an average 7-point reduction in IQ compared to those in the lowest.[9] Higher urinary levels of OP pesticide metabolites among children increases the risk for attention deficit disorder 55-95% — levels common in North America amongst children consuming conventionally grown foods.[10]

Cardiovascular Disease. Cardiovascular disease and hypertension are associated with higher serum levels of specific POPs, including both dioxin-like PCBs and non-dioxin-like PCBs. Differing effects on gender were seen for specific classes of POPs; for example, PCDDs had as much as a 5-fold increase in risk for hypertension among women in the highest quartile, with no association in men, while PCBs had a 2-3 fold increase in risk among men, but not among women.[11,12]

Assessing POP Load

Direct Measures. Several laboratories are now measuring the levels of specific POPs in urine, blood, adipose tissue and breath. The big advantage, of course, is that this allows identification of which POP(s) a patient is being exposed to thus facilitating determination of source. The problem is that there are a lot of POPs, so picking the right ones can be challenging, and if many are tested, the costs can become prohibitive.

The big advantage of indirect measures is that they allow an assessment of total load and since they are commonly available lab tests, the cost is much less.

GGT. GGT appears a good indirect measure of total chemical load. A growing body of research is now showing that a key body response to POP exposure is up-regulation of glutathione production to facilitate detoxification.[13] As noted in my 2012 editorial "What Do We Tell Our Patients About Alcohol?" (IMCJ 11.6) GGT is directly proportional to the amount of alcohol consumed. GGT is a strong predictor of death, probably as it is an indirect measure of toxin exposure. Note that the risk of death is 2- to 4-fold higher in those with higher GGT compared to those in the bottom quartile.[14] Within the "normal" range, GGT predicts risk for type 2 diabetes, gestational diabetes, coronary heart disease, hypertension, stroke, dyslipidemia, fatty liver, chronic kidney disease and cancer—often more accurately than the commonly accepted risk factors.[15,16]

Uric Acid. Recently, Stephen Genuis, MD—an expert clinician and researcher in environmental medicine in Edmonton, Alberta—commented to me that he has been seeing elevation in serum uric acid in his most toxic patients and that their levels decrease as they detoxify. I took a look at the research and found some intriguing early research; one study found a strong correlation between perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) and serum uric acid, again, within the "normal" range.[17]

Homocysteine. As POPs impair methylation, a logical assumption is that there ought to be a correlation between exposure and elevated homocysteine levels. However, a review of the research 1/16/13 did not find any reports of a correlation—or not. It is unclear at this time if we are simply too early in the discovery process or if some other factor is precluding a correlation.

Intervention

At with every toxin, the primary intervention is to first decrease exposure. Since these toxins bioaccumulate and bioconcentrate in the food chain, an organic and primarily plant-based diet is probably the most effective strategy for reducing exposure. Diet has been shown to be the largest source of exposure to OP pesticides in children and an organic diet dramatically reduces urinary metabolites of these pesticides.[18,19] The other major non-industrial sources of exposure are phthalates in personal care products and bisphenol A (BPA) in many food containers.

Next is to support the body's own mechanisms for elimination of the organic toxins. Two of particular interest are fiber—for binding in the gut—and glutathione which both facilitates detoxification and protects tissues from the oxidative effects of so many of these toxins. Providing support for glutathione synthesis either directly or with precursors such as N-acetylcysteine may be indicated in those at greater risk or exposure levels is a sound strategy.[20]

There is some research support for the old-time naturopathic therapy of "sweating out the toxins." One study looked at firemen suffering neurobehavioral dysfunction from exposure to polychlorinated biphenyls (PCBs). They found that a combination of diet, exercise, and sauna improved several measures of cognitive function.[21] Genuis, mentioned above, recently demonstrated that

phathalates and their breakdown products are excreted in the sweat.[22] His same team also reported recently the excretion of BPA in sweat.[23] Of particular interest, they even found BPA in the sweat of individuals with no apparent BPA in their serum or urine.

Finally, as some if not many of the damaging effects of POPs are via epigenetics due to hypomethylation,[24] methyl donors, such as folic acid, betaine and B12, reduce the risk of conditions ranging from autism to cardiovascular disease and may be indicated in those with high exposure and/or signs of impaired methylation capacity, i.e., elevated homocysteine.[25,26]

Summary

At this time, I estimate that 75% of the general population is suffering some dysfunction and increased risk of serious disease from chemical exposure. This number is, of course, certainly higher in patients suffering chronic disease. Bottom line: decreasing toxin exposure and facilitating detoxification is a critical foundation for the practice of integrative medicine. Once again, the old time natural healers, both conventional and unconventional, were right—there is no substitute for healthful living.

About the Author

Dr. Joseph E. Pizzorno, ND is president of SaluGenecists, Inc., Editor of *Integrative Medicine, A Clinician's Journal*, President Emeritus and Founder of Bastyr University and Chair of the Bioclinic Naturals Scientific Advisory Board.

Through education, research, publishing, policy advancement, and solution-driven innovation, Dr. Joseph E. Pizzorno has earned international respect for his visionary leadership integrating science-based natural medicine into health care delivery models. In his 40-year career, he has shared with millions around the world the profound efficacy of natural medicine.

THIS IS AN ADAPTATION OF DR. PIZZORNO'S EDITORIAL IN ISSUE 12.2 OF *INTEGRATIVE MEDICINE, A CLINICIAN'S JOURNAL*. IT HAS PRIMARILY BEEN MODIFIED TO INCLUDE CANADIAN DATA.

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Don't Look, Don't Find: Health Hazards of Genetically Modified Food

Claire Robinson, MPhil

Genetically modified (GM) foods are derived from crops or animals that have had their DNA changed by the insertion of DNA from foreign and unrelated organisms in a way that would not happen naturally.[1] Genetic engineering is different from conventional breeding, which can only take place between closely related organisms, such as wheat with wheat. Genetic engineering allows DNA to be transferred across species barriers, conferring new properties on the organism.

GM foods were first released onto world markets in the mid-1990s. The European Union and other countries require GM foods to be labelled, but the United States, where the bulk of GM foods are grown and consumed, does not. Canada also does not require labelling. Genetic modification is mostly confined to a few commodity crops: soy, maize, canola, sugar beet, and cotton. Almost all commercially available GM crops are engineered to tolerate being sprayed with herbicide or to express a pesticide, or both.[2]

The most detailed scientific study ever performed on the health effects of a GM food was published last year. The findings of the research study, led by Prof Gilles-Eric Séralini at the University of Caen, France, were shocking. Rats fed over a two-year period with GM maize and the Roundup herbicide with which it is grown had increased rates of severe organ damage, tumours, and premature death.[3]

The study should have been a wake-up call to the world, but most members of the public and healthcare practitioners are in danger of learning nothing from it. The reason? Within hours of the study's release, a concerted media campaign swung into action to discredit it. Quotes from scientists criticizing the paper were circulated by the UK-based Science Media Centre,[4] an organization that takes funding from GM companies.[5]

One of the critics pointed to the unexpected nature of Séralini's findings. Mark Tester, research professor at the Australian Centre for Plant Functional Genomics, University of Adelaide, said, "The first thing that leaps to my mind is why has nothing emerged from epidemiological studies in the countries where so much GM has been in the food chain for so long? If the effects are as big as

SÉRALINI STUDY DESIGN AND FINDINGS

Séralini's study[3] tested the long-term effects of Monsanto's GM NK603 maize, which is engineered to survive being sprayed with Roundup herbicide, and Roundup. The study used 200 rats divided into ten groups, each of ten males and ten females. The GM maize alone was tested on three groups at 11%, 22% and 33% of the total diet. GM maize which had been sprayed with Roundup in the field was tested on three groups in the same proportions. Roundup alone, given in drinking water at three different doses, was tested on three groups. The lowest dose corresponded to contamination found in some tap water, the intermediate dose to the maximum level permitted in the USA in animal feed, and the highest dose to half the strength of Roundup as used in agriculture. Controls were fed a diet containing 33% non-GM maize and plain drinking water.

In treated males, the most commonly affected organs were the liver and kidneys, and deaths were mostly due to liver and kidney disease. Hepatic congestion and necrotic foci were 2.5–5.5 times more frequent in all treatment groups than controls. The activity of the liver enzyme gamma-glutamyl transferase was increased up to 5.4 times for the groups fed GM maize plus Roundup, a possible sign of toxicity.

For all treatments and both sexes, 76% of altered parameters were kidney-related. In treated females, sodium and chloride ions increased in urine. The same ions decreased in serum, as did levels of phosphorus, potassium, and calcium. Creatinine clearance in urine decreased in all treatment groups compared with female controls.

In females, the androgen/estrogen balance in serum was modified by GM maize and Roundup treatments. In males fed the highest Roundup dose, levels of estrogen more than doubled.

Up to 14 months, no animals in the control groups showed any signs of tumours, compared with 10–30% of treated females, except the group consuming the highest proportion of GM maize plus Roundup. By the 24th month, 50–80% of females in all treated groups had developed tumours, with up to three per animal, whereas only 30% of controls were affected.

Whereas 30% of control males and 20% of control females died before the mean survival time, up to 50% of males and 70% of females died prematurely in some groups containing GM maize.

Link to study: http://www.sciencedirect.com/science/article/pii/S0278691512005637

purported, and if the work really is relevant to humans, why aren't the North Americans dropping like flies?"[4]

This quote was cited uncritically in media articles worldwide.[6] Yet no reporter asked how many epidemiological studies have been carried out to examine the effects on humans of eating GM foods. The answer: none. Nor did they ask how such studies could be carried out in the country where most GM foods have been eaten for the longest time, the United States, given that GM foods are not labeled there and consumption cannot be traced.

Criticisms circulated by the Science Media Centre and quoted in the media were answered by Séralini's team in the journal that published his original research.[7] Criticisms were also addressed on a public information website, gmoseralini.org, set up by citizens and scientists who were concerned that important findings were being buried.

Subsequent investigations showed that most of Séralini's critics had conflicts of interest that went undisclosed in the Science Media Centre media releases and articles that quoted them.[8,9] Public interest scientific groups commented that double standards are used to evaluate studies on GM food safety, with those that find risk being subjected to relentless criticism, whereas those that conclude safety go unchallenged.[10,11]

The scientifically valid way to test Séralini's findings would be to repeat the study or to extend it into a full-scale carcinogenicity study, using larger groups of rats. But long-term studies like Séralini's have never been carried out by GM developer companies, nor are they required by regulators anywhere in the world. Studies that have found problems with GM foods have not been followed up. The preferred way is to discredit the researcher and the findings. This can include campaigns to persuade journal editors not to publish a paper or, if it is already published, to retract it.[12,13] Such a retraction campaign was waged against Séralini's study,[14] albeit unsuccessfully.

When are statistically significant findings not biologically relevant?

Séralini designed his 2012 study as a direct follow-up to Monsanto's own 90-day rat feeding study on the same GM maize, carried out in support of regulatory authorization. Statistically significant changes were found in the GM-fed rats, but the Monsanto authors claimed they were not biologically relevant.[15] The European Food Safety Authority (EFSA) agreed,[16] though biological relevance with respect to changes in GM-fed animals has never been defined.

Séralini's team obtained Monsanto's raw data, which had been kept hidden under commercial confidentiality agreements with regulators. The team's re-analysis, published in 2009, concluded that the data revealed signs of liver and kidney toxicity in the GM-fed rats. GM-fed rats showed increased liver weights and urine creatinine clearance, together with a reduction in blood creatinine and a decrease in blood urea nitrogen.[17]

Séralini's team decided to find out whether the initial signs of toxicity seen in Monsanto's 90-day study were biologically irrelevant, as Monsanto and EFSA claimed, or whether over time they might develop into serious pathology. They replicated Monsanto's study design but extended the length from 90 days to two years. The results were alarming. Signs of toxicity found in the 90-day study developed into severe organ damage, tumours, and premature death.[3] These effects had not shown up in Monsanto's 90-day test[15] because it was too short: the first tumour in Séralini's experiment only appeared four months into the experiment.[3]

Séralini's findings revealed that industry and regulatory claims of biological irrelevance of effects found in 90-day tests are invalid. They showed further that the regulatory system for GM foods is inadequate and cast into question the safety of all commercialized GM foods. Criticisms by some regulatory agencies of Séralini's findings[18,19] should be viewed with this fact in mind.

Safety testing and regulatory oversight

The rat feeding studies typically performed in support of regulatory authorizations for GMOs last for a maximum of 90 days, a sub-chronic period equivalent to only 7–9 years in a human.[20] The studies are designed and conducted by the same company that wishes to commercialize the GMO.

The US regulatory system is even weaker. The US food regulatory agency, the Food and Drug Administration (FDA), does not require safety tests at all. Nor does it require labelling for GM foods because it assumes that they are substantially equivalent to non-GM foods and Generally Recognised As Safe (GRAS).[21,22] Substantial equivalence has never been scientifically or legally defined.[23] GM foods cannot accurately be termed GRAS,[24] since GRAS status requires a scientific consensus of safety based on data, and no such consensus exists with relation to GM foods. The FDA allowed the first GM foods to be released onto world markets in spite of warnings by its own scientists that genetic engineering is different from conventional breeding and poses special risks, including the production of new toxins or allergens.[25,26,27,28,29,30]

No consensus of safety has emerged since. Reviews of the literature show that studies funded or carried out by the GM industry, or in which funding is undisclosed, tend to conclude safety, whereas studies carried out by scientists independent of industry are more likely to find hazards.[31,32,33]

What is the problem with GM foods?

The genetic engineering process is inherently imprecise and causes widespread disruption to the genome, which can lead to unintended effects. These can include the creation of novel toxins or allergens or altered nutrient value.[22,34,35,36]

A study on the GM insecticidal maize MON810 showed that its proteins were altered compared with those in the non-GM variety. Unexpected changes included the appearance of a new form of the protein zein, a known allergen that was not present in the non-GM variety.

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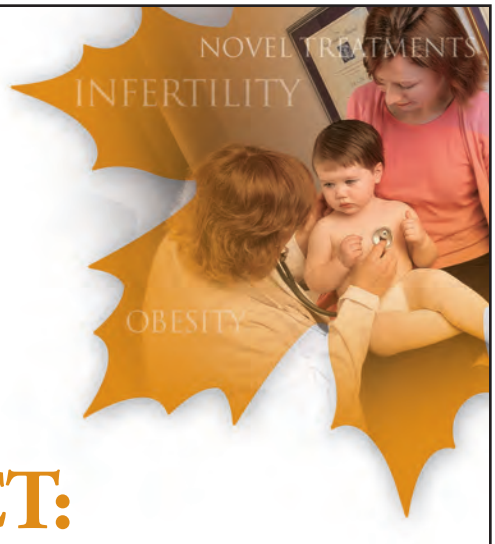

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Other proteins were present in both their natural forms and in truncated and lower molecular mass forms.[37] These findings suggest disruptions in gene structure and function in this GM crop.

Another study showed that Monsanto's GM herbicide-tolerant soy had 27% higher levels of an allergen and anti-nutrient, trypsin-inhibitor, than the non-GM parent variety.[38]

Overview of animal feeding studies with GM foods

A review of animal feeding studies with GM crops concluded that they cause toxic effects such as hepatic, pancreatic, renal, or reproductive effects and may alter the hematological, biochemical, and immunologic parameters (details in the sections below). The authors added that most of the studies were too short to enable the full range of toxic effects to be evaluated and called for long-term toxicity studies on GM foods before commercialization.[31]

A review of 19 animal feeding studies (including those of industry) on GM soy and maize found that GM-fed animals showed signs of toxicity. Rats fed GM Bt maize over three generations showed histopathological changes in the liver and kidneys, including congestion, cell nucleus border changes, and severe granular degeneration in the liver. Rats fed GM Bt maize for 90 days had a significantly lower albumin/globulin ratio, indicating a change in hepatic metabolism. The review authors noted that such effects may be markers of the onset of chronic disease, but that long-term studies would be required to assess this more thoroughly.[39]

The need for long-term safety testing of GM foods was highlighted by the French food safety agency ANSES, which is responsible for national authorizations of GMOs in France, in its criticism[40] of Séralini's study.[3] ANSES's literature search turned up only two long-term studies examining the health effects of GM foods.[40] One is only available in Japanese.[41] The other found problems. Mice fed GM soy over a 24-month period showed changes in the expression of proteins relating to hepatocyte metabolism, stress response, and calcium signaling, indicating more acute signs of ageing in the liver.[42]

A review of studies on GM foods by Snell et al (2011) concluded that they are safe,[43] but this cannot be justified from the data presented. Some of the studies examined did not look at health effects, but focused on parameters of interest to food producers, such as feed conversion in livestock. Some studies found toxic effects but these were dismissed as not biologically relevant, either by the authors of the original studies or by the authors of the review. Also, the review authors applied double standards, in that they accepted conclusions of safety at face value yet dismissed findings of risk on the grounds of methodological weaknesses. These weaknesses were, however, common to studies finding safety and those finding risk, as admitted by the review authors.

Studies on GM insecticidal crops

Most GM insecticidal crops are engineered to express a GM form of the Bt insecticidal toxin, derived from the from the naturally occurring soil bacterium *Bacillus thuringiensis*. GM Bt crops were commercialized on the basis of the assumption that the Bt toxin expressed in GM plants is the same as the 'wild' Bt toxin used as a biological pesticide by conventional and organic farmers. But this assumption is false.[39,44] The Bt toxins in GM plants are truncated or otherwise modified. There is at least a 40% difference between the toxin in Bt176 maize and natural Bt toxin.[39]

Such differences mean that humans and animals that eat Bt crops are eating an insecticide with no history of safe use in food.[44,45] Indeed, Bt176 maize was withdrawn by the developer Syngenta in the wake of accusations that it caused illness and deaths in cows,[46] though Syngenta denied the allegations.[47]

Another false assumption underpinning the release of GM Bt crops is that the toxin is broken down harmlessly in the digestive tract. Bt toxin from GM crops can survive the digestive process, as shown *in vitro* and *in vivo*.[48,49] Bt toxin protein has been detected in the blood of pregnant women (range of 0 to 1.50 ng/mL) and in the blood supply to their fetuses.[50] It is not known if the Bt toxin was of GM origin, if the protein was intact or fragmented, or if this dose could cause illness in humans. However, even fragments of a protein could cause allergies, autoimmune disorders and chronic disease,[51] and the onus is not on the public to prove that GM crops cause harm, but on industry to prove that they are safe prior to release. It is clear that the most basic safety tests were not done.

Weaning and old mice fed GM Bt maize for periods of 30 and 90 days respectively showed a disturbance in intestinal and peripheral immune response, namely alterations in the percentage of T and B cells and of CD4+, CD8+, γδT, and αβT lymphocytes. An increase of serum cytokines IL-6, IL-13, IL-12p70, and MIP-1β after Bt maize feeding was also found, an effect associated with allergic and inflammatory responses.[52] GM Bt potatoes caused the disruption, multinucleation, swelling, and increased degradation of ileal surface cells in rats fed over a two-week period.[53]

Laboratory studies in mice found that GM Bt toxin produces a potent immune response when administered intragastrically or by intraperitoneal immunization.[54,55] The Bt toxin protein was found to bind to the mucosal surface of the small intestine of the mice, which the authors said could lead to changes in the physiological status of the animals' intestine.[56] The Bt toxin protein also enhanced the immune response of the mice to other substances.[57]

GM peas engineered to contain a different insecticidal protein (α-amylase inhibitor) found that the insecticidal protein acted as a sensitizer in mice, prompting the mice to develop immune reactions to a protein from eggs. This is called immunological cross-priming.[58]

Recent attempts[59,60] to claim that a new study[61] resolves concerns raised by the first study[58] are unfounded, as it used a different methodology. In the first study, the mice were fed intragastrically, an approximation of human dietary exposure, and then tested for allergic reaction.[58] In the new study, mice were first intraperitoneally or intranasally immunized with the GM and non-GM test proteins, then fed intragastrically with GM peas and

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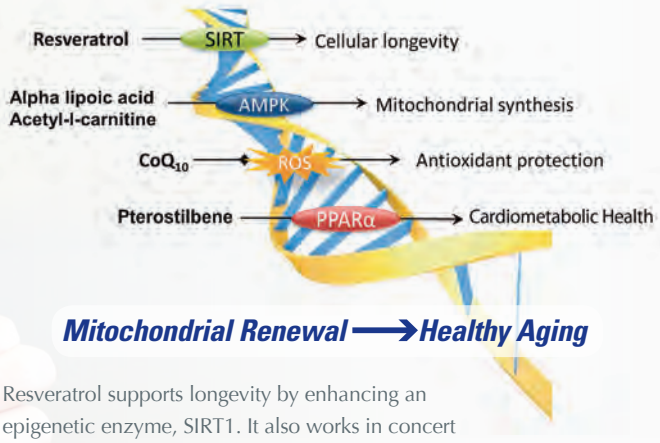

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non-GM beans containing the proteins, and then tested for allergic sensitization. The result: both GM peas and non-GM beans were found to be equally allergenic.[61] A question could be asked as to whether the initial immunization – not the usual way a human is exposed to food – was a predictable way to sensitize the mice to any food.

An *in vitro* test confirmed that Bt toxin proteins in GM crops are not inert in human cells. The Bt toxin protein Cry1Ab caused cell death in human embryonic kidney cells from 100 ppm.[45]

Studies on GM Roundup-tolerant soy

Mice fed GM soy showed changes in the constituents of pancreatic acinar cells and in the synthesis and processing of zymogen (an enzyme precursor), compared with controls fed non-GM soy.[62,63] The GM soy-fed mice had markedly reduced pancreatic levels of the enzyme α-amylase, which helps break down starch into sugars.[63]

A multigenerational study in rats found decreased weight, increased mortality, and decreased fertility in rats fed GM Roundup-tolerant soy.[64,65] The Russian researcher who carried out the study found her work subjected to a highly irregular review process in the pages of a scientific journal.[66] Whereas the review process was condemned in some media outlets,[67,68,69] her findings were never followed up.

GM Roundup-tolerant soy will necessarily contain elevated levels of Roundup herbicide. Far from being benign, Roundup has been linked in laboratory and epidemiological studies and clinical reports to serious health effects, including endocrine disruption, DNA damage, birth defects, cancer, and neurological disorders. Some toxic effects have been found at low doses comparable to those found in food and feed crops and drinking water.[3,70,71,72,73]

Case studies and treatments

Given the absence of epidemiological data on the effects of consuming GM foods, one of the best sources of information may be clinical case studies.

One case study involves a boy living in the US. He was eight years old in March 2012, when he began suffering severe gastrointestinal pain after eating. He was constipated and had blood in his stool. Tests for celiac disease proved negative. In October 2012 the boy's mother heard about GM foods and removed them from his diet. She also gave him a preservative-free probiotic. Within weeks, the gastrointestinal symptoms vanished. To date the boy remains healthy and symptom-free.[74]

Other case studies are presented in the documentary film, *Genetic Roulette: The Gamble of Our Lives*.[75] The film and its director are subject to the usual attacks directed at critics of GMOs, so members of the public are encouraged to reach their own conclusions. According to practitioners and patients interviewed in the film, symptoms that can improve or disappear when GM foods are removed from the diet include gastrointestinal disorders, food intolerances and allergies, immune responses, and asthma. Speed of recovery varies but full results are typically seen within six weeks.[75] Farmers interviewed in the film[75] and other media outlets[76] have reported improvements in the health of livestock after changing their diet from GM to non-GM, notably in gastrointestinal disorders, reproductive problems, and birth defects.

Conclusion

The evidence supports the American Academy of Environmental Medicine's (AAEM) statement on GM foods, which notes that they have not been properly tested for human consumption but that animal studies offer "ample evidence of probable harm". The AAEM recommends that physicians prescribe non-GM diets to patients.[77]

In practice this means avoiding processed foods and foods subject to genetic modification, including derivatives like maize starch and oils derived from GM soy and canola. Whole and organically grown foods cooked from scratch should be favored, as organic production excludes GM seeds and many synthetic pesticides. Probiotics and measures aimed at ameliorating leaky gut syndrome, such as minimizing intake of sugar and refined foods, may also be helpful.

Non-GMO shopping guides and mobile phone apps are available, and shoppers can seek foods carrying organic and "Non-GMO Project Verified" labels.

About the Author

Claire Robinson is research director at the food sustainability and science policy nonprofit Earth Open Source; co-author of the report GMO Myths and Truths (Earth Open Source 2012: http://bit.ly/ZILXBd); editor of GMOSeralini.org; and an editor at GMWatch.org.

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Improving Indoor Air Quality: A Call to Action

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The World Health Organization has stated that outdoor air pollution accounts for 1.3 million deaths worldwide every year.[1] In examining the WHO listing of the leading causes of death (Table 1) it is apparent that deaths from outdoor air pollutants come in just between tuberculosis and diabetes mellitus.[2]

However, numerous studies continue to demonstrate that when air pollution levels rise, deaths from heart disease (#1 on this list) and respiratory problems (#4 on the list) correspondingly increase. When the impact/influence of air pollutants to these other causes of death is taken into account, the staggering reality of the contribution of air pollutants to morbidity and mortality would be revealed.

TABLE 1
Global deaths due to various conditions

World	Deaths in millions	% of Deaths
Ischemic heart disease	7.25	12.8%
Stroke (CVAs)	6.15	1.8%
Lower resp infxn	3.46	6.1%
COPD	3.28	5.8%
Diarrheal diseases	2.46	4.3%
HIV/AIDS	1.78	3.1%
Resp tract cancers	1.39	2.4%
Tuberculosis	1.34	2.4%
Diabetes Mellitus	1.26	2.2%
Traffic accidents	1.21	2.1%

http://www.who.int/mediacentre/factsheets/fs310/en/

Studies from around the globe reflect the reality that when urban air pollution rates rise, the hospitals in those cities see more cases of respiratory and ischemic heart disease deaths than at times of lower pollution.[3,4,5,6] Although the aim of this article is to discuss indoor air pollution, the simple reality is that the air inside of our homes originates from the outside. The addition of various toxicants from items inside the home are added to the pollutants coming into the home with the "fresh air" (from outside), making indoor air more contaminated than outdoor air.

In 1985, the Total Exposure Assessment Methodology (TEAM) study by the Environmental Protection Agency (EPA) changed the way indoor air quality (IAQ) was viewed. This study showed that the greatest personal exposure to levels of volatile organic compounds (VOCs), originated within the home and not from outside air as had previously been thought.[7,8] This study looked for the presence of 20 different VOCs in indoor air, outdoor air, breath and "personal air"(defined as the air that a person is exposed to) in a study sample of 355 persons in Elizabeth and Bayonne, New Jersey over a three-month timespan. Since both of these cities have numerous chemical plants in the area it could be assumed that outdoor chemicals contaminants would have contributed to the majority of indoor air pollutants, however the study concluded this not to be the case.

The subjects' "personal air" was collected by attaching sampling cartridges to their clothing. Personal air samples revealed very high exposure levels to 11 VOCs (Table 2). The levels were much higher than would have been predicted by outdoor air concentrations, with levels at times exceeding 10 times the concentration of VOCs in the outdoor air. The major source of these "personal exposures" came from indoor air, which showed much higher levels of VOCs, especially at night, than what was measurable in the back yard of the same home in the same time frame. In addition to measuring toxicants in the "personal air", the researchers also measured toxicants in breath samples to measure the amount of toxins exhaled by the subjects.

Dichlorobenzene (from mothballs and deodorants), styrene (from plastics, foam rubber, cigarette smoke, and insulation), tetrachloroethylene (from dry cleaning), vinylidene chloride, styrene, and xylene (from cigarette smoke and paints), and benzene, ethylbenzene and xylene (from cigarette smoke and gasoline) were all commonly detected in the breath samples. It was noted that higher levels of benzene, xylene and tetrachloroethylene were also recorded in personal sample cartridges after the study subjects frequented a gas station or dry cleaners. Not surprisingly, levels were also higher in smokers, than in non-smokers.

TABLE 2
The Volatile Organic Compounds Found Consistently in Breath Samples in the TEAM Study

Chloroform	Styrene
1,1,1-Trichloroethane	m,p-Dichlorobenzene
Benzene	Ethylbenzene
Carbon Tetrachloride	o-Xylene
Trichloroethylene	m,p-Xylene
Tetrachloroethylene	

The elevated chloroform levels detected were attributed to the use of water-disinfectants in the water supply. A 2001 study in Texas examined serum levels of trihalomethanes (chloroform, bromodichloromethane, dibromochloromethane, and bromoform) from water disinfectant treatment in a sample of women. The highest serum levels of trihalomethanes were detected when the blood sample was taken soon after showering.[9]

The Three Greatest Indoor Air Pollutants: Mold, Tobacco Smoke and Carpeting

Mold

The indoor air pollutant that most commonly causes health problems is mold. Mold can be present both from ongoing sources of moisture and as the result of one-time flooding. The most toxic indoor mold is *Stachybotrys charatum*, also known as "Toxic Black Mold". The growth of *Stachybotrys* requires an ongoing moisture source, and therefore it is commonly found in the areas of the house with plumbing present such as laundry rooms, bathrooms, and kitchens. *Stachybotrys* can also be present in basements due to moisture entering through the concrete, or throughout the house from leaks in the roof, window/door sills and casing. Water pipes running through the walls that were punctured during drywall installation are another possible source. *Stachybotrys* overgrowth has also been found in laundry areas due to improper dryer venting, allowing for a continuous source of moisture.

Stachybotrys produces toxins/microbial VOCs that have been associated with increased rates of allergy and asthma, respiratory, immunological and neurologic problems.[10] The common presentation of persons exposed to *Stachybotrys* includes headache, memory loss, hearing loss, lack of concentration, fatigue, sleep disturbance, facial swelling, rashes, nosebleeds, diarrhea, abdominal pains and respiratory difficulties.[11]

One of the most common indoor mold contaminants from a one-time "flood" (ie: overflow of sink, tub, toilet, broken water heater, severe rainstorm, etc.) is *Penicillium*. *Penicillium* is the most common mycotoxin to be associated with "sick building syndrome", (with *Stachybotrys* being the second most common cause) and the spores of both *Penicillium* and *Stachybotrys* can stay present in a home long after the moisture source has ceased.[12]

TABLE 3
Activities associated with higher personal exposure and breath levels

Smoking	Benzene, xylene, styrene, ethylbenzene
Visiting the service station	Benzene
Driving	Benzene
Visiting the Dry Cleaner	Tetrachloroethylene
Working in a chemical plant	Ethylbenzene, styrene, xylene
Working as a painter	Ethylbenzene, styrene, xylene
Working with plastics	Ethylbenzene, styrene, xylene

TABLE 4
Home products and personal exposure and breath levels

Moth balls, deodorants	Paradichlorobenzene
Plastics, foam rubber	Styrene
Insulation	Styrene
Dry cleaning	Tetrachloroethylene
Paints	Vinylidene chloride, styrene, xylene
Gasoline	Benzene, Ethylbenzene, xylene
Tap water	Chloroform, Bromodichloromethane
Smoking	Benzene (double of non-smokers),styrene

While indoor air purifiers can help remove these spores from the indoor air, complete removal of the contaminated building materials and remediation of the cause of moisture presence are the two critical steps in clearing the mold presence.

Environmental Tobacco Smoke (ETS)

ETS is a common, primary indoor air pollutant that is fairly easily remediated. The previously mentioned TEAM study found that cigarette smoke is the primary cause of high levels of benzene and styrene in indoor air, and a recent study concluded that cigarette smoke is the primary source of childhood lead exposure.[13] Benzene, a known carcinogen, is just one of the many carcinogens in cigarette smoke.[14,15] Exposure to ETS has been linked to increased rates of lung cancer for non-smoking spouses.[16,17,18] These data have indicated that smokers who were exposed to ETS as children and who continued to smoke as adults had higher rates of lung cancer. Another study indicated that maternal, but not paternal smoking, increased lung cancer risk for children raised in the home in their later years. However a large multicenter European study failed to confirm this.[19] Childhood ETS exposure has been repeatedly linked to respiratory problems including higher rates of asthma[20] (odd ratio [OR] 1.4) and respiratory infection (OR 1.32 for lower exposure levels and 1.74 for higher exposure levels).[21] When ETS exposure occurred in children who already had evident allergies the odds ratio for acute respiratory infections jumped to 3.39.

ETS exposure in pregnant women appears to be a factor in delivering babies with low birth weight. Smoking mothers have an OR of 4.2 for delivering babies "small-for-gestational-age". Non-smoking mothers who are exposed for ETS have an OR of 2.1.[22] Paternal cigarette use was also shown to reduce birth-weight by 120g per pack of cigarettes smoked per day. Indoor tobacco smoke has also been linked to increased allergic reactivity in children. A German study of 3-year-old children revealed that those who were exposed to cigarette smoke both pre and postnatally had significantly higher risks of food allergen sensitization than unexposed children, with an OR of 2.3.[23] Those who were exposed only postnatally had an OR of 2.2, showing that post-natal exposure carried the greatest risk for allergic sensitization in children.[24] ETS exposure has also been implicated in leading to an increased risk of ischemic heart disease.[25]

Carpeting

Indoor carpeting can be a significant source of VOC emissions and the retention of pesticide residues inside a home or office. When the Unites States Environmental Protection Agency (EPA) investigated the cause of their employees' severe health problems after moving into their new headquarters in 1988, they found that these health issued were directly related to elevated levels of VOCs in the indoor air. Further investigation revealed that the main source of the elevated VOCs was the newly installed carpet. A partial list of chemicals present in carpeting is presented in Table 5 and it is evident that some of these chemicals are the same as those found to be elevated in the TEAM study. Many of the compounds including 4-phenylcyclohexene, trichloroethylene (TCE), benzene, xylene, toluene, styrene, the methylbenzenes, are known neurotoxins. Because carpeting can have a neurotoxic effect via the emission of these compounds, Anderson Labs[26] began testing the carpets to determine the effects of VOCs on the immune system. In their experiment, they exposed mice to air that was blown over carpet samples, and recorded the effect on the mice. In testing over 400 samples, they found neurotoxicity present in over 90% of the samples, including some that resulted in death.

TABLE 5
A partial list of chemicals present in carpet[27]

Formaldehyde	Isocyanates
TCE	Diphenyl ether
Toluene	Butadiene
Acetonitrile	Hexadecanol
1-Ethyl-3-methylbenzene	1-H-indene
1,2,4-Trimethylbenzene	Polyacrylates
4-Phenylcyclohexane	Oxarium
2-Butyloctanol-1	Phthalic acid esters
1,3,5-Cycloheptatriene	Xylene
Dodecane	Methacrylic acid
1-Methylnaphthalaene	1-Chloronaphthalene
1-Methyl-4-Tridecene	1,2,3-Trimethylbenzene
Octadecenyl Amine	1-Methyl-3-Propylbenzene
2,3,7-Trimethyldecane	Cyclopentadiene-ethenyl-2-ethylene
Azulene	Undecane, 2,6-Dimethyl
Benzene	1,4-Dihydroxyacenophthene
Methyl methacrylate	Hexamethylene Triamine
Styrene	2-Methylnaphthalene
Ethylzylene	5-Methyltridecane
Biphenyl	Tetradecene

It is important to note that different types of carpet emit different chemicals. Testing of two different rubber-backed carpets (styrene-butadiene rubber) samples showed high emission levels of styrene and 4-phenylcyclohexene (4-PCH), the chemical responsible for the "new carpet odour".[28] The carpet with a polyvinyl chloride (PVC) backing emitted formaldehyde, vinyl acetate, isooctane, 1,2-propanediol, and 2-ethyl-1-hexanol, while the carpet with the polyurethane backing primarily emitted butylated hydroxytoluene.

A 1990 study conducted in Swedish primary schools concluded that there was a strong relationship between "chronic sick building syndrome" and the presence of wall-to-wall carpeting in the schools, a history of atopy and psychosocial factors. Once carpets were removed, or complaining workers relocated to an older building (without the new carpet), the number of reported symptoms showed a statistically significant decline.[29] In a separate study, the same lead author also examined the effect of household compounds on asthma rates and found that among the household items linked to increased asthma rates were wall-to-wall carpeting, formaldehyde, VOCs and CO_2.[30]

The Dust Connection

The majority of indoor air toxins and toxicants readily attach to dust particles, and fabric (e.g., carpet, upholstery, draperies).[30] Old rugs and sofas have more dust, lead, pesticides and mutagenic capability than newer carpets and sofas. Carpeting is a major deposit site for lead in the home maintaining the household lead content despite the use of classic approaches to remediate and releasing lead into the air when walked upon.[31] Soiled upholstery has also been shown to be a source of indoor lead exposures.[32] Household dust is credited to be the carrier for 10-58% of the daily phthalate exposure for U.S. residents.[33] Dust also turns out to be a major source vector of daily exposure to the organophosphate pesticides and brominated flame retardants that are now found in virtually all persons in North America.[34, 35]

Steps to take to reduce the toxicant levels in our indoor air

The first step in the environmental medicine approach and treatment is always the AVOIDANCE of toxins and toxicant exposures. This embodies the naturopathic principle of prevention. In the case of indoor air quality, the source(s) of indoor air pollution should be identified, and this can be accomplished by using a simple questionnaire (Table 6) with patients.

After identifying areas of concern, steps can then be taken to remove or reduce the release of toxicants in the home.

The next step is to utilize proper furnace filters in the home heating, ventilating and air conditioning system (HVAC). Most HVAC systems are designed to handle a Minimum Efficiency Rating Value (MERV) of 7. MERV 7 filters are pleated fabric filters that clear up to 35% of particulate matter (between 3 – 10 um in size) from the home air, a critical step in reducing the level of pollutants in the air. The low cost, commonly used filters are easy

TABLE 6
Questionnaire to identify source(s) of indoor air pollution

	YES	NO
Musty smells (need to identify the source of the smell to eliminate the smell)		
History of water damage		
Visible mold		
Wall-to-wall carpeting		
Smoking (tobacco, food burning, fireplace) indoors		
Use of air fresheners		
Dry cleaning		
Fragrances in the home		
Scented laundry supplies		
Antimicrobial surfaces		
Chlorinated water		
Shoes worn indoors		
Attached garage		
Natural gas appliances		
Pets in the home		
Use of cheapest furnace filters (they look like spun fiberglass rather than pleated fabric)		
Ozone generator in home		
New cabinetry in the home		
New furniture in the home		

to identify: they do not have pleated fabric, but instead look like spun fiberglass. These have a MERV rating of 4 and filter only 20% of the particles larger than 10 um from the air, and clearing out nothing below 10 um in size.

Once these measures are in place the next step would be to obtain a high-quality air purifier for the home, as these dramatically reduce the exposure to indoor air pollutants. While the use of MERV 7 furnace filters are an important first step, HVAC systems do not have the capacity to force all the indoor air through filters small enough to remove the majority of toxicants from the air (fine and ultrafine particulate matter that is less than 10 um in size), which is why high-quality home air purifier systems are needed. Passive air purifiers (stand alone units) do not have a fan to force air through a set of filters, and are therefore are not effective. A study conducted in Southern California schools compared the air-cleaning powers of furnace filters, passive air purifiers and high-quality panel filters.[36] The results showed that the combination of good furnace filters and high-quality panel filters were able to clear out 87% of ultrafine particles (less than 2.5 um, such as diesel exhaust particles) and 96% of fine particles (PM 2.5 um or larger, such as vehicular exhaust and plasticizers), the two most damaging of the outdoor air pollutants. The high-quality panel filters alone were also very effective, but not as good as the combination.

The benefits of indoor air purifiers cannot be emphasized enough. While moving to an area with lower outdoor air pollution would be the best solution for many, that option is rarely available. Instead, one can choose to improve the quality of their indoor air and reduce their exposure during the hours that they are at home and/or at work. The health benefits will far outweigh the cost of a quality air purifier (the two best models on the market right now are averaging about $1,000.00).

About the Author

Walter J. Crinnion, ND received his degree in Naturopathic Medicine from Bastyr University in Seattle, Washington in 1982 with their first graduating class. He then opened a family practice and began to specialize in allergies and in treating chronic health problems caused by environmental chemical overload. In 1985 he opened the most comprehensive cleansing facility in North America for the treatment of chemically poisoned individuals.

He is a favorite and frequent lecturer at both Naturopathic and Allopathic medical conferences. He has published several articles in peer-reviewed journals on the topic of environmental overload. He has been on the board of directors of the American Association of Naturopathic Physicians and was the recipient of their first award for in-office research in 1999 and was awarded it a second time in 2002. He has been on the adjunct faculty of Bastyr University (Seattle, WA), the National College of Naturopathic Medicine (Portland, OR), and the University of Bridgeport School of Naturopathic Medicine (Bridgeport, CT). He is a professor at the Southwest College of Naturopathic Medicine (Tempe, AZ) and the chair of their Environmental Medicine Department. In 2001 he appeared three times with Barbara Walters on ABC's "The View". His first book: *Clean, Green and Lean* was published by Wiley and Sons in 2009.

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Canaries in the Coal Mine: Multiple Chemical Sensitivity and Reducing Exposure to Household Environmental Toxicants

Dr. Alexandra Triendl-Dimitriu, ND, and **Adria Vasil**

Whether we live in an urban centre or rural outpost, we carry a body burden of pollutants that can't entirely be avoided. Chemical compounds and environmental toxicants have permeated every corner of the globe, including the confines of our private households. Exposure to scents, solvents, pesticides and plastic softeners can't always be avoided in the world at large but we can reduce exposures in our homes.

For those that develop health concerns such as chemical sensitivities from exposure, eliminating these toxins from their personal environs becomes essential.

Multiple Chemical Sensitivity MCS, also known as chemical intolerance, environmental illness and chemical hypersensitivity,[1] is the body's physiological response to being overexposed to environmental toxicants. These compounds accumulate in the body causing serious metabolic and systemic dysfunctions.[2] Patients with MCS have reported reactions to several classes of chemicals including solvents, pesticides, perfumes, cleaners, formaldehyde and others.[3] As naturopathic doctors we can initiate treatment by supporting the detoxification process, addressing vulnerabilities to chemical build up, replenishing nutrient depletion and educating our patients about minimizing their exposure to xenobiotics.

A summary report regarding the medical evidence for MCS was issued by the Canadian Human Rights Commission in 2007, which recognized environmental sensitivities such as MCS as a disability.[4] MCS is also recognized by Health Canada and The Canadian Center for Occupational Health and Safety. In 2007 in Canada 1.4% of males and 3.4% of females aged 12 and older were diagnosed with MCS[5] though many more reported feeling ill when exposed to common chemicals. Household population studies in the United States have reported prevalence rates of chemical sensitivity between 12.6% and 33%.[6]

MCS can be initiated by one large exposure, continuous low level exposures, or exposure to chemicals from a renovation of a home or workplace.[6] In 1999, a group of 34 researchers and clinicians with experience treating and researching MCS revised a consensus statement supporting the definition of MCS.[7] It includes the following six criteria:

1. The symptoms are reproducible with repeated chemical exposure
2. The condition is chronic
3. Low levels of exposure (lower than previously or commonly tolerated) result in manifestations of the syndrome
4. The symptoms improve or resolve when the incitants are removed
5. Responses occur to multiple chemically unrelated substances
6. Symptoms involve multiple organ systems

Etiology

The mechanism of action of MCS is elusive and poorly understood by the medical community. The introduction of thousands of chemicals into our air, water, food, soil, products and increasing exposure to electromagnetic radiation has led to several theories of the impact these compounds are having on our physiology. Some common theories include:

Immunotoxicity

Many chemicals, including formaldehyde, solvents, hydrocarbons, and organochlorines, have been shown to suppress the immune system.[2] These effects include, a decrease in natural killer cell activity, T-cell effector functions, T-cytotoxic induction, plasma cell responders, phagocytic activity and an increase in mast cell degranulation.[2] Most disturbing is the induction of autoimmunity by chemical exposure.[8] Elevated antibodies - specifically anti-myelin, anti-parietal, anti-smooth muscle and anti-brush border antibodies - have been detected in chemically exposed people.[8]

Elevated Nitric Oxide/Peroxynitrite

This theory proposes that seven classes of chemicals such as organic solvents, organophosphorus, carbamate, organochlorine and pyrethroid pesticides activate N-methyl-D-aspartate (NMDA) receptors in the brain, creating a feedback loop in which both nitric oxide and peroxynitrite are elevated. NMDA receptors are found on cell membrane surfaces in the brain, the peripheral nervous system, the bronchi and gut. When these receptors become sensitized, elevated levels of nitric oxide inhibit cytochrome P450, impairing detoxification. Elevated levels of peroxynitrite increase blood brain permeability allowing chemicals increased access to the central nervous system. This sensitization of NMDA receptors

and subsequent chronic elevation of nitric oxide and peroxynitrite appear to trigger sensitivity reactions in MCS patients.[9]

Airway Inflammation and Neurogenic Inflammation

Research demonstrates that inhaled chemical substances bind to sensory nerve C-fibers in the respiratory mucosa triggering an inflammatory response.[10] Various chemicals cause receptors on sensory nerves to produce substance P and other inflammatory mediators causing myriad respiratory conditions such as asthma and rhinitis. This interaction is separate from an immune-mediated inflammatory response.[10] To explain how other symptoms in MCS like fatigue, headaches and confusion manifest from the interaction between inhaled irritants and respiratory mucosa, researchers have discovered "neurogenic switching," a mechanism by which a sensory impulse is rerouted by the CNS to distant locations causing neurogenic inflammation at other sites.[11]

Limbic kindling/neural sensitization

This model suggests limbic kindling through the olfactory-limbic system.[12] There is a direct pathway from the olfactory bulb into the limbic system that governs emotions, learning, and memory, and regulates cognitive, immune and endocrine functions. It is called "kindling" because kindling refers to the process of sensitizing neural tissue. Some individuals are thought to have been sensitized or "kindled" to low-levels of chemical exposure. In essence individuals with MCS develop a heightened response to chemical exposure by way of the limbic neuronal network.[12]

In the past, researchers have assumed that MCS is of psychogenic origin and have characterized it as a somatoform disorder.[13] This assumption has been critically reviewed and there appears to be no objective evidence of psychogenic etiology for MCS.[14] In fact, in a multi-center cross-sectional survey of MCS patients, 60-70% of MCS patients did not report treatment for depression, anxiety or any kind of adjustment disorders, most reported "good" or "excellent health" throughout the first 30 years of life. However, they did seek psychological treatment secondary to chemical sensitivity.[15]

Symptomatology

MCS presents a wide range of symptoms expressed in multiple organ systems. Although there is no empirically validated symptom profile, headaches, fatigue and cognitive deficits were predominant among MCS patients.[16] Specifically, four neurological symptoms have been attributed to MCS patients from low-level exposure to chemical substances.[17] These four symptoms are as follows: having a stronger sense of smell than most people, feeling "spacey," feeling dull or groggy and having difficulty concentrating.[17] On a broader scale, the most prevalent symptoms reported[16] are presented in Table 1.

Researchers have discovered that many patients diagnosed with MCS also meet the criteria for fibromyalgia and chronic fatigue syndrome.[16] In addition, much overlap has been observed with MCS, asthma and allergies. In fact several co-morbid conditions exist in the MCS population such as arthritis, food allergies, mood disorders, thyroid conditions, bowel disorders, diabetes, cancer and epilepsy to name a few.[18]

TABLE 1
Percentage Prevalence of Symptoms Reported for MCS

Symptom	%*	Symptom	%*
Headache	55	Myalgia	25
Fatigue	51	Nausea	20
Confusion	31	Dizziness	18
Depression	30	Memory problems	14
Shortness of breath	29	Gastrointestinal symptoms	14
Arthralgia	26	Respiratory symptoms	14

* The percentage of MCS patients exhibiting a particular symptom

Diagnosis

Symptoms of MCS are widespread and range from mild to severe. There are no definitive diagnostic tests for MCS.[4] In fact, physical exams and general lab tests reveal unremarkable results in those with MCS.[16] However, a comprehensive case history, ruling out other conditions, following the 1999 case criteria for MCS and administering a validated screening instrument are helpful in reaching a diagnosis. The Environmental Exposure and Sensitivity Inventory (EESI) is an excellent tool for screening, providing a standard approach for measuring chemical sensitivity.[19] The questionnaire contains five self-rating scales including Symptom Severity, Chemical (Inhalant) Intolerances, Other Intolerances (medications, alcohol, food), Life Impact and Masking (measurement of ongoing chemical exposure).[19] A copy of the shorter version of the questionnaire called QEESI or Quick Environmental Exposure and Sensitivity Inventory can be obtained at www.chemicalsensitivityfoundation.org.

Laboratory testing

Since there are no biomarkers for MCS, a prudent approach would be to test for immunotoxicity, allergy, endocrine disruption, as well as liver and kidney function to assess severity of damage.

Many independent laboratories offer environmental pollutant panels. Chemicals and their metabolites can be detected in blood, serum, plasma and urine. These tests primarily assess exposure to parabens, solvents, phthalates, chlorinated pesticides, PCBs, organophosphates, bisphenol A and heavy metals.[20,21] A urinary organic acid test can detect markers for mitochondrial energy production, oxidative damage, amino acid, vitamin and mineral insufficiencies, methylation sufficiency, detoxification sufficiency, neurotransmitter metabolism and dysbiosis.[20] This type of testing can provide greater insight into a patient's cellular metabolic processes allowing the practitioner to tailor individual treatment plans.

Treatment

Naturopathic doctors have the opportunity to provide patient-centered care, by treating the whole person with safe and effective treatments. We can educate our patients to make lifestyle changes and support them and teach them strategies on how to cope with their disturbing symptoms during the healing process.
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Gut Inflammation/Hyperpermeability

An elimination diet identifying food sensitivities and any other digestive issues that should be treated.

Detoxification

Supplements that aid Phase 1 biotransformation:
B-vitamins are vital for the cyclooxygenase systems, especially pyridoxine, niacin, thiamine, riboflavin and choline.[22] Magnesium, selenium, vitamin C and E are also essential.[22]

Supplements aiding Phase 2 biotransforamation:
The amino acids vital for conjugation are glycine, glutamine and taurine. Taurine is important because it also aids in the sulfation pathway.[22]

Additional supplements that help maintain glutathione levels include: alpha lipoic acid, N-acetylcysteine and milk thistle.

Diet

Encourage patients to eat cruciferous vegetables, high in indole-3-carbinol, which helps liver detoxification.[22] These vegetables include broccoli, brussel sprouts, cabbage and cauliflower to name a few. Whey protein helps increase glutathione levels thereby aiding liver detoxification. A high protein, low carbohydrate diet has been shown to increase clearance of toxicants from the body.[22]

Physical Therapy

Researchers have discovered that infra red sauna treatments can increase solvent clearance from the blood.[23] Contrast hydrotherapy and dry skin brushing help detoxification by improving circulation and lymphatic drainage.[24] Castor oil packs placed over the liver can reduce inflammation, increase circulation, lymphatic flow and help eliminate toxins.[25]

Choosing Healthier Household Products

As committed as increasing numbers of Canadians may be to picking greener cleaners or choosing organic produce, a variety of pollutants still make their way into our homes via our couches, taps, electronics, building materials, and even the dirt we drag in on the bottom of our shoes. Some, like fragrance and the ethanolomines in cleaning products, hang in the air. Many end up settling into household dust – compounds such as flame retardants and plastic-softening phthalates. Others come in via the water we drink. How can you help your patients minimize exposure to household pollutants that may compromise their health? Some steps you may suggest are small yet surprisingly effective, like having a 'no shoes in the house' rule or opting for VOC-free paint. Others involve a bit more financial investment, such as purchasing a quality HEPA vacuum cleaner and choosing low-emitting renovation materials (ie cabinets with no added formaldehyde). The following is a break down of 12 common household pollutants, where they can be found in the home and some suggestions for healthier alternatives.

TABLE 2
Twelve Common household pollutants and how to avoid them

Household Pollutant: FRAGRANCE

Potential health impacts	Where it's lurking	Healthier Alternatives
The term "fragrance" can cloak the usage of dozens, even hundreds of ingredients, including many hormone disruptors (such as phthalates) and sensitizers (i.e. over 100 volatile organic compounds).[26, 27] May trigger headaches, wheezing, airway irritation, worsening asthma, contact dermatitis, mucosal irritation, nausea, dizziness, fatigue[28, 29]	Synthetic fragrance can be found in cleaning products (even greener cleaners like Method), fabric softener/laundry soap, air fresheners/deodorizers, scented candles, home fragrance oils, personal care products	- Look for unscented* cleaners, laundry products and personal care products by brands like Dr. Bronner's and Nature Clean - Replace fabric softener with 1 cup of vinegar in rinse cycle and PVC-free dryer balls, reusable static eliminating sheets or hang dry - Burn unscented candles, preferably beeswax or soy Note that essential oils and essential oil-derived ingredients like linalool also contain irritating volatile organic compounds that may be sensitizing. *Even products listed as unscented can have masking fragrances.

Household Pollutant: ETHANOLAMINES (MONO-, DI- AND TRIETHANOLAMINE; 2-AMINOETHANOL)

Potential health impacts	Where it's lurking	Healthier Alternatives
Corrosive; may cause skin irritation; severe skin burns/eye damage in concentrations found in oven cleaners/drain openers; lung irritant at higher concentrations.[32, 33]	Extremely common in conventional all purpose cleaners, glass cleaners, fabric refresher, disinfectants, shower cleaners, laundry detergent, oven cleaners, drain openers	- Health store cleaning brands do not contain ethanolamines. - Use vinegar and water for all purpose cleaning; sprinkle baking soda as a scouring agent and a little lemon juice as a degreaser - Make your own detergent with ½ cup of soap nuts and 2 cups of boiling water, simmer - Microfibre cleaning cloths like Blue Wonder are favoured by the chemically sensitive because they can be used with plain water; no cleaning products necessary.

Household Pollutant: RADON

Potential health impacts	Where it's lurking	Healthier Alternatives
A radioactive gas that increases risk of developing lung cancer[66]	Basements, granite counters, thanks to the uranium naturally present in rock	- Those living in basement apartments or those that spend more than four hours a day in lower level rec rooms should consider getting home tested for radon, particularly if they are smokers since radon compounds the risk of lung cancer. Granite counters can be tested as well. - Seal cracks in foundation - Increase ventilation

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Household Pollutant: FORMALDEHYDE

Potential health impacts	Where it's lurking	Healthier Alternatives
One of the most common VOCs (volatile organic compounds) and a known human carcingen.[34] Exposure may trigger eyes/ nose/throat irritation, coughing, wheezing, increased incidence of asthma[35, 36]	Main source of exposure in homes is generally particle board/ plywood/compressed wood cabinets/furnishing/flooring (including parquet, bamboo flooring bound with urea formaldehyde glues). Other sources include permanent press curtains/textiles, smoke from fireplaces/ wood stoves, candles, paints, varnish, adhesives, air fresheners, cigarette smoke, and improperly vented gas stove/kerosene heaters. In pre-1980 homes, wet/deteriorating urea formaldehyde-based insulation can be a concern. Note: it can takes weeks, months, years for formaldehyde to offgas.[37, 38, 39]	- Look for flooring/ cabinets/ furniture that is either solid wood, zero formaldehyde, certified 'no added formaldehyde' or made with 'ultra low-emitting formaldehyde'. - A product like *AFM Safecoat Safe Seal* can be applied to porous wooden surfaces to reduce offgassing. - Stick to VOC-free paint, adhesives. - Ensure chimneys are well-maintained.

Household Pollutant: SOLVENTS (BENZENE, TOLUENE, HEXANE, ACETONE, XYLENE, STYRENE, PERCHLOROETHYLENE AKA PERC)

Potential health impacts	Where it's lurking	Healthier Alternatives
Diverse group of chemical dissolvers that may trigger dizziness, confusion, fatigue, headache, nausea, rashes, shortness of breath, memory and hearing loss, depression, cancer (benzene is a known carcinogen, perc and styrene are likely human carcinogens)[40]	Dry cleaned items (release low levels of perc into air), cleaning products, paint (particularly oil paint), paint stripper/thinner, carpeting, carpet glues, paraffin candles, synthetic air freshener, adhesives.	- Look for perc-free dry cleaners using wet cleaning method. - Ask about Green Label Plus carpet and carpet adhesive certification - Look for paint stripper free of methylene chloride like Soy Gel or homemade paste of washing soda and water - Use cleaner-burning beeswax or soy candles rather than paraffin - Purchase VOC-free paints and adhesives

Household Pollutant: PHTHALATES

Potential health impacts	Where it's lurking	Healthier Alternatives
Family of, by and large, plasticizers, several of which are considered reproductive and developmental toxins,[52, 53] as such six phthalates have been restricted in children's toys in Canada. Four are being banned from all consumer goods (with the exception of outdoor products) in Denmark.	Used to soften vinyl/ PVC plastic and prolong synthetic scents. Found in vinyl flooring/wallpaper/ countertops, synthetic leather furniture/apparel, shower curtains, older toys, mouthguards, varnish, vinyl diaper covers, squishy PVC sandals, vinyl school supplies (erasers, binders, backpacks) as well as MMA-containing acrylic retainers and dentures and some enteric-coated medication (drugs such as Asacol and a number of probiotics have tested positive[54]).	- Look for vinyl-free flooring, cabinets, counters countertops - Opt for grasscloth or paper-based wallpaper rather than vinyl-base - Inquire about PVC- / MMA-free dental appliances - Use wool, fleece or other PVC-free diaper covers - Search for sandals made of cork, leather, EVA - Use unscented household and bodycare products

Household Pollutant: FLAME RETARDANTS (PDBES AND TDCPP, AKA CHLORINATED TRIS)

Potential health impacts	Where it's lurking	Healthier Alternatives
PBDEs are a partly banned family of brominated flame retardants linked to neurological, behavioural, reproductive, liver, thryoid damage.[41] Chlorinated tris are listed in California as known carcinogens and must come with a cancer warning. Early evidence on newer brominated Firemaster 550 documents its endocrine disrupting properites.[42]	Upholstered furniture (ie sofas), curtains, electronics, household dust, carpet padding, fatty foods (flame retardants accumulate in fat of meat, fish, dairy, and some vegetable oils such as peanut butter).[43] One 2011 study found over 1/3 of children's products such as change pads, baby carriers, high chairs, contained chlorinated tris.[44]	- Wet mop and dust regularly with damp cloth - Vacuum with a quality HEPA vacuum cleaner (see allergyconsumerreview.com for buying tips) - Purchase PBDE-free electronics (Nokia, Apple, LG and Samsung are now free of brominated flame retardants)[45] - Today's upholstered furniture is largely PBDE-free, using chlorinated tris and Firemaster 550 instead[46]; alternatives include latex and wool stuffed furniture; Ikea furniture is free of chlorinated tris and brominated compounds - Wool is naturally flame-retardant - Minimize high fat animal products; choose leaner dairy/meat products

Household Pollutant: PESTICIDES

Potential health impacts	Where it's lurking	Healthier Alternatives
Low level exposure to organophosphate (OP) pesticides is associated with impaired cognitive function[47] and with ADHD in children.[48] Inhaling pyrethrins can cause wheezing, coughing, shortness of breath, chest pain and blisters[49]	Trace pesticide residues are found on conventional produce. Long banned pesticides such as PCBs and DDT can still be found in household dust and carpets (PCB wood floor finish was common in 1950s and 60s[50]). Glycophosphate (Roundup), 2,4-D (Weed-B- Gon, Killex) and pyrethrins are banned in one or more Canadian provinces but still available elsewhere. While chrysanthemum-based pyrethrin (a neurotoxin) is banned from backyard pesticides in Ontario, it's still available for indoor pest control, including flea shampoos.	- Eat certified organic foods (organic diet found to provide immediate protective effect against exposure to OP pesticides)[51] - Mix 1 tbsp of natural dishsoap in 1 litre of water for use as all-purpose pesticide spray - Release beneficial nematodes (microscopic worms) to chow down on certain grubs, weevils and beetles - Add weed-inhibiting corn gluten fertilizer to your lawn and pour boiling water or vinegar on sidewalk weeds.

Household Pollutant: BLEACH (SODIUM HYPOCHLORITE)

Potential health impacts	Where it's lurking	Healthier Alternatives
Corrosive; can cause severe irritation/damage to skin and eyes. Vapour may trigger wheezing, shortness of breath[30] higher exposure may aggravate chronic respiratory problems and heart conditions[31]	Liquid bleach, toilet bowl cleaners, laundry products, bathroom cleaners, all purpose cleaners	The most potent natural disinfectants are thyme oil-based household disinfectants (killing 99.99% of bacteria, fungus and influenza A; available at health stores). -Hydrogen peroxide and vinegar also reduce bacteria counts.

Household Pollutant: LEAD

Potential health impacts	Where it's lurking	Healthier Alternatives
Neurotoxin to which exposure may lead to memory loss, fatigue, headaches, changes in mood, lower IQ, decreased dexterity, fertility problems and future risk of osteoporosis in exposed children.[62]	Water pipes (lead was permitted, nationally, in pipes until 1975 and in solder until 1986), dust/flakes/chips from household paint in older homes (interior paint could contain lead until 1976, exterior paint, 1991[63]), cheap children's jewellery, older toys, lead crystalware, lead-glazed ceramics, contaminated soil, PVC horizontal mini blinds pre-1996.	- Install a water filter, keeping in mind that pitcher filters are not certified to reduce lead - Test old paint for lead before sanding/renovating; - Paint or drywall over lead paint, or cover with vinyl-free wallpaper - Test glazed ceramics, blinds, jewellery with LeadCheck Swabs

Household Pollutant: MERCURY

Potential health impacts	Where it's lurking	Healthier Alternatives
Depending on exposure levels, this neurotoxin, may lead to memory loss, headaches, neuromuscular effects, headaches, tremors.[64]	Air pollution from coal plants, broken fluorescent and compact fluorescent bulbs, glass thermometers, LCD TV and computer screens (only released when cracked), button cell batteries, dental amalgams as well as larger predatory fish such as tuna, shark, swordfish.	- Eat low mercury fish such as sardines and lake trout - Bring CFLs, button cell batteries, old thermometers to recycling drop off - Invest in LED bulbs - When fluorescent light is broken, clear the room and air it out for 5-10 minutes, turn off forced air and collect shards with stiff cardboard, sticky tape, damp paper towel and place in sealable jar or bag[65]

Household Pollutant: BISPHENOL A

Potential health impacts	Where it's lurking	Healthier Alternatives
This estrogen mimicker may be linked to changes in breast development, breast and prostate cancer,[55, 56] diabetes,[57] obesity,[58] as well as inflammation and oxidative stress in post-menopausal women.[59] Associated with heart disease[60]	Canned food/drinks, clear plastic water bottles, dental devices, ceramic resin dental fillings, thermal cash register receipts, toilet paper (thanks to receipts in recycled content)	- Look for canned items with BPA-free lining (ie Eden Foods, except canned tomato) - Stew fresh tomatoes - Inquire about porcelain fillings and BPA-free alternatives - Search for BPA-free lids for home canning - Opt for stainless steel water canisters - Since BPA-free baby bottles have been found to leach traces of BPA and/or other estrogenic compounds, best to stick with glass bottles encased in silicone[61]

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Toxic Chemicals in Personal Care Products

Dr. Jacqueline Cooper, ND, with contributions from **Dr. Andrea Maxim,** ND and **Dr. Daisey Kent,** ND

When assessing a patient and determining the root causes of their symptoms, all patients should be screened for their choice of personal care products (PCPs). The majority of these products on the market contain chemicals that are detrimental to human health.

The David Suzuki Foundation identified twelve of the most dangerous chemical ingredients in PCPs and surveyed Canadians to determine their frequency of exposure. They found 80% of the products being used by consumers contained at least one of the twelve toxic ingredients they had highlighted. While this provides cause for concern, what is even more disturbing is that there are over 10,000 chemicals used in PCPs, many of which have not been tested for human safety.[1]

While the amount of chemical exposure from PCP use may be small, clinical concerns centre on bioaccumulation that occurs due to daily usage. Furthermore, new research shows that current mechanisms for testing the safety of chemicals are insufficient.[2] Currently, regulators use high doses of a chemical to determine its safety. If there are no significantly deleterious health effects at a particular level, all measures below this established amount are deemed safe.[3] The health effects of a high dose exposure do not accurately predict low dose effects.[4] For example, phthalates, commonly found in fragrances added to PCPs, caused allergic reactions upon exposure to a concentration 1000 fold less than the current safety standard established.[5] This reaction would not have been predictable based on studies that only examined high dose exposure to phthalates.[6] Non-monotonic dose-response curves have also been reported for a number of endocrine disrupting chemicals.[7] Thousands more have yet to be analyzed in this manner, thus heightening the importance of avoiding chemically laden PCPs.

Chemical exposure via PCPs has been associated with a host of medical conditions including, but not limited to: contact dermatitis, respiratory irritation, chronic fatigue, mood imbalances, endocrine imbalances, reproductive toxicity, neurotoxicity, infertility and cancer.[8-12]

Health Effects of Endocrine Disrupting Chemicals in PCPs

This article will highlight the clinical effects of exposure to endocrine disrupting chemicals (EDCs) found in personal care products. Chemicals in this category that are of greatest concern include: BHA & BHT, phthalates, parabens, siloxanes and triclosan. EDCs can affect the system in a number of ways. One way they exert an effect is by interacting with hormone receptors; some chemicals acting as agonists, others antagonists.[13] More recent research has been investigating the affect EDCs have on key enzymes involved in steroid hormone synthesis and metabolism, specifically cytochrome P450 enzymes.[14] One example of evidence pertaining to this mechanism of action is the ability of EDCs to inhibit aromatase conversion of testosterone.[15] It is hypothesized that this mechanism of interference could lead to dramatic shifts in endogenous levels of hormones, yielding a greater clinical affect than interactions with receptors.[16]

Listed below are common signs and symptoms that may result from exposure to endocrine disrupting chemicals:[17-20]

TABLE 1

FEMALES	MALES
• Juvenile menstruation • Premature breast development • Premenstrual symptoms (migraines, breast tenderness, low back pain, cramping) • Intermenstrual bleeding • Fibrocystic breasts • Infertility • Miscarriage • Endometriosis • Fibroids • Vaginal dryness • Night sweats • Stubborn weight gain around the hips, buttocks and thighs • Insulin Resistance	• Gynecomastia • Galactorrea • Premature breast development • Loss of muscle tone • Low libido • Erectile dysfunction • Depression • Stubborn weight gain in the hips and thighs • Insulin Resistance

Endocrine disrupting chemicals tend to be lipophilic and can be stored for long periods of time in adipose tissue. They can also alter the distribution of adipose tissue in the body. Women accumulate more adipose tissue around the hips, buttocks and thighs while men typically accumulate fat in the intra-abdominal (visceral) areas. Increased exposure to EDCs can cause males to present with a distribution of adipose tissue that is typically seen in females. In addition to the redistribution of fat, EDCs can make shedding weight difficult as they tend to upregulate the number of subcutaneous adipocytes and prevent lipolysis.[21] Because adipose tissue has the capacity to synthesize biologically active steroids, as EDCs concentrate there they are likely to alter this process via interference with steriodogenic enzymes.

Exposure to EDCs first occurs *in utero* due to maternal exposure endogenously and throughout the pregnancy. Exposure may continue in the post-natal period via breastmilk.[22] In male newborns, it is suspect that endocrine disruption *in utero* may lead to defects of the Sertoli and Leydig cells which contribute to cryptorchidism, hypospadius and increased probability of testicular cancer.[23,24,25] With pediatric patients, one should closely monitor for signs of abnormally rapid tissue growth and development, particularly around puberty. Young females are entering puberty as early as 7 or 8 years-old instead of 11 to 13 years of age.[26] While hormonal disruption may have begun *in utero* it is equally as important to screen for PCP use in younger patients, as products made for infants and children have just as many, or more, dangerous chemicals as those marketed for adults. Also there is concern that the infants and children tend to absorb larger amounts of these chemicals and are less able to neutralize their impact in the body.

The rate of hormone-related cancers is on the rise, with growing evidence connecting the impact of estrogen on carcinogenesis.[27,28,29] Currently there are about 160 xenoestrogens which may be implicated in the development of cancer, with most exposures coming from transdermal absorption.[30] Estrogen receptors are most abundant in the breasts, testes, ovaries and uterus. Estrogen receptors also have relatively high concentrations in the spleen while the lowest levels occur in the kidney, thymus, skin and lung.[31] In addition to mimicking estrogen, EDCs as mentioned previously, can interfere with steroidogenic enzymes which may increase endogenous estrogen.[32] At high enough levels, estrogen can produce reactive oxygen species, decrease glutathione-S-transferases and increase cellular oxidative DNA damage, all of which can precipitate carcinogenesis.[33] Male cancers including testicular and prostate may also be related to xenoestrogen exposure and the disruption of endogenous hormone levels via EDC interference with steroidogenic enzymes.[34,35]

Relevant Lab Tests to Screen for EDC Exposure

Lab tests used to monitor a patient's hormonal health include: fasting blood glucose, fasting insulin, HBA1C, SHBG, complete thyroid panel (TSH, free T3 and free T4), serum or salivary levels of total and free testosterone, progesterone, estriol, estrone and estradiol, DHEA and cortisol. There are a number of other tests helpful in assessing pathology due to EDC exposure. An environmental panel will measure urinary metabolites of parabens, phthalates and other chemicals, helping to clarify the source of toxicity. If you suspect excess estrogen, consider a urine steroid hormone test to measure metabolites. In the past, levels of 2-OH and 16-OH estrones were used to determine the liver's ability to break down estrogen. It was thought that an increased ratio of 16-OH-estrone metabolite to 2-OH-estrone metabolite was correlated with various forms of cancer.[36] However, this is now being disputed as newer evidence indicates the ratio is not predicative of risk; measuring the 4-OH estrone metabolite may be a better indicator.

Selecting Healthy Alternatives

In considering alternatives, while there is an ample supply of "natural" personal care products on the market, it is imperative to recognize that despite the marketing messages, these seemingly natural agents may lead to similar toxic exposures as the synthetic commercial products. In determining whether a particular PCP is safe, the physician should take several factors into consideration.

First, plant based extracts may actually contain undisclosed parabens or other preservatives. The initial plant material may have been organic, but chemical preservatives are often added to stabilize the extract. Current labeling regulations do not require individual components of the extract compound to be itemized on ingredient lists.[37,38] Thus, consumers are often misled with statements such as *"made from organic grapefruits."* At this time Canada's protection of organic labelling only applies to food and not PCPs. However, if a product is USDA Certified Organic the consumer can be assured that the product meets standards safe for human consumption. If a product does not carry this certification, the best way to ensure that there are no hidden chemicals is to call the company directly and request information regarding their extraction process and use of preservatives.

As an example, an emerging concern in the realm of natural personal care products involves the use of grapefruit seed extract (GSE) as a preservative. Commercial sources of GSE have been found to have significant anti-microbial properties.[39] However, when analyzed with thin layer chromatography, the commercial sources of GSE were found to differ greatly from ethanol extracts of grapefruit seeds. The majority of commercial GSE samples analyzed contained significant amounts benzethonium chloride, a quaternary ammonium chloride that is used in hospital and laboratory settings as a disinfectant.[40,41,42] The only commercial sample analyzed that was not adulterated with benzethonium chloride, like the ethanol extract did not demonstrate any anti-microbial activity.[43] So while many individuals, including naturopathic doctors, use GSE as a prophylactic anti-infective agent, a review of current literature concludes that the anti-microbial effect of GSE is attributed to the synthetic chemicals acquired in the commercial extraction process.

In addition to concerns regarding its potential as a dermatological irritant, one of the greater concerns regarding benzethonium chloride is its effect on hERG channels. hERG channels are a subtype of potassium channels, predominantly found in cardiac tissue, but also expressed in the brain, kidney, liver and lung. [44] Benzethonium chloride was found to have an inhibitory effect on hERG channels. Clinically, inhibition of the channel manifests in an extended QT interval, which can lead to long QT syndrome (LQTS).[45] Drug induced LQTS is the most common cause of drug induced arrhythmias and sudden death.[46] During the period from 1990-2006, 29% of the drugs withdrawn from market or denied approval were due to their potential to prolong the QT interval or induce fatal ventricular tachyarrhythmia.[47] So while plant based extracts such as GSE may sound safe, its safety is dependent on the method of extraction (many commercial extractions utilize chemicals which leave contaminants in the end product) as well as the preservatives used to stabilize it. Again, the only way for a practitioner or consumer to be sure of the safety is to contact the company directly and request information regarding their manufacturing process.

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Replacing toxic PCPs with safer alternatives is imperative to the health of our patients. However, the financial cost of doing a complete overhaul can become high and offputting to the patient. Encouraging a gradual replacement of products is likely to garner greatest compliance. When prioritizing product replacement use the following factors to determine which products must be replaced first.

- Length of time spent on the skin – creams, deodorants and sunscreens stay on your skin throughout the day allowing them to penetrate deeper, thus increasing the likelihood of systemic effects. This effect is amplified by the addition of chemicals designed to enhance absorption. Another major concern is that many moisturizers contain occlusive agents whose purpose is to create a physical barrier that prevents epidermal water loss. This physical barrier inhibits the skin's ability to eliminate waste products. Therefore, removing or reducing the use of products that stay on the skin for an extended period should take precedence over rinse off products like shampoos, conditioners and soaps.
- Area of application – the stratum corneum, which provides the skin's barrier function, varies in thickness regionally throughout the body. The skin on the face, especially around the eyes, and mucosal membranes are more susceptible to penetration of chemicals. While areas less vulnerable, due to increased thickness of the stratum corneum, include the forearm and buttocks.[48]
- Frequency of use – products that are used every day are of far greater concern that those used intermittently or sparsely.
- Chemical content – obviously the more chemicals the product contains the more important it is to find a suitable replacement. Refer to Fig. 2 for a list of the top twelve offenders as identified by the David Suzuki Foundation.

Reading ingredient labels to screen for harmful chemicals can be daunting. A safe way to ensure you are avoiding harmful chemicals is to look for a label that states the product is USDA certified organic. The term organic is not enough, for in Canada the federal regulation of labelling something as organic only applies to food; there is no regulation of personal care products that use the term organic. However, if a product bears the USDA organic label it is at least 95% organic and has been deemed safe for human consumption. The USDA standards for personal care products are the same standards for food.[49] While not as strong as the USDA standards there are other certifications that do distinguish a product as being *significantly* better than the vast majority of PCPs:

- EcoLogo/Environmental Choice ecologo.org
- Green Seal greenseal.org
- National Sanitation Foundation nsf.org

Ultimately, the safest approach to personal care is to use only items you would allow yourself to ingest. It is important to shift patients' thinking toward this philosophy because what we slather on our porous skin ends up in our bloodstreams and can accumulate in adipose tissue and internal organs, similar to what we ingest orally. Furthermore, substances absorbed through the skin pose more of a systemic danger as they bypass the liver and are not broken down.

TABLE 2

CHEMICAL OF CONCERN	ADVERSE REACTION	COMMONLY FOUND IN
BHA & BHT	**Endocrine disrupter**, probable carcinogen, allergies, immunotoxicity, neurotoxicity	lipstick, moisturizers, sunscreen, deodorants, antiperspirants, makeup
Coal Tar Dyes	contaminated with heavy metals, neurotoxicity, contact dermatitis, respiratory toxicity	shampoo, hair dyes, antipruritic creams
DEA (diethanolamine)	**suspected reproductive toxicant**, probable carcinogen, contact dermatitis	soap, shampoo, conditioner, lotions, bubble baths
Dibuytly phthalate	**Endocrine disruptor** and reproductive toxicant	nail polishes
Formaldehyde-releasing preservatives	Carcinogenic, dermatitis, joint pain, chronic fatigue, heart palpitations, respiratory irritant, weakens immune system, neurotoxicity	hair products, sun screen, nail polishes, anti-perspirants
Parabens	**Endocrine disruptor**, carcinogen, neurotoxicity	body washes, cleansers, shampoos, toothpaste, hair products
Fragrance or Parfum	**Endocrine disruptor**, headaches, dizziness, behavioral changes, depression, irritability, asthma	perfumes, colognes, any scented products, often found in 'scentless' products which are then covered with a scent masking agent.
PEG compounds	often contaminated with carcinogenic agents; toxic to kidneys and nervous system; irritant to skin and lungs	hair dye, sunscreen, deodorant, anti-bacterial soap
Petrolatum	Inhibits the skin's ability to excrete toxins; often contaminated with carcinogenic agents	moisturizers, hair products
Siloxanes	**Endocrine disruptor**, **reproductive toxicant**	deodorants, moisturizers, hair products
Sodium laureth sulfate	often contaminated with carcinogenic agents	shampoo, conditioner, soaps, facial cleansers, toothpastes
Triclosan	suspected **endocrine disruptor**, believed to contribute to antibiotic resistance in bacteria	facial cleansers & moisturizers, body wash, anti-bacterial soaps, deodorants, toothpastes

Venturing into the kitchen for materials for personal care is a great idea. Not only is this DIY approach affordable, but using fresh ingredients means greater antioxidant and enzymatic activity, while completely bypassing all preservatives.

For <u>moisturizers</u>, consider edible oils:

- Coconut oil is an excellent facial or body moisturizer with antimicrobial and anti-fungal properties.[50] It is light, does not clog pores, nor does it stain clothes. It also can be used with a Q-tip to remove residues of eye-makeup after washing your face.
- Almond and olive oil are other options for moisturizers (however the yellow/green color discoloration may be off putting for some skin tones).
- Tamanu oil is powerful oil with a particularly therapeutic effect. It has anti-microbial and anti-inflammatory actions. It acts as regenerative serum and improves micro-circulation. It is more expensive so its use can be limited to the face/neck as an anti-aging serum, or applied to prevent scarring.
- Rosehip oil is yet another powerful oil which acts as an intense hydrator and also stimulates keratinocyte differentiation.[51]

<u>Toners</u>

- Green tea has valuable astringent properties that make it a worthwhile toner. Its potent antioxidant profile imparts anti-aging properties. Lastly, it's a valuable resource for protecting against sun damage.[52]

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Cleansing Masks

- Yogurt makes a great cleansing mask for those suffering from acne. The probiotics help compete with the offending bacteria (*Propionibacterium* acnes). Note: should not be used by those with dairy sensitivities.
- Honey (unpasteurized) is well-known for its vulnerary and anti-microbial properties[53] and can be mixed with yogurt or oatmeal into a paste for facial masks to treat scars and skin lesions.[54]
- Avocado contains nutrients and fatty acids that make it a great base or addition to a face mask.

Hair Care

- Beer, instead of being ingested, can be used as a shampoo. It helps to strengthen the hair as it is full of B vitamins.[55]
- Apple cider vinegar as a hair rinse is a great conditioner and shine-booster as it helps to remove residues left by conventional hair products.
- Avocado is also a great choice as a conditioner or weekly hair mask, due to the healthy fats it contains.

Detoxifying Options

- Alkaline mineral salts are a versatile item that can be added to baths to draw out acids and toxins and assist in re-establishing a more alkaline pH. These salts can also be moistened and applied to the scalp or rubbed onto skin for exfoliation.
- Clays are helpful in drawing toxins out of the skin. Zeolite is an aluminosilicate, similar to clay. It is particularly powerful at extracting and neutralizing toxins. Its negative charge attracts positively charged toxins, and its honeycomb structure allows it to bind the toxin effectively. Animal studies utilizing clinoptilolite, a particular type of zeolite, showed that topical application to areas afflicted with skin cancer led to improvement in overall health status, prolongation of life-span, and decrease in tumor size.[56]

Deodorants

- Natural options for deodorants include Himalayan salts or oil bases, such as shea butter or coconut oil, combined with essential oils such as lavender, citrus or lemongrass.

Although typically less scrutinized, the PCPs that a patient uses should be analysed as closely as the foods they ingest. This article has highlighted some of the mechanisms of action and clinical effects of the EDCs present in PCPs. However, this only represents a portion of the damaging physiological effects attributed to exposure of chemicals from PCPs. The majority of products on the market contain chemicals which have been identified as toxic to numerous facets of human health. Therefore, a responsible, thorough naturopathic assessment must incorporate screening for chemical exposure via personal care products. And subsequently, a comprehensive treatment plan should include educating the patient on how their use of personal care products can possibly improve health or be a contributing cause of disease.

NATUROPATHIC MAY MEDICINE WEEK 6-12

A national initiative led by the CAND, Naturopathic Medicine Week (NMW) is facilitated by the regional naturopathic associations and schools. Our goals for NMW are to increase the public's awareness of the benefits of naturopathic medicine and drive new patients into ND clinics across Canada. NMW is an excellent opportunity for naturopathic doctors to plan community awareness events, such as presentations at local community venues, and contribute articles to the local press. We encourage you, our members, to be creative when marketing and planning events. Sky's the limit and we are here to assist you!

Need some ideas or support? Contact your regional representative (see www.cand.ca/index.php?id=246#2185). Easy to organize event ideas and support material, such as handouts, posters and PowerPoint presentations can be found on the "NMW tools" page in the CAND's Members Only website.

A variety of community-based promotions are being scheduled to heighten public awareness about NMW and direct the public to event listings on the regional/CAND websites. For example, the CAND and NDO will be attending the Green Living Show in Toronto April 12th to 14th.

Confirm your event details and contact your regional rep or the CAND with the location, presentation date, time and topic. Your event details will shared with the CAND and promoted on the CAND and provincial websites where applicable (see www.naturopathicmedicineweek.ca for details).

Watch for email updates from your regional reps and the CAND. We look forward to working with you to achieve another successful Naturopathic Medicine Week!

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About the Authors

Dr. Jacqueline Cooper, BSc, ND practices in Ontario, just outside Toronto in the Markham Unionville area. Jacqueline empowers her patients by helping them identify and address the factors that influence health and disease. She has a special focus on skin and healthy weight management. She can be contacted at jcoopernd@naturopathicfoundations.ca or on Twitter @JCooperND.

Dr. Daisey Kent MSc, ND has recently begun practice in the Cowichan Valley on Vancouver Island, BC. She has a Master of Science in the field of epigenetics. Knowing the importance of lifestyle on our genetic expression led Daisey to study Naturopathic Medicine. Part of her enthusiasm for health, includes the health of our planet. As Doctor as Teacher, she is committed to living in partnership with nature.

Dr. Andrea Maxim, ND is proud to be serving the Haldimand and Oakville community. She has a keen interest in functional medicine, digestive disorders and hormone imbalance. Her treatments focus on using whole foods and high dosed nutrients. As an adjunct, treatment plans include acupuncture, biopuncture, homeopathy and counseling to further bring balance to the body. Dr. Maxim has been awarded Hamilton's Naturopathic Doctor of the Year for 2013.

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Examining Children's Vulnerability to Environmental Toxins and Strategies to Minimize Exposure

Dr. Leslie Solomonian, ND

During the past several decades, the quantity of toxic, manufactured chemicals and substances present in the environment has increased significantly, often with limited appreciation of their harmful physiologic impacts. Children in particular have unique vulnerabilities to these toxins due to their characteristic behaviours and physiology.

Although the consequences of some of these substances are becoming better understood, a number of factors make it challenging to determine the specific mechanism of damage and ultimate impact of each and every chemical, particularly on fetuses and children.

Research has made it clear that exposure to environmental toxins during the developmental years of life increases the risk of disease in individuals throughout their lifespan and in future generations.[1,2] The interaction between multiple substances, developing tissues and the potential for transgenerational health impacts is complex. When set against a background of academic, industrial and political forces, it is critical that healthcare providers promote the precautionary principle to families and the community. Reducing the burden of exposure to all environmental toxins and gently promoting endogenous detoxification mechanisms in children may have tremendous impacts on the health of this generation.

Swimming in a stew of synthetic substances – what have we learned?

Methods historically used to predict toxic doses of chemicals are now recognized as faulty[3] and grave errors in toxicological predictions have been made. Thalidomide and diethylstibesterol (DES) are examples of medications that were presumed to be safe in pregnancy, resulting in dramatic and transgenerational (in the case of DES) consequences for offspring of women taking these medications.[4-6] The fallout from the use of these substances has informed current toxicological research.[4,6]

Unfortunately, by the time it is recognized that a substance is causing harm it can be difficult to reverse the damage due to impacts on offspring or to the effects of bioaccumulation, deterioration and contamination of soil, water and air.[1,3,7] There are a significant number of chemicals in use currently that are known to have a detrimental impact on the health of ecosystems around the world. Some estimate that over 70,000 chemicals are produced industrially[2] with up to 75% of those in greatest volume having limited or no toxicity testing.[1]

As research evolves, we gain greater understanding of the complex mechanisms and impacts of these chemicals on human health, particularly that of fetuses, infants and children. Synergistic, cumulative and additive effects of multiple substances affect the dynamic physiology of growing children in profound ways.[8] The children of this generation are ultimately experimental models for the impact of these substances.[1,9] Even if cause-effect relationships are not fully established the precautionary principle dictates that if a chemical is at all implicated in harm, measures should be taken to control its use.[2,9,10]

The unique vulnerability of children

Children are particularly sensitive to toxic exposure for a number of key reasons:

Fetuses, especially during the first trimester, are rapidly developing and are vulnerable to chemical and hormonal impacts on the vital organs during this period.[11-14] Rapid growth and proliferation of poorly differentiated cells results in greater opportunity for mutagenic and epigenetic influences.[15] Very low levels of chemicals may be necessary to affect cell differentiation and signal programming *in utero*, and manifestation of these effects may not become obvious until adulthood or even the next generation.[12,16]

The placenta is less protective of the fetus than was previously believed.[3] Exposure *in utero* to poor nutrition, alcohol, cigarette smoke, psychosocial stress, and environmental chemicals all affect development, DNA expression and ultimately adult health.[12,13] In many cases, effects of exposure may not even manifest in the exposed parent, reflecting the significant plasticity of children with respect to neurologic and reproductive development.[12,15,17] Fetuses and newborns have immature epithelial barriers (skin, gut, lungs, blood-brain barrier), and limited detoxification and DNA repair mechanisms, making the physiological exposure to chemicals and their impact more dramatic than in an adult.[3,12,14,18] This particular vulnerability and susceptibility to epigenetic effects has been aptly identified as the "fragile fetus".[13]

Exposure via breastmilk has been shown to be significant. Polychlorinated biphenyls (PCBs), DDT (despite being discontinued in the 1970s), dioxins, dibenzofurans,

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polybrominated diphenyl ethers (PBDEs), and heavy metals all have been found in breast milk of women worldwide. These substances are largely lipophilic and bioaccumulate in the breast; the quantity in breastmilk reflects the concentration in the blood.[19-21] Twenty percent or more of maternal body burden of some persistent pollutants, such as PCBs, can be transferred during six months of lactation.[19] It is important to note that breastmilk is still considered the be the absolute best food for infants due to its many immunological, nutritional and attachment-promoting benefits.

Physiologically, children have a higher metabolism with a greater intake of air, food and water per unit of body mass than adults, resulting in a proportionately higher exposure to chemicals.[12,22] Children breathe and play closer to the ground, where dense vapours and air-borne chemicals tend to accumulate[8,22] and hand-to-mouth behaviour increases oral consumption of chemicals in household products and dust.[18] Limited food acceptance results in higher exposure to individual pesticide residues in the foods consumed in higher quantities.[21] Poor nutrition and genetic polymorphisms affecting detoxification mechanisms may increase the susceptibility of some children to environmental toxins.[23]

Psychosocial stress has also been suggested by some to be a toxin. It is likely that physical/chemical and social stressors are additive, since both may affect physiologic pathways of oxidation, inflammation, endocrine and immune system functioning, DNA methylation, and neurodevelopment in similar ways. It has been demonstrated that children exposed to chronic stress *in utero* and during early childhood have decreased resilience to stressors, likely mediated via the immune and endocrine systems. This decreased resiliency may also modulate the ability to respond adequately to environmental toxins. As a result, children living in poverty and less optimal psychosocial settings are at a greater risk of disease, not only due to potentially increased exposure to chemicals from, for example, poorer quality food and contaminated soil, but also due to the synergy between harmful physical and emotional toxins.[24]

Mechanisms of Toxic Damage on Children and the Developmental Origins of Adult Disease

Due to the tremendous diversity of toxins to which children are exposed, there is an equally broad spectrum of mechanism of damage and consequential outcome. Some key themes, however, have emerged.

Neurotoxins such as heavy metals, dioxins and PCBs have been associated with lower IQ, learning disabilities, autism spectrum, ADHD, visual/hearing deficits, and behavioural problems.[9] Childhood is the most critical time of brain development, extending well into the third decade of life; given the immature blood-brain-barrier *in utero* and in infancy, the brain is particularly vulnerable to neurologic insults during this time.

Exposure to some chemicals is known to increase the risk of miscarriage through their lethal effects on developing cells.

Other toxins induce *non*-lethal genetic damage, often mediated by oxidative processes, leading to the initial mutations of carcinogenesis which may not manifest until young or later adulthood. Epigenetics seems to play a potentially significant role as well, with environmental chemicals altering the methylation of genes, affecting DNA transcription.[6,13]

Many of the persistent organic pollutants (POPs) are known endocrine disrupters, acting by blocking or mimicking hormones, thus interfering with metabolism and cell cycle control.[14] The reproductive system and thyroid seem to be particularly vulnerable. Inhibition of thyroid hormone reception at target cells *in utero* may be a key mechanism mediating neurological deficits in children. Endocrine disrupting chemicals are implicated in impaired development of brain development[25,26] and can have myriad effects on reproduction, including early onset of puberty, interference with ova and sperm development, infertility, chromosomal abnormalities, miscarriage, preterm delivery, low birth weight and cancers of reproductive organs.[14]

The effects of endocrine-disruptors seem to follow a nonmonotonic dose-response curve, unlike that typically assumed in toxicity evaluations.[11,12] In hormonally mediated impacts, low doses may have different effects than high doses of the substance.[3,6] Bisphenol A (BPA), for example, seems to act not only via stimulation of estrogen receptors[13] but also via non-nuclear mechansims[3] including impairment of calcium signaling pathways in the pancreas and the activation of proinflammatory adipokines, increasing the risk of obesity and glucose dysregulation.[13] A series of endocrine disrupting chemicals, including pesticides, organophosphates, phthalates, heavy metals and solvents may interfere with adipose metabolism and homeostasis via endocrine and neurological pathways.[12] Exposure to these toxins during critical stages of development may be contributing to lifelong risks of obesity and its concomitants in a similar way as suboptimal nutrition.[12,13,21]

Assessment of toxic load

Few laboratory tests are clinically useful or sufficiently cost effective to predict the impact of environmental exposure to an individual.[27] Bradstreet et al. offer a comprehensive review of blood and urinary biomarkers that may be helpful in the assessment of environmental toxicity or detoxification impairment in children with autism or ADHD, two conditions associated with a high burden of environmental toxins.[28] Hair mineral analysis as a method for quantifying heavy metals may be useful in children due to its non-invasive methodology; however, the validity of this technique remains questionable.[27,29] Serum gamma-glutamyltranspeptidase (GGT) has been proposed as a non-specific measure of chemical toxicity.[30]

It can be assumed, due to the ubiquitous nature of environmental toxins, that all individuals carry some degree of chemical burden from fetal development onward.[7] Based on the knowledge that the effects of toxicity may not be appreciated until adulthood,

incorporating burden reduction and detoxification/elimination support for all pediatric patients is appropriate as we aim to optimize conditions for health[31] while a comprehensive exposure history can allow the practitioner to assist families in identifying specific sources of exposure.[1]

Minimizing toxic burden and promoting detoxification and elimination

The importance of reducing toxic burden from preconception onward, particularly during fetal and childhood development, is reinforced by research that indicates the presence of persistent organic chemicals in follicular fluid and semen.[9,23] The primary strategy in any approach to reducing toxic burden is to minimize exposure, as this can reduce overall body load.[32,27] Once exposure has been minimized, the natural vitality of children often makes them very responsive to the simple yet deeply acting approaches of optimal nutrition, hydrotherapy and nature cure.

A good quality diet is critical, one that is plant based, minimizes fatty animal products, and prioritizes organic, free-range and non-GMO sources.[33-35] Ideally animal products should be organic as much as possible, due to the impact of bioaccumulation of lipophilic POPs. By reducing animal products in general and replacing (at least some of the time) with legumes, nuts, seeds and fibre-rich whole grains, the more expensive organic selections become more financially accessible.[36,37] Families may need support in moving toward a plant-based diet in a way that does not increase the glycemic burden of the diet, and ensures that nutritional adequacy is met, particularly for nutrients readily available from animal sources such as protein, B12, iron and zinc.

The Environmental Working Group's "Dirty Dozen" and "Clean Fifteen" are excellent resources to support patients in choosing what produce to selectively buy organic.[38] Foods that are eaten frequently, especially by children, should also be from organic and non-GMO sources while local fish advisories should be followed to reduce the ingestion of mercury.[18]

A predominantly organic and GMO-free plant-based diet is beneficial not only to reduce the burden of exposure, but to increase antioxidants. The phytochemicals, vitamins and minerals found in many plant foods play a significant role in increasing antioxidant mechanisms in cells, both protecting cells from DNA damage, and upregulating detoxification through endogenous mechanisms.[18] For example:

- Glucosinolates provided by the *brassica* group of vegetables play a key role in regenerating cellular glutathione levels, a critical component of intracellular antioxidant and detoxification processes.[39,40,47] They also appear to upregulate nuclear factor erythroid 2-related factor 2 (Nrf2), a cytoplasmic transcription factor which activates intracellular detoxification enzymes.

- Curcuminoids found in turmeric enhances phase II detoxification through a similar mechanism, and also appears to reduce inflammation via inhibition of NFkappaB.[18,40] Families can easily incorporate turmeric into routine cooking.
- Ellagic acid from walnuts and pomegranate, carnosic acid from rosemary, polyphenols and catechins from green tea and organosulfur compounds from garlic all may act through similar pathways, and should be encouraged in a family's diet.[46]
- Phytoestrogens from soy foods may be protective via epigenetic mechanisms for obesity due to environmental obesegens.[12] It is recommended that families seek out GMO-free soy foods such as tofu, tempeh and miso, as opposed to processed soy products.
- Sea vegetables may act to bind heavy metals and organic compounds (PCBs, dioxins) in the gut and increase their elimination. Chlorella has been shown to reduce dioxin load in breast milk and may be a means of heavy metal detoxification.[18,32,45]

Optimal gut health is paramount for effective elimination of toxins contained in bile. Probiotics can positively influence the metabolism of xenobiotics, thus encouraging optimal detoxification and elimination processes.[18] This appears to be particularly relevant if there is a history of antibiotic use. Adequate viscous fiber is of key importance, as the fiber binds conjugated toxins present in bile to enable their elimination.[45] Flax and chia meal are excellent sources; they are also a source of lignans, which inhibit aromatase and block xenoestrogens, thus protecting the body from adverse hormonal influences.[18] Rice bran fiber appears to be particularly effective at reducing the toxic load of the body.[32,47]

Melatonin is a significant antioxidant, and may provide some protective benefit against the oxidative damage.[48] Encouragement of an optimal sleep schedule and environment with the family, minimizing ambient light or electromagnetic radiation is a strategy to increase endogenous melatonin formation. Other elements can be used therapeutically to enhance detoxification enzymes, upregulate intracellular antioxidant function and promote the production of glutathione. Standardized extracts of silymarin, N-acetyl-cysteine and alpha-lipoic-acid are all safe and well-known promoters of detoxification in the liver particularly, and can be safely given to children at weight-appropriate doses once solid food has been introduced.

A survey of chemicals in the household and immediate environment can support families in reducing exposure. Some tips include:

- Cleaning should be done with homemade cleaners or products identified as being of low toxic load (see elsewhere in this issue).
- Dust should be removed via vacuum or wet-mop.
- Hands washed frequently with soap and water, due to significant hand-to-mouth behaviour in children.
- Shoes should be removed before entering the home
- Solvents or chemicals used for occupation or hobbies (and clothes worn while using them) should be kept out of the home.
- Plastic toys and items should be avoided.
- Indoor spaces should be ventilated adequately and frequently.
- Clothing can be purchased second-hand to reduce exposure to flame-retardants – this is not a good strategy for mattresses or plastic toys/items, since deterioration of the plastics occurs over time, possibly increasing exposure in second-hand items.[43]
- Families can be encouraged to use cars less, instead walking, bicycling or using public transit. This not only encourages physical activity which promotes elimination, but also reduces emissions more broadly.
- Muscle-powered tools should be encouraged, reducing the use of motor-powered mowers and blowers.
- On days identified as having high levels of particulate matter, it is advised to reduce outdoor activity during peak traffic hours.

Modelling has a tremendous impact on children – making these behaviours standard in childhood will increase the likelihood that individuals will continue making such choices as they move through life.

Naturopathic doctors can encourage families to connect with nature by spending time outdoors. It has been shown that time spent in natural environments promotes health, potentially through the regulation of the hypothalamic-pituitary-adrenal axis and other endocrino-neurological pathways.[44] A child who spends time outdoors may develop a stronger connection to nature and be more likely to be a steward of her natural world. Letting children see where their food comes from through patronization of farmer's markets and organic butchers benefits not only the physical health of the individual, but the economic and social health of the community. Due to the suspected synergy of emotional and chemical toxins, it is of critical importance, to optimize attachment of children to trusted adults, as a means of reducing stress and increasing resiliency.[24]

Naturopathic approaches such as constitutional hydrotherapy treatments, application of castor oil to the skin over the abdomen and liver, and the promotion of sweating through carefully supervised saunas and regular physical activity all can be powerfully effective ways to promote the detoxification and elimination of environmental chemicals from a young body.

Naturopathic Doctors as Advocates

Broad, public health challenges such as environmental toxicity require multi-tiered approaches in order to create effective change. Naturopathic doctors are exceptional at working with the individual and the family to make choices that benefit the health of the family unit. However, health improvement on a broader level requires advocacy on the part of the clinician, the profession as a whole, as well as families advocating for their children's future.

A number of governmental and non-governmental conferences have identified the need to act aggressively to reduce the chemical burden, particularly on children. The UN has identified environmental health as a child's right[9] and the G8 has declared the issue as a priority, as has the WHO.[9,22] In 2001, Canada and 119 other nations signed a treaty to phase out use and production of 12 POPs, and minimize the industrial release of dioxin and furans. As a result, many countries do tend to apply the precautionary principle to industrial chemical use.[19] However, despite these international meetings that have recognized and identified the threat of the environment to children, tens of thousands of chemicals continue to be produced and used every year, many without thorough understanding of their impact on children, especially when exposure is in conjunction with other chemicals.[22]

It has been suggested that educating healthcare providers about these concepts can be more effective than targeting the public directly.[23] Thus, practitioners have a responsibility to educate patients, and encourage political and consumer action. Information can be provided in clinics and in the wider community to encourage our communities to write their MPs, MPPs and MLAs, pressuring political representatives to uphold the treaties that the government has signed.[49] Letters can also be written to manufacturers and distributors of products to which children are commonly exposed requesting a review of chemicals used in production, or explaining a chosen boycott of a particular company or product. Charitable contributions and purchasing power can be given to organizations that actively do this work as well. Naturopathic doctors can model environmental awareness through products chosen and used in clinics, methods of travel; these choices can be highlighted through a statement of environmental values posted in the clinic. Information on environmental health can be shared on clinic websites and through articles in media publications. Naturopathic doctors can directly connect with their local schools to provide education and promote healthy indoor air quality.

In addition to the precautionary principle, it is important to identify chemicals that are causing harm. This requires research, monitoring and documentation of exposure.[23] Clinicians can be involved in routine monitoring of spontaneous and induced

abortions and infertility. It has been proposed that an international standardized breast milk monitoring programme would be an effective way to identify exposures and trends.[22] Naturopathic doctors could play a role in advocating for and establishing such a program.

Conclusion

Despite limitations in reliable objective assessment of environmental burden, it can be assumed that all children carry some degree of toxicity. Environmental chemicals have been shown to have significant and lifelong impact on the growth and development of children, who are uniquely vulnerable to the damaging effects of these toxins, thus increasing the risk of disease throughout the lifespan. Optimal diet and lifestyle choices can play a significant role in minimizing the impact of environmental chemicals on children, and thus the health of the next generation. Naturopathic doctors are uniquely positioned to educate families about these impacts, to counsel avoidance of these toxins, promote their removal from the body, and advocate for better regulation and reduction of health-disrupting compounds.

About the Author

Dr. Leslie Solomonian, ND is a naturopathic doctor in Toronto and Assistant Professor at CCNM where she provides instruction in pediatrics, philosophy and clinical medicine. Leslie is experienced in working with young families in a variety of venues and ways. She strongly believes that a child's wellbeing is affected by the wellbeing of the family, community and environment. She sees healthy children as the key to a healthy future.

Top strategies to decrease toxic burden and promote elimination

1. Brightly-coloured plant-based, largely organic and GMO-free diet
2. Frequent physical activity and regular sweating
3. Stress reduction and adequate sleep
4. Intentional selection of household and personal care products that have been identified as having a lower toxic burden.
5. Minimization of plastics and maximization of household items made of natural substances.
6. Adequate outdoor activity

Key online resources
(all accessed January 28, 2013)

Healthy Child Health World
www.healthychild.org
Aimed at empowering parents to protect children from environmental chemicals

Environmental Working Group
www.ewg.org
Education and advocacy to reduce toxic burden

Skin Deep
www.ewg.org/skindeep
A searchable database of chemicals used in personal care products

Taking an Exposure History
www.ocfp.on.ca/docs/committee-documents/taking-an-exposure-history.pdf
A clinical tool to support the evaluation of environmental exposure

Government of Canada "Healthy Canadians"
www.healthycanadians.gc.ca/environment-environnement/index-eng.php
Resources to improve the quality of the living environment for families

Canadian Partnership for Children's Health and Environment
www.healthyenvironmentforkids.ca
Research, education and advocacy

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