



Medical Group

Archives of Community Medicine and Public Health

ISSN: 2455-5479

DOI

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Dates: Received: 01 January, 2017; **Accepted:** 01 April, 2017; **Published:** 04 April, 2017

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Keywords: Autoimmune disease; Glyphosate; Probiotics; Lactobacillus; Microbiome; Healthcare costs; Government regulations

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Research Article

Autoimmune Disease: Budget-buster or Enlightened Solutions?

(The coming epidemic and the new administration in Washington)

Abstract

A rising epidemic among Americans threatens to disrupt the new US administration's promise of affordable health insurance for all. The epidemic consists of a dramatic and ongoing increase in the incidence of autoimmune diseases (AD) across the populations of nearly all Western countries, diagnosed under approximately 100 different disease labels, and currently estimated to afflict up to 50 million Americans. One potential reason for the epidemic appears to be autoimmune reactions in people to immune 'triggers' in foods, a prime example of which may be the newly described GMO foods' antigenic glyphosate-induced misfolded proteins. An analysis was undertaken, using a case study approach, to compare the relative cost/benefit ratios of treating the oncoming AD epidemic among Americans using the standard medicine (SM) pharmaceutical immunosuppression drug treatment model as compared to treating AD using a functional medicine (FM) approach of probiotics, lifestyle modification and improved diet choices along with governmental regulations to reduce consumption of trigger foods. We conclude that, for the American people over the next 10 years, applying only SM could cost up to \$2 trillion more than a potentially equally or more effective diagnosis and treatment program emphasizing FM and government action to reduce trigger food consumption and avoid confounding influences from industry. While these two models are not mutually exclusive, our analysis suggests that the US government has a series of difficult choices ahead which will impact both its population's health and the affordability of their health insurance over the next decade and beyond.

Abbreviations

AARDA: American Autoimmune Related Diseases Association, Inc.; AD: Autoimmune disease; ADHD: Attention deficit hyperactivity disorder; AS: Asperger's syndrome; D: Democrat; DNA: Deoxyribonucleic acid; FL: Florida; FM: Functional medicine; GDP: Gross domestic product; GMO: Genetically modified organism; IgG: Immunoglobulin; IL: Illinois; MN: Minnesota; NCAAPG: National Coalition of Autoimmune Patient Groups; NHE: National Health Expenditure; R: Republican; RNP: Ribonucleoprotein; SM: Standard medicine; SSA: Sjögren's syndrome A; TNF: Tumor necrosis factor; USDA: United States Department of Agriculture; WHO: World Health Organization

Introduction

There has been a dramatic recent rise in the incidence of autoimmune disease in industrialized countries [1], and this has been associated with dysbiosis in the gut [2]. It has been proposed that this increase may be due to environmental triggers from processed foods [3], especially foods contaminated with glyphosate, embedded within misfolded and/or proteolysis-resistant proteins [4,5].

At the same time, disagreement about the health system in the USA abounds today. The American government is currently undergoing a wholesale revision of the health insurance and medical re-imburement regulatory environment. Further, by some measures, and according to some critics, the USA spends more on healthcare than any other country while delivering relatively less health for its citizens [6].

Critics say, for example, that the Food and Drug Administration and congress are beholden to the pharmaceutical industry [7]. Medical education and clinical trials of new drugs are subsidized and influenced adversely by the pharmaceutical industry [8], say these critics. Big agribusiness is said to influence the USDA and other government agencies through misinformation about healthy choices, such as in recommendations for diet of whole grains as 25% of the Nutrition Plate [9-11]. Such grains, some experts believe, have toxic components such as antigenic proteins, and dangerous contamination levels of pesticides, particularly glyphosate [4,5].

Furthermore, critics allege that the Environmental Protection Agency issues regulations favoring industry while allowing harmful levels of pesticides in food and widespread distribution of genetically modified foods containing toxins

in unprecedented amounts [2-5,12]. Also, say critics, the medical profession is essentially captured financially within this system, such as by medico-legal practice guidelines [13] issued by experts who regulate in favor of special interests and against the public interest, thus limiting practice options and adequate reimbursement for the more effective and economical approaches.

Study Design

In this setting, we have chosen the oncoming epidemic of autoimmune disease on which to author a case-study-based analysis to answer the following question in regard to the USA: If no other consideration but optimizing the health of the American population in a cost effective and forthright manner was paramount, how should the American people and their government proceed?

Epidemics can be costly; autoimmune disease may be next

The typical patient with autoimmune disease [14,15] is a woman (the X chromosome is thought to house predisposing genetics) who may or may not, over a number of years, progress irregularly from vague complaints such as joint pain, muscle pain, and fatigue to perhaps more serious debility, to perhaps eventually organ failure, and in some cases even death. If the case presents as textbook lupus or Crohn's disease or rheumatoid arthritis, the patient might be routed directly to disease-specific treatment early. However, more commonly and due to difficulty in diagnosis for most cases, non-specificity in test results, varying intensity of symptoms over time, and other factors, patients are often attended by multiple physicians over years until an autoimmune disease label is finally attached. Meanwhile, the costs mount in terms of suffering in the patient, and financial costs both to the patient and to the healthcare system of the country overall. Incidence and prevalence figures are shown in Table 1.

The epidemic of autoimmune disease

The frequency of AD in the USA over the past 3 decades has been rising at an astounding 8.8% average annual increase, according to experts [1]. The pattern of rising incidence of some of the more commonly recognized autoimmune diseases is depicted in figure 1.

In a recent review of the subject [15], researchers summarized the situation as follows: "Taken together, the number of people suffering from autoimmune diseases is 24-50 million Americans, 16% of the US population. To put it in perspective, autoimmune disease prevalence equals heart disease and cancer combined."

Complicating the diagnosis of autoimmune disease, it appears that the appropriate training needed for recognizing and treating autoimmune disease is not widespread among primary care practitioners. As Abid Khan, MD, founder of one of the first Autoimmune Disease Clinics in the USA, described it [14]. "I started seeing a lot of patients, especially women, who have seen other specialists and who were dismissed as having

fibromyalgia, chronic pain syndrome, depression, anxiety. A subset of those patients, in fact, did have those diagnoses, as well as an autoimmune disease, but were dismissed as being complainers. No workup was done. Their leads were not followed up on. There was never any biopsies done or blood tests done. And when they were done, the right kind of test may not have been ordered, or the test may have been appropriately ordered but testing methods at the lab may not have been optimal."

What's causing the increase?

Causation - that was the subject Dr. Noel R. Rose, M.D., director of Johns Hopkins Autoimmune Disease Research Center, was addressing when he said, [14] **"There has to be some kind of environmental exposure, because genetics—which account for about a third of all cases—don't change that fast. Environmental triggers will be the next wave of research."**

Indeed, results of important work in such research are now becoming available. Two recent papers propose that the current epidemic in autoimmune disease may be primarily due to the active ingredient in the pervasive herbicide, Roundup [4,5]. Glyphosate, acting as a non-coding amino acid analogue

Common Autoimmune Diseases	Incidence Estimates	Prevalence Estimates
Hashimoto's Disease	---	14 Million in 2008
Inflammatory Bowel Disease	70,000 per year [2014]	1.6 Million in 2014
Multiple Sclerosis	200 per week [2015]	400,000 - in 2015
Psoriasis	---	7.4 Million adults in 2013
Rheumatoid Arthritis	---	1.3 Million in 2009
Sjogren's Syndrome	---	4.0 Million in 2014
Type 1 Diabetes	---	1.25 Million in 2012

Table 1: Modified from Feldman et al. [15]. A Snapshot of Incidence-Prevalence Numbers for Autoimmune Disease in USA.

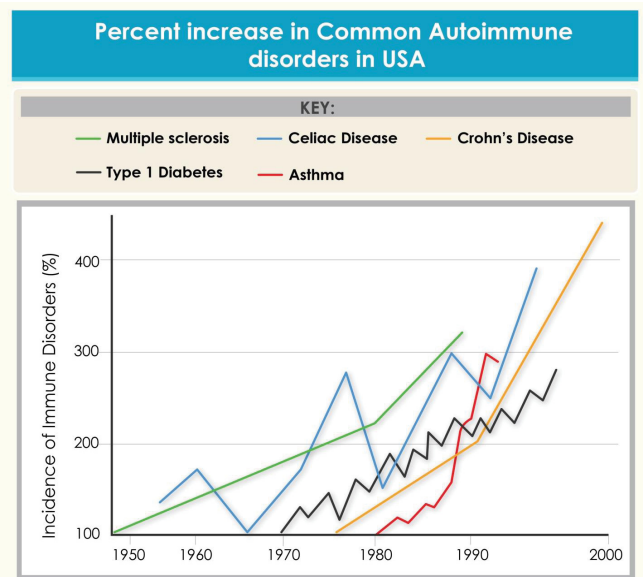


Figure 1: Bach JF. The Effect of infections on susceptibility to autoimmune and allergic diseases. N Engl J Med. Sep 2002;347(12):911-920.

of the coding amino acid, glycine, may be getting into proteins through a substitution error during synthesis in place of glycine [4,5]. This alters the function of these proteins, sometimes in catastrophic ways. In particular, it causes them to resist proteolysis, and this can lead to autoimmune disease through molecular mimicry [16]. The widespread adoption of core crops genetically engineered to resist glyphosate since the late 1990's led to a corresponding dramatic rise in the use of glyphosate in agriculture [17], such that it is now the most widely used herbicide in the world.

A critical finding in a paper (soon to appear) is that multiple vaccines that are administered to children at a young age are contaminated with glyphosate [18]. This is likely due to the fact that the vaccines often contain products derived from cows and pigs fed a high dose of glyphosate in their feed, such as fetal bovine serum, bovine or porcine gelatin, and chicken eggs. In fact, the authors showed that high levels of glyphosate are present in bovine collagen [18], a protein whose amino acid sequence contains up to 25% glycine residues. Also significant is that glyphosate was found in porcine pepsin and trypsin, digestive enzymes that are important for protein metabolism in the gut. Unmetabolized proteins lead to autoimmune disease through molecular mimicry. Autism has recently been recognized as an autoimmune-related disorder by many experts. Specifically, researchers demonstrated, in a 2013 study of more than 2,700 mothers of children with autism, that about one in 10 mothers have antibodies in their bloodstream that react with proteins in the brain of their babies [19].

After diagnosis, treatment, but at what cost/by which protocol?

The National Health Expenditure Fact Sheet [20] outlines healthcare costs, as shown in Table 2 below for 2015, the most recent year for which data are available.

Specific costs are not easily ascribed to the category of autoimmune disease due to difficulty in collating costs

among various diagnoses. For example, standard therapy with immunosuppressive drugs (SM) is associated with significant adverse effects and toxicity, requiring monitoring and managing adverse effects, for which surveillance may need to continue long after the drugs have been stopped [21]. Among those side effects are risk for development of cancer, in particular cutaneous and hematological cancers [21]. The commonest cause of long-term morbidity and mortality in patients with autoimmune disease is cardiovascular disease. Women less than 45 years old with systemic lupus erythematosus are 50 times more likely, and patients with rheumatoid arthritis are twice as likely, to have a myocardial infarct in the next 8–10 years when compared with healthy age- and sex-matched controls [21].

Nevertheless, cost estimates have been proposed, as for example by the American Autoimmune Related Diseases Association, Inc. (AARDA) in their April 2013 online statement [22]: “Some 50 million Americans live and cope with autoimmune disease (AD), 75 percent of whom are women. AD is one of the top 10 leading causes of death of women under the age of 65. It encompasses more than 100 diseases, including psoriasis, Graves’ disease, Sjögren’s syndrome, multiple sclerosis, rheumatoid arthritis, Crohn’s disease and lupus. It is responsible for more than \$100 billion in direct health care costs annually.” In the 2011 report [23] by AARDA and the National Coalition of Autoimmune Patient Groups (NCAPG) entitled *The Cost Burden of Autoimmune Disease: The Latest Front in the War on Healthcare Spending*, cost analysis included adding the out-of-pocket patient expenses, the cost to work productivity and earnings, and the impact on disability and Medicare, resulting in their analysis concluding that true costs extend to hundreds of billions of dollars. Among the solutions to control costs, they suggested streamlining the process of diagnosis, funding research at the national level, and coordinating functional medicine (FM) care via community-based triage centers.

Estimating future costs

To attempt to address the potential future costs of the oncoming epidemic of autoimmune diseases, we have chosen to compare anticipated costs of treatment using Functional Medicine (FM) as the main therapeutic tool versus Standard Medicine (SM) as characterized by routine laboratory testing, immune suppressive drug use and standard hospital care. In this context, we will review the case of an 11 year old girl stricken with autoimmune disease, a case reported online by Dr. Mark Hyman [24], used herein as an example of how autoimmune disease treatment costs can vary by treatment protocol. But first, we will explore research regarding the immune system, and an example of how a simple ‘treatment’ such as supplying probiotics to infants, can alter the future risk of autoimmune disease.

The immune system, probiotics and autoimmune disease risk

An excellent article to look to for basic understanding of how autoimmune disease arises and how to reduce risk is a review article which appeared in the American Journal of

Historical National Health Expenditure- 2015

NHE grew 5.8% to \$3.2 trillion in 2015, or \$9,990 per person, and accounted for 17.8% of Gross Domestic Product(GDP).
Medicare spending grew 4.5% to \$646.2 billion in 2015, or 20 percent of total NHE.
Medicaid spending grew 9.7% to \$545.1 billion in 2015, or 17 percent of total NHE.
Private health insurance spending grew 7.2% to \$1,072.1 billion in 2015, or 33 percent of total NHE.
Out of Pocket spending grew 2.6% to \$338.1 billion in 2015, or 11 Percent of total NHE.
Hospital expenditures grew 5.6% of \$ 1,036.1 billion in 2015, faster than the 4.6% growth in 2014
Physician and clinical services expenditures grew 6.3% of \$634.9 billion in 2015, a faster growth than the 4.8% in 2014.
Prescription drug spending increased 9.0% to \$324.6 billion in 2015, slower than the 12.4% growth in 2014.
The largest shares of total health spending were sponsored by the federal government (28.7 percent) and the households (22.7percent). The private business share of health spending accounted for 19.9 percent of total health care, other private revenues accounted for 6.7 percent spending, state and local governments accounted for 17.1 percent, and other private revenues accounted for 6.7 percent.

Table 2: Modified from CMS.gov.

Experimental Immunology in 2013 [25]. The basic message is that, when we understand that the prime contact our immune system has with the environment is the gut, our intestine, we can supply inexpensive corrective measures which are remarkably effective. The first lesson we should understand is that an equilibrium arises naturally within the gut between defense against invasive pathogens versus tolerance for innocuous substances and beneficial organisms. However, the most crucial time to receive the beneficial bacteria is perhaps in infancy. Autoimmune disease appears to arise when this delicate equilibrium is disturbed, such as by humans not receiving the appropriate balance of beneficial bacteria early in life, or through periodic or chronic exposure to antibiotics and other toxins that disrupt the microbiome balance. Fortunately, by re-introducing this equilibrium through supplying probiotics, and then maintaining a healthy gut through appropriate dietary choices, it appears we may short-circuit autoimmune disease risk at relatively low cost.

For example, we humans co-evolved with our microbiome, those bacteria which reside in our intestine and which in normal circumstances consist of over 500 beneficial species, existing in harmony. However, whereas once we acquired such a microbiome in a natural manner, such as during vaginal birth, 32% now are born via Caesarian section [26]. This reduces the acquisition of a normal microbiome. Similarly, indiscriminate use of antibiotics causes defects in our microbiome. Glyphosate is itself patented as an antimicrobial agent, and it behaves like a chronic low dose antibiotic through its pervasive presence in our food, and it preferentially kills beneficial bacteria [27].

When the normal microbiome is imbalanced, pathogenic organisms find it easier to set up shop. For example, researchers [28] have found that, where *Candida albicans* infection develops, although a normal microbiome might resist or overcome such an infection, the risk of developing Celiac disease is increased in susceptible individuals. The trigger for Celiac disease in that circumstance, according to recent research [28], appears to be a cross-reaction between *Candida albicans* protein and gliadin protein, a grain protein in diet. This is especially pronounced in genetically-susceptible individuals. Presence of glyphosate in the grain protein, due to the now widespread practice of spraying wheat with glyphosate just before harvest as a desiccant, will cause it to resist proteolysis, and presence of glyphosate in the digestive enzymes, impairing their function, will have a synergistic role.

On a brighter note, in a landmark prospective study [29], researchers in Finland demonstrated that re-establishing a more normal microbiome, even just through a one species addition one time of *Lactobacillus*, can have remarkable and long lasting benefits. Seventy-five infants who were randomized to receive *Lactobacillus rhamnosus* GG (ATCC 53103) or placebo during the first 6 months of life were followed up for 13 years. At the age of 13 years, Attention Deficit Hyperactivity Disorder (ADHD) and/or Asperger's Syndrome (AS) was diagnosed in 6/35 children (17.1%) in the placebo and none in the probiotic group ($P = 0.008$). The conclusion suggested by the study is that a single dose of a single species of probiotic substantially reduced the risk. Although the testing was only for these

two conditions, the authors suggest that the risk of other autoimmune disorders might have similarly been reduced across the board.

The choice of *Lactobacillus rhamnosus* was based on its known ability to deter activity of the fungus *Candida* in the human body [30]. For example, a randomized clinical trial had previously been undertaken with 80 premature infants, with a view to preventing candidiasis. *Candida* can be a major threat to the lives of such infants with their underdeveloped immune systems. The group of infants receiving *L. rhamnosus* for six weeks were significantly less likely to have their intestine colonized by *Candida* (23% compared with 49% in the control group). *Lactobacillus* is one of the most adversely affected species following exposure to glyphosate, probably because of its strong dependency on manganese, which glyphosate chelates, making it unavailable [31].

Multiple strains of *Lactobacillus* and other enteric bacteria have been found to be beneficial as probiotics in humans, treating autoimmune diseases ranging from colitis to eczema to rheumatoid arthritis [32-34]. Oral administration of a probiotic supplement containing *Lactobacillus plantarum* to mice protected them against neuronal injury and abnormal behavioral effects induced by aluminum exposure [35]. Research on mice with social deficits linked to a microbial imbalance demonstrated remarkable behavioral improvements through supplements with *Lactobacillus reuteri*, a species found in human breast milk [36]. There are many papers showing benefit of *Lactobacillus* in particular in treating rheumatoid arthritis that was induced in rats in models where collagen is used as a trigger for disease together with lipopolysaccharide or Freund's adjuvant [37-40]. Collagen likely plays an important role in human autoimmune disease, particularly due to its high glycine content, making it especially susceptible to glyphosate substitution. Indeed, high levels of glyphosate have been found in bovine collagen [18].

Case Presentation

The case history of 11-year old Isabel is available online [24]. Briefly, here is how the attending physician, Dr. Mark Hyman, described her presentation: "Isabel, a cute 10-year-old girl from Texas who loved riding horses, walked into my office a year and a half ago with one of the most severe cases of autoimmune disease I had ever seen. Her face was swollen, her skin was inflamed (see photos online), her joints were swollen, her immune system was attacking her entire body - her muscles, her skin, her joints, her blood vessels, her liver, and her white and red blood cells. Isabel couldn't squeeze her hand or make a fist. The tips of her fingers and toes were always cold from Raynaud's disease that inflamed her blood vessels. She was tired and miserable and was losing her hair. Isabel was on 'elephant' doses of intravenous steroids every three weeks just to keep her alive, and she was taking prednisone, aspirin, acid blockers, and methotrexate, a chemotherapy drug used to shut down the immune system daily. Despite these mega-doses of medication she still wasn't getting any better, and her lab tests were still abnormal. Her doctors wanted to add another powerful immune suppressing drug (a TNF alpha blocker) to the regimen of medication she was already taking. This drug

increases the risk of cancer and death from overwhelming infection, because it prevents the immune system from fighting infections normally. The inflammation slows down; thus, the autoimmune symptoms may abate, but you are at risk for cancer and infection. Unwilling to accept this as the only course of treatment, they came to see me.”

Dr. Hyman has separately published steps for autoimmune disease treatment, which are available online [41], and are as follows:

Dr. Hyman's 'Nine Steps to Treating Autoimmune Disease'

1. Check for hidden infections — yeast, viruses, bacteria, Lyme, etc. — with the help of a doctor, and treat them.
2. Check for hidden food allergens with IgG food testing or just try *The UltraSimple Diet*, which is designed to eliminate most food allergens.
3. Get tested for Celiac disease, which is a blood test that any doctor can do.
4. Get checked for heavy metal toxicity. Mercury and other metals can cause autoimmunity.
5. Fix your gut. For details, see my [Dr. Hyman's] blog on irritable bowel syndrome.
6. Use nutrients such as fish oil, vitamin C, vitamin D, and probiotics to help calm your immune response naturally.
7. Exercise regularly — it's a natural anti-inflammatory.
8. Practice deep relaxation like yoga, deep breathing, biofeedback, or massage, because stress worsens the immune response.
9. Tell your doctor about functional medicine and encourage him or her to get trained.

Case evaluation by attending physician

This is how Dr. Hyman described online his initial evaluation of Isabel [24]: “When I talked to Isabel the first time, I found many potential triggers for her inflammation. She was being exposed to a toxic mold, *Stachybotrys*, in her house. Her mother worked in limestone pits exposing her to excessive amounts of fluoride while pregnant. Isabel had all her immunizations before 1999 when thimerosal was removed from vaccines. She also had a thimerosal-containing flu shot every year. Thimerosal contains mercury and mercury is a known immune toxin. This problem was compounded by her diet, which included large amounts of tuna and sushi which she loved and ate regularly (and which exposed her to even more mercury), and loads of dairy, gluten, and sugar. In the year before she got sick, she also had many courses of antibiotics.”

“Mold, mercury, antibiotics, sugar, dairy, gluten—all potential immune irritants.”

“Isabel's lab tests at her first visit with me were frightening. Her muscle enzymes and liver function tests showed severe damage. She had many autoimmune antibodies (anti-nuclear antibodies, rheumatoid factor, anti-SSA, anti-DNA, anti-RNP, lupus anticoagulant), a sign that the levels at which the body was attacking itself were extremely elevated. Other markers of inflammation were extremely high as well. Her white blood count and red blood cell count were low. Her vitamin D was also low. She had elevated levels of antibodies to gluten, which is a common cause of autoimmune disease and triggers significant intestinal inflammation. And her mercury level was extremely high in her urine after a provocation test (the only way to assess total body burden of metals). Normal is less than three. Hers was 33.”

Case treatment results

Any unbiased observer would say the results of treatment were amazing. Dr. Hyman posted online [24]: “Two months after I first saw Isabel and discovered and treated the underlying causes of her inflammation—after, as she says she, ‘stopped eating gluten, dairy, and sugar and took some supplements’ she was symptom free. In less than a year, she was completely healthy (see photo online), her blood tests were normal, and she was off all her medication.” It is heartening to see the difference [24,41] in the ‘before treatment’ and ‘after treatment’ photos of Isabel posted online by Dr. Hyman. It should be noted that dairy, gluten and sugar are all foods that are likely to be highly contaminated with glyphosate, with casein and gluten supplying glyphosate-embedded allergenic peptide sequences provoking autoimmunity through molecular mimicry.

Analysis

Method for cost analysis

In our present analysis, using the case study of Isabel, we will apply the following determinations for the oncoming epidemic of autoimmune disease (AD). We will assign a cost to preventative probiotics use in children, in line with results of probiotic use in children. We will also assign a cost to dietary change involving mainly a switch to 100% certified organic food [42,43]. We will apply a factor of risk reduction to that treatment, and a corresponding cost savings. We will apply a cost estimate to autoimmune disease treatment as applied where possible at least partially in accordance to the protocols of the AARDA/NCAPG recommendations [23] and Dr. Hyman [41]. We will contrast these estimated costs to the estimated costs of no probiotics preventative care or dietary modifications and treatment according to standard methods, as exemplified by Isabel's case prior to her visits to Dr. Hyman.

Probiotics preventative treatment and organic food

Providing probiotics to children across the USA, in a school nurse administered voluntary program in elementary school once per school year, can be estimated to cost \$0.10 per treated student. Admittedly, this is a rough estimate. However, we think this is reasonable, especially if we consider a future time when mass production can reduce cost. For example, Walgreens

currently offers a twin pack of 200 tablets of Acidophilus plus Lactobacillus probiotics for \$16.00, which comes to \$.08 per tablet.

Where 25% of students are treated, a low estimate of uptake of offer to treat, the cost would be approximately:

36 million students in elementary school x 0.25 x \$0.10 = \$900,000

The benefits estimate, based on the Finland study, are a reduction in risk of autoimmune disease of 25%. The cost of adopting a 100% organic diet is variously estimated at up to approximately a 50% increase in food cost per year, and potentially offset by cost-saving strategies such as ending purchases of boxed cereal and other fast-food products, accessing nearby farmers' markets, etc. [42,43].

Cost using standard treatment

Cost estimates of a chronic disease are notoriously difficult to quantify and estimates vary widely depending on the statistical method employed [44]. Furthermore, in the case of autoimmune disease (AD), the cost estimation is further uncertain for reasons previously mentioned, including difficulty in collating among different disorders. What is herein presented is necessarily not rigorous, given the inevitable lack of definitive data and multiple unknowable factors. Nevertheless, the analysis presented here may serve as a starting point for others to more precisely define measurements as data become available. Hence, what is presented is a thumbnail "first go" at the issue. Therefore, based on an assumed starting cost of AD annually, roughly based on the AARDA/NCAPG estimate of 'hundreds of billions' of dollars in current treatment/social costs, and rounding to \$250 billion as current-year estimate for use here, what follows is a first rough analysis. With regard to AD treated using SM, and using an estimated increase in disease prevalence annually which varies from increasing approximately 9% in the early years to increasing approximately 5% in later years, and calculating using flat cost of treatment over the 10 years period, the cost of SM treatment costs can be roughly estimated as follows:

$\$250 \text{ billion} \times (1.10 + 1.2 + 1.3 + 1.4 + 1.5 + 1.6 + 1.7 + 1.8 + 1.9 + 2.0) = 15.5 \times \$250 \text{ billion} = \$3.87 \text{ Trillion}$

Cost with probiotics prevention and functional medicine protocol

By correspondence, starting with the same current treatment costs and AD disease incidence, and by applying cost reduction estimates in regards to the probiotics plan in schools, the FM treatment approach, but adding cost estimates for training and triage center establishment in the first 2 years, and operation in the following 8 years, a thumbnail rough approximation of comparative costs can be derived as follows:

Beginning in year 3, a factor for disease incidence reduction in AD incidence over the next 8 years of the 10 year period is assigned, occurring theoretically as the probiotics-treated cohort ages and the consumption of trigger foods is reduced

via public education, warning labels and retail sales taxes on added sugar and glyphosate- or wheat-containing-foods, thus reducing AD incidence, and therefore reducing further the treatment costs simultaneously, as happened in Isabel's case. The observed savings in the Isabel case are unknowable in exact amount, but should include a reduced treatment cost in as much as no additional drugs were used, and a reduced incidence of post-immunosuppression side effects, since no further immunosuppressive drugs were applied, and less disability costs, less family costs, and less health insurance claim costs.

Hence, this thumbnail estimate for reduced treatment costs per case for FM as compared to SM over the full scope of a reduced number of AD cases overall would account for significant savings, we assume. Taken together, these two main factors are roughly assumed to justify an AD cost reduction in the 8% to 20% annual range, beginning in year 3 and progressively more prominent as the probiotics-treated cohort ages. Accordingly, this rough accounting yields the following:

$\$250 \text{ billion} \times (1.11 + 1.2 + 1.1 + 1.0 + 0.9 + 0.8 + 0.7 + 0.6 + 0.5 + 0.4) = 8.31 \times \$250 \text{ billion} = \$2.08 \text{ Trillion}$

Further cost savings via tax on triggers

It makes sense to tax foods which contain triggers for autoimmune diseases. For example, if, in addition to the measure described above, it was additional policy of the government to tax added sugar in food/beverages at 1.0 cent per gram added sugar, and tax capture of 20% of added sugar versus total per capita consumption, and a factor of reduced consumption due to tax of 30%, with the resulting funds used to defray the costs of treating the coming autoimmune disease epidemic, the cost analysis over 10 years is reduced by the following amount:

$(150 \text{ lbs/citizen}) \times 454 \text{ gm/lb} \times .2 \text{ capture} \times \$0.01 \text{ tax/gm} \times 330 \text{ million citizens} \times 0.7 = \$32 \text{ Billion annually} \times 10 \text{ years} = \$0.32 \text{ Trillion in taxes}$

These taxes would logically be levied by the same legislative bodies that currently tax tobacco, i.e. federal, state, and even city authorities. It should be noted that such tax-based incentives are already happening. In the November, 2016 election in the United States, a soda tax initiative was on the ballot in three cities (two in California and one in Colorado). All three initiatives passed, indicating that voters are supportive of measures of taxing trigger foods.

It would also be of great value to determine glyphosate contamination levels in various food products and heavily tax those products that are found to generally be highly contaminated with glyphosate. This would also encourage farmers producing these foods to switch to growing organic versions instead in order to avoid the "glyphosate tax."

While we have not conducted any tests of glyphosate contamination in foods in association with this paper, we believe that tests already conducted by the Canadian government are



sufficient to show that there is widespread contamination. An effort is now underway in Canada, spearheaded by the activist, Tony Mitra, in cooperation with the Canadian government, to quantify glyphosate contamination in various foods, and based on country of origin. Mitra has now published an e-book detailing his findings from perusing over 7,000 records of glyphosate test results for various foods consumed in Canada. A logical next step would be to assign a tax proportional to mean glyphosate contamination levels in products identified as especially highly contaminated, such as lentils and beans sprayed with glyphosate before harvest [45].

Bottom Line Comparison of Costs of Autoimmune disease over next 10 years

\$2.08 Trillion – \$0.32 Trillion = \$1.76 Trillion FM model
vs \$3.87 Trillion SM model

We estimate that the financial cost of the upcoming autoimmune disease epidemic can be cut by more than half via using probiotics prevention, FM protocol for treatment, and a small retail tax on selected foods/beverages with added sugar and/or glyphosate contamination.

Other tax revenue – recommended beneficial uses

For those who believe that a 1 cent per gram tax at retail on added sugar in foods and beverages is insufficient to yield the hoped-for-benefit of reducing per capita sugar consumption, additional tax revenue can be recommended.

Using a portion of the expected funds from the above described additional taxes for useful public purposes might include: Subsidizing organic food costs for families defraying costs of organic farming, including costs of certification and training; even paying members of congress an equal amount of money as they received in political donations from special interests/industry the previous year, on the promise they would support the Functional Medicine, Probiotics, organic diet prevention method and improved triage system funding herein described. Such cost might be relatively small, as the chart in Table 3 of top recipients in 2015–2016 of sugar lobby donations suggests [46]. While amounts ranging in the tens of thousands of dollars may seem large at a personal level, they are very small in comparison to the costs of treating diseases that are caused by toxic chemicals in the food.

Discussion

It is obvious that one case may not be representative of an entire epidemic, and that one ‘cure’, however impactful, may not translate into prevention or treatment across the board. Meanwhile, the World Health Organization (WHO) and others [47–57] have spoken of the curative and preventative power of functional medicine style (FM) diet, nutrition, and treatment. Further, if the proposed program for voluntary probiotics in schools, and for enabling FM based treatment, education and regulation, is undertaken, adjustments will be needed as the program proceeds. Nevertheless, given the stakes involved, a

logical foundation upon which to build appears to have been reasonably advanced herein.

Childhood probiotic foods in the school setting are now being offered on the menus of selected schools in the USA [58]. If this program proves to have value, it can be expanded. A potential means to overcome bureaucratic, special interest and political obstacles has been outlined.

The cost of the impending epidemic can perhaps still be halved if action at the national level is taken soon. If the herein described national program is considered, it is logical to argue for the recommendations of national organizations such as AARDA and NCAPG. Treatment protocols similar to that recommended by Dr. Mark Hyman would merit consideration by experts empaneled to decide on practice guidelines, and wherein no special interests are given primacy.

Who could disagree that the nation would be best served by education based on science, in elementary school, high school, college, nutrition training and medical school? Such education should include a revision of the Nutrition Plate, in recognition of science and the influence of trigger foods on autoimmune disease causation.

Functional medicine (FM) is currently not much supported by the pharmaceutical industry, it seems for the obvious reason that FM eschews a prime reliance on drugs. Similarly, various organs of government which harbor special interests do not place emphasis on promoting FM. These undermining elements should be resisted or corrected. As part of the future, sufficient monies for clinical trials wherein FM is given a chance to perform against standard approaches should be provided by government. The potential savings to taxpayers justifies such an approach immediately, and patients have noticed that nutritional self-adjustments have helped their symptoms, and are therefore asking practitioners for them as part of their therapy [59]. Change is slow, but some medical schools have started teaching their students how to cook so the graduating doctors will feel comfortable when counseling patients on nutrition [60]. The recently reported success in reducing AD in patients by teaching them how to avoid certain lectin-containing foods is encouraging [61,62].

Top Recipients, 2015-2016, Sugar Lobby Donations

Candidate	Office	Amount
Rubio, Marco (R-FL)	Senate	\$90,725
Curbelo, Carlos (R-FL)	House	\$45,400
Clinton, Hillary (D)		\$44,104
Peterson, Collin(D-MIN)	House	\$41,600
Duckworth, Tammy (D-IL)	House	\$38,500

Table 3: Modified from opensecrets.org.

A pilot program of public advertising warning of foods which contain likely triggers for autoimmune disease should be instituted. If successful, warning labels could be mandated by congressional action in a manner similar to the restrictions on smoking and cigarette sales. Furthermore, trigger food sales could be taxed at retail, and revenue used to further the program of prevention and treatment. In light of the newly confirmed science regarding glyphosate and its potential to cause increased triggering potential for autoimmune disease, foods which contain high levels of glyphosate would carry a warning.

Conclusion

The United States of America and its people appear to be at a crossroads with regard to health care and health insurance. Just as they face a re-organization and new administration, the country also appears to be facing a rising autoimmune disease epidemic. If the recommendations herein described are implemented to enable FM and spur governmental action to reduce trigger food consumption, it appears that a major savings could be realized, both as a reduction in suffering for the population, and as a significant decrease in cost to the American taxpayer.

Acknowledgement

This work was funded in part by Quanta Computers, Taipei, Taiwan, under the auspices of the Qmulus Project.

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