Oxidative Stress Index as A Public Health Survey Instrument

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Abstract—Recently, a method for assigning the probability of disease onset to all people, those clinically ill as well as those without prevalent disease, has been described and termed the Oxidative Stress Index (OSI). The OSI has also been used to show which disease causing parameters are more contributory to the onset of Alzheimer's disease and projected a similar capability for other diseases. A third application of the OSI is presented here. It can be used as a public health survey tool to shed light on the health impacts on people living or working proximate to points of pollutant releases.

I. INTRODUCTION

People with chronic diseases and those who are disease free but living unhealthy lifestyles are known to be candidates for numerous non-communicative diseases, as well as more frequent and more severe bouts with infectious diseases [Zeliger 2016]. Recently, a method for assigning the probability of disease onset to all people, those clinically ill as well as those without prevalent disease, has been described and termed the Oxidative Stress Index (OSI). This method is a non-invasive diagnostic protocol based upon a questionnaire addressing oxidative stress (OS) elevating factors that include genetics, disease status, lifestyle and environmental exposure with the sum of the positive answers equal to the OSI [Zeliger, 2017, 2019]. It has been recently shown that the OSI is an indicator of parameters that elevate the likelihood of the onset of Alzheimer's disease and projected be so used to demonstrate which parameters may be associated with the onsets of other diseases [Zeliger 2019a].

The OSI, as originally formatted, does not predict which disease will more likely develop with increasing OS, only that further disease is predicted with increased OS, as numerically shown by elevated OSI values. It is proposed here that the OSI may also be used to carry out public health surveys to determine increased risks for disease onset to individuals who are chronically exposed to environmental pollutants such as air pollutants emanating from chemical and petroleum storage and transfer sites, power plant and other industrial stacks, leaking toxic landfills, heavy metal recycling plants and other OS elevating factors such as electromagnetic radiation. Using the OSI, members of communities that are impacted by chronic environmental spills and releases can be surveyed to determined how proximity to release points and durations of exposure can predict the likelihood of disease onset.

II. METHODS

The hypothesis proposed here is based upon a literature review of published studies on the causes of OS and OS induced disease, methods of measuring OS and the empirical and mechanistic associations between OS and disease onset [Zeliger 2016 and the numerous references contained therein. The questionnaire used to determine OSI contains questions that address all OS raising factors, including genetic factors, environmental exposures, lifestyle and current disease status and treatment.

III. RESULTS AND DISCUSSION

A. Oxidative Stress

It is well known that all disease is accompanied by elevated OS, a property whose status can be measures by a number of biomarkers, including F2-Isoprostanes, lipid hydroxides and hydroperoxides, hydroxycholesterols, aldehydes and ketones [Zeliger, 2016]. Of these, the most widely used is malondialdehyde (MDA), which is stable in serum, as well as readily and accurately analyzed for [Nielsen, et al, 1997]. MDA level, as well as other biomarkers, however, can vary widely depending upon food eaten, environmental exposures, state of one's health or even the time of day when serum is drawn [Nielsen, et al, 1997]. The OSI questionnaire reduces such uncertainty by addressing multiple aspects of a person's regular life, including disease status, medications, diet, employment, environmental exposures, and stress, etc., that elevate OS [Zeliger 2016].

B. Dose Response Relationship

Total Oxidative Stress has been shown to be related to disease onset, whether coming from single sources or from combinations of multiple sources, in a dose response relationship [Zeliger, 2016]. Hence, the OSI can reliably predict the likelihood of disease onset in people exposed to OS elevating sources when compared to cohorts not so exposed [Zeliger 2017, 2019a].

C. Late Onset of Disease

OS caused diseases manifest themselves only after long term (years or decades) exposures to causative agents. Examples of such diseases are cardiovascular diseases, type 2 diabetes, respiratory diseases (including asthma and COPD), numerous cancers and neurological diseases (including Alzheimer's disease). Genetic factors as well as chronic exposures to OS raising chemical pollutants and radiation are well known to be associated with these late

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onset diseases [Swaroop, et al., 2009; Zeliger and Lupinski, 2015].

D. Questionnaires

Questionnaires, such as the Charlson Comorbidity Index, are routinely used to solicit patient background information on prevalent diseases, symptoms and likelihood of further disease onset [Charlson et al., 1987]. The Alzheimer's Questionnaire is another example [Sabbagh, et al., 2010].

E. The Oxidative Stress Index In Health Surveys

It is well known that chronic exposures to chemical pollutants are a cause of numerous environmental diseases. For example, living proximate to heavily traveled highways results in a greater likelihood of respiratory disease onset and that the likelihood declines in a linear fashion as place of residence is distanced from such highways, where airborne concentrations of vehicle exhausts also decline linearly [Huynh, et al, 2010]. Accordingly, the closer one resides to a heavily traveled highway, the greater the exposure to exhaust pollutants and the greater the oxidative stress impact on one's body. Thus, using the OSI, it becomes possible to numerically assign probabilities of disease onset related to such exposure as a function of distance from a disease causing emission source. Adding distancing questions to the OSI and surveying individuals at varying distances from a pollutant emission source up to distances where these emission provide zero impact, i.e., where levels of the pollutant equal ambient background levels up to background levels enables the one to assess the pollution (and hence the oxidative stress) impact of the emission. It also enables the establishment of safe residential distances from the particular emission source. The OSI questionnaire has been modified to accomplish just this. The modified version of the OSI is shown in Table 1.

IV. DISCUSSION

As all factors known to raise OS have been incorporated into the modified OSI questionnaire shown in table 1, it now becomes possible to determine a person's total OS status that incorporates chronic exposure to a pollutant source. The OSI is non-invasive, yet predicts OS levels and offers insights into which parameters are the most contributory to disease onset. Though all individuals with disease symptoms will require medical diagnosis and treatment, using the OSI does not require invasive testing to determine how a community is being impacted by a chronic chemical or radiological exposure when statistically significant numbers of people are thus evaluated. Individual items in the OSI are presented in alphabetical order and may differ widely from one item to the next. This is deliberate so that an individual or surrogate answering the OSI questions is required to consider each item alone, rather than a part of a series of related questions, which could cause the responder to just check all the items in a single set. When used as a public health survey instrument, the OSI is able to factor out disease causes other than a particular well defined exposure by incorporating control cohorts into the survey. Thus the disease impact of a particular causative agent can be determined.

V. LIMITATIONS

The public health survey version of the OSI asks respondents to estimate distances from emission sources to their residences to their residences and to report prevalent diseases. With a small number of individual respondents, these can lead to errors. With statistically significant numbers of respondents, however, such limitations are eliminated and reliable survey results regarding the health impacts of toxic environmental contaminant exposure can be determined.

VI. CONCLUSIONS

The hypothesis presented here is that the modified version of the Oxidative Stress Index presented here is potentially a valuable non-invasive tool that can be used to carry out public health surveys to assess the health impacts of chronic chemical and radiological emissions on members of impacted communities.

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APPENDIX

TABLE 1. OXIDATIVE STRESS INDEX AS A PUBLIC HEALTH SURVEY INSTRUMENT

OXIDATIVE STRESS INDEX (OSI) CHECK LIST		
DISTANCE OF HOME FROM CLOSEST POLLUTION EMISSION SOURCE (PETROLEUM OR CHEMICAL STORAGE TANK, LANDFILL OR OTHER CHEMICAL OR RADIATION EMITTING SOURCE). Check only one		
☐ 0.1 mile or less	☐ 0.6 mile	☐ 1.0-1.5 miles
☐ 0.2 mile	☐ 0.7 mile	☐ 1.6-2.0 miles
☐ 0.3 mile	☐ 0.8 mile	☐ 2.0-2.5 miles
☐ 0.4 mile	☐ 0.9 mile	☐ 2.5-3.0 miles
☐ 0.5 mile	☐ 1.0 mile	☐ 3.0 miles or more
☐ Years at current residence (enter number of years)		

FAMILY HISTORY

Put one check for each parent, sibling (sister or brother) or grandparent who has or had each of the diseases or conditions identified.

- ☐ Parent with neurological disease - Alzheimer's, Parkinson's, Lou Gehrig,
- ☐ Parent with diabetes
- ☐ Parent with heart disease, heart attack or stroke
- ☐ Parent with asthma or COPD
- ☐ Parent with allergies - hay fever, animals, food or chemicals
- ☐ Parent with cancer
- ☐ Siblings with neurological disease - Alzheimer's, Parkinson's or Lou Gehrig,
- ☐ Siblings with diabetes
- ☐ Siblings with heart disease, heart attack or stroke
- ☐ Siblings with asthma or COPD
- ☐ Siblings with allergies - hay fever, animals, food or chemicals
- ☐ Siblings with cancer
- ☐ Grandparents with neurological disease - Alzheimer's, Parkinson's or Lou Gehrig,
- ☐ Grandparents with diabetes
- ☐ Grandparents with heart disease, heart attack or stroke
- ☐ Grandparents with asthma or COPD
- ☐ Grandparent with allergies - hay fever, animals, food or chemicals
- ☐ Grandparent with cancer

Total Family History Checks _____

GENDE Female _____ Male _____
R

- AGE**
- Check all age boxes that apply. If, for example, you are 55 years old check the first two boxes. If you're 82, check all 5 of these boxes
- ☐ 40 or older
 - ☐ 50 or older
 - ☐ 60 or older
 - ☐ 70 or older
 - ☐ 80 or older

- WEIGHT**
- If you are overweight from your recommended weight, check all the weight boxes that apply. If, for example you are 40 pounds over your recommended weight, check the first three boxes and add three checks to the total. Find your recommended weight on the weight chart at the end of the OSI checklist.
- ☐ 10 - 20 pounds overweight
 - ☐ 21 - 40 pounds overweight
 - ☐ 31 - 60 pounds overweight
 - ☐ 61 - 80 pounds overweight
 - ☐ 81 or more pounds overweight

Total age and weight checks _____

ILLNESSES and CONDITIONS

- Check all illnesses or conditions that you have been diagnosed with and currently have.
- ☐ Acne
 - ☐ ADHD (Attention Deficit Hyperactivity Disorder)
 - ☐ AIDS or HIV
 - ☐ Alcohol addiction
 - ☐ Allergic rhinitis (sinus inflammation)
 - ☐ ALS (Lou Gehrig's disease)
 - ☐ Anemia
 - ☐ Anorexia
 - ☐ Anxiety disorder
 - ☐ Appetite loss
 - ☐ Arthritis
 - ☐ Asthma
 - ☐ Autism and ASD
 - ☐ Autism or autism spectrum disorder (ASD)
 - ☐ Benign prostate hyperplasia (enlargement - BPH)
 - ☐ Bipolar disorder
 - ☐ Bronchitis (chronic)
 - ☐ Bulimia
 - ☐ Bulging or herniated disc
 - ☐ Carpal tunnel syndrome
 - ☐ Cancer - Check all that apply. If stage three, for example, check first three
 - ☐ Cancer - stage 1
 - ☐ Cancer - stage 1 or 2
 - ☐ Cancer - stage 1, 2 or 3
 - ☐ Cancer - stage 1, 2, 3 or 4

- ☐ Cardiovascular disease
- ☐ Chronic Fatigue Syndrome (CFS)
- ☐ Crohn's disease
- ☐ Common cold (frequent)
- ☐ COPD (chronic obstructive pulmonary disease)
- ☐ Crohn's disease
- ☐ Dementia
- ☐ Dengue fever
- ☐ Dental abscess (frequent)
- ☐ Depression
- ☐ Diabetes (type 1 or type 2)
- ☐ Diarrhea (frequent)
- ☐ Diverticulitis
- ☐ Drug addiction
- ☐ Eczema
- ☐ Emphysema
- ☐ Endometriosis
- ☐ Epilepsy
- ☐ Fibromyalgia (FM)
- ☐ Flu
- ☐ Frequent common colds
- ☐ Frequent headaches
- ☐ Frequent indigestion
- ☐ Frequent infection
- ☐ Frequent itching
- ☐ Frequent rashes
- ☐ Frequent sinus infections (sinusitis)
- ☐ Glaucoma
- ☐ Gout
- ☐ Gum disease
- ☐ Heart attack
- ☐ Heart Disease or heart problems
- ☐ Hemorrhoids
- ☐ Hepatitis B (chronic)
- ☐ High blood pressure (hypertension)
- ☐ High cholesterol
- ☐ Herpes
- ☐ Inflammatory bowel disease
- ☐ Irritable bowel syndrome (IBS)
- ☐ Kidney disease
- ☐ Leukemia
- ☐ Liver cirrhosis
- ☐ Liver disease
- ☐ Lupus
- ☐ Lyme disease
- ☐ Macular degeneration
- ☐ Malaria
- ☐ Metabolic syndrome (pre-diabetes)
- ☐ Middle ear infection (frequent)
- ☐ Migraine headaches
- ☐ Multiple chemical sensitivity (MCS)
- ☐ Multiple sclerosis
- ☐ Obesity
- ☐ Osteoarthritis
- ☐ Osteoporosis
- ☐ Parkinson's disease
- ☐ Periodontal disease (swollen or bleeding gums)
- ☐ Post-traumatic stress disorder (PTSD)
- ☐ Rocky Mountain spotted fever
- ☐ Psoriasis
- ☐ Rosacea
- ☐ Schizophrenia
- ☐ Seizures
- ☐ Sexually transmitted disease (STD)
- ☐ Shingles
- ☐ Sjogren's syndrome
- ☐ Sleep apnea
- ☐ Stroke
- ☐ TB (Tuberculosis)
- ☐ Thyroid disease
- ☐ Tourette syndrome
- ☐ Tremors
- ☐ Ulcers
- ☐ Varicose veins
- ☐ West Nile Fever
- ☐ Yellow fever
- ☐ Zika

Write in the names of any other illnesses you have that were not listed above and check those.

Total Symptoms Checks ____	
TEST RESULTS	
	The following address results obtained from test doctors ordered done as part of annual examinations. Check all that apply to you.
_____	High or low blood sugar
_____	High or low BUN (blood urea nitrogen)
_____	High or low calcium
_____	High or low carbon dioxide (bicarbonate)
_____	High or low chloride
_____	High cholesterol
_____	High or low creatinine

- ___ High glucose
- ___ High or low potassium
- ___ High PSA
- ___ High or low sodium
- ___ High triglycerides
- ___ Low blood oxygen
- ___ Low potassium

Total Test Results Checks ___

PRESCRIPTION MEDICINES REGULARLY TAKEN

Check each of the boxes that apply. If you regularly take five prescription drugs, for example, check **all** of the first 5 items, so that the total number of items checked equals the total number of prescriptions regularly taken.

- ___ 1 prescription
- ___ 2 prescriptions
- ___ 3 prescriptions
- ___ 4 prescriptions
- ___ 5 prescriptions
- ___ 6 prescriptions
- ___ 7 prescriptions
- ___ 8 prescriptions
- ___ 9 prescriptions
- ___ 10 or more prescriptions
- ___ Have a heart pacemaker

Total Prescription Medicine Checks ___

DIET

Check each item that applies to the foods that are part of your **regular** eat.

- ___ Alcoholic beverages (beer, wine, spirits) more than 1 drink per day
- ___ Artificial sweeteners for coffee or tea
- ___ Canned or frozen cooked foods regularly eaten (soups, pastas, meats)
- ___ Bread and pasta made primarily from white processed flour
- ___ Fast food frequently eaten
- ___ Fewer than 3 fruits or vegetables a day
- ___ Grilled, smoked or blackened meat, chicken or fish
- ___ Food high in fat (whole milk, cheeses, foods cooked with butter and animal fat)
- ___ Often eat processed foods (bacon, hot dogs, salami, sausages, deli meats)
- ___ Eat red meat more than 2 times a week
- ___ Eat foods high in sugar (sweetened drinks and desserts)
- ___ Salty food

Total Diet Checks ___

LIFE STYLE

These items refer to where you live, the type of work you do and chemicals you may be exposed to

- ___ Are a farmer that regularly uses pesticides
- ___ Burn wood for heat or for cooking
- ___ Constantly use a cell phone
- ___ Drink chlorinated water
- ___ Drink more than one alcoholic drink per day
- ___ Exercise less than one half hour a week

- ___ Have mold in your home
- ___ Have new (less than 6 months old) carpet in your home
- ___ Have pets in your home that you are allergic to
- ___ Live down wind from a smoking industrial chimney
- ___ Live in a city with air quality alerts
- ___ Live or work close to a cell tower
- ___ Live or work near high voltage electrical transmission lines
- ___ Live near a heavily traveled highway or road
- ___ Live near a landfill
- ___ Live with a smoker
- ___ Regularly experience allergic reactions in your home
- ___ Regularly experience allergic reactions in your work place
- ___ Regularly use room or furniture deodorants
- ___ Regularly play contact sports

Tobacco use. Check **all** of the items that apply. For example, if you smoke one pack of cigarettes a day, check both of the first 2 items. If you smoke two packs a day, check all of the first 4 items.

- ___ Smoke 10 cigarettes or less daily (even just one)
- ___ Smoke a pack a day (20 cigarettes)
- ___ Smoke a pack and a half a day (30 cigarettes)
- ___ Smoke two packs a day (40 cigarettes)
- ___ Smoke more than two packs a day
- ___ Smoke 1-5 cigars a day
- ___ Smoke 6 or more cigars a day
- ___ Use smokeless tobacco
- ___ Work as a toll booth collector
- ___ Work in very hot or very cold conditions regularly
- ___ Work in an adhesives or coatings manufacturing plant
- ___ Work in an agricultural chemical manufacturing plant
- ___ Work as an automobile, diesel or aircraft mechanic
- ___ Work with chemicals on the job regularly
- ___ Work in a dusty environment regularly
- ___ Work in a landfill
- ___ Work in a hair or nail salon
- ___ Work in metal refinery or mill
- ___ Work as a miner
- ___ Work in a noisy environment
- ___ Work in a paint, lacquer, stain or varnish manufacturing plant
- ___ Work as a painter
- ___ Work as a pilot or flight attendant
- ___ Work as a pesticide applicator
- ___ Work in a petroleum refinery
- ___ Work in a plastics manufacturing plant
- ___ Work in a plywood or particle board manufacturing plant
- ___ Work in a polluted environment (road paver, toll booth operator, for example)
- ___ Work in a water or sewage treatment plant
- ___ Work in wood treatment plant

Total Lifestyle Checks ___

OSI, Total of All Checks ___