James L. Holly, M.D.

Oxidative Stress: Why is it important to me?
By James L. Holly, MD
Your Life Your Health
The Examiner
January 20, 2005

Stress? Surely, we all know everything there is to know about stress! But, do we? When I was a medical student in the late 60s and early 70s, we studied biochemistry. The metabolic processes of the human body were fairly well understood, but as yet the practical applications of that knowledge were not always obvious.

Today, what was once considered "basic science" and which was studied as a foundation for the clinical science, is now an integral part of medical decision making. **Oxidative stress** is an illustration of this. As we discuss this issue, it will become obvious why it is important for you to understand this biochemical process and why it is important for you to take steps to decrease oxidative stress in your body.

First, what is it? Oxidative Stress is not, in and of itself, a disease but a condition that can lead to or accelerate disease. Oxidative stress occurs when the available supply of the body's antioxidants is insufficient to handle and neutralize free radicals of different types. The result is massive cell damage that can result in cellular mutations, tissue breakdown and immune compromise.

The body constantly reacts with oxygen as part of the energy producing processes of cells. As a consequence of this activity, highly reactive molecules are produced known as free radicals. These interact with other molecules within the cell, which can cause oxidative damage to proteins, membranes and genes. This damage has been implicated in the cause of certain diseases and has an impact on the body's aging process.

This oxygen "paradox" results from the fact that we cannot live without oxygen, yet it is also dangerous to our existence. The same process that causes iron to rust, cut apples to turn brown, or food to decay is waging an out-and-out attack on every living cell in your body. We are essentially rusting inside and are not even aware it is happening.

The Enemy: Free Radicals

Free radicals are oxygen molecules or atoms that have at least one unpaired electron in their outer orbit. In the process of using oxygen during normal metabolism within the cell to create energy (called oxidation), free oxygen radicals are created. They essentially have an electrical charge and desire to get an electron from any molecule or substance in the vicinity. They have such violent movement they have been shown chemically to create bursts of light within the body. If these free radicals are not neutralized rapidly, they may create more volatile free radicals or cause damage to the vessel wall, cell wall, lipids, proteins, and even the nucleus (DNA) of the cell.

The most dangerous free radicals are the small, mobile, and highly reactive oxy radicals. Other dangerous varieties of oxygen are known as reactive oxygen species (ROS). While

ROS are not technically free radicals, they are no less unstable and are highly reactive with the molecules around them.

Oxidative stress contributes to both the initiation and the promotion of many major diseases. Oxidative attacks help cause the disease in the first place, and then add impetus to its spread in the body. In the case of heart disease, oxidative stress can cause major damage even after treatment has been started.

The implications of free radicals and ROS go further. It now seems that the 'clinical presentation' of many diseases -- how the illness appears when a patient arrives at a clinic -- may reflect not different causes, but variations in the protection provided by the body's *antioxidant* (anti-oxidative stress) defenses. In a hurricane, the weakest section of a house collapses first, whether it is a window, a door, or a roof. Under oxidative stress, the weakest link in the body may be the first to give way.

Benefits of free radicals

The many chemical reactions that occur in the body routinely produce free radicals. The body can, however, usually keep these free radicals under control. Moreover, despite the long list of problems they cause, free radicals are not all bad. They play an essential role in a healthy human body. The body tries to harness the destructive power of the most dangerous free radicals -- the oxy radicals and ROS -- for use in the immune system and in inflammatory reactions. Certain cells in these systems:

- engulf bacteria or viruses,
- take up oxygen molecules from the bloodstream,
- remove an electron to create a flood of oxy radicals and ROS, and
- bombard the invader with the resulting toxic shower.

This aggressive use of toxic oxygen species is remarkably effective in protecting the body against infectious organisms.

Unfortunately, the process may go out of control, creating a chain reaction that leads to over-production of free radicals. These reactions are no less damaging to the body than other formations of free radicals.

What makes oxidative stress worse and increases the potential for illness?

There are many factors that can significantly increase the amount free radicals the body produces.

Excessive Exercise

In his book, *The Antioxidant Revolution*, Kenneth Cooper, M.D., emphasizes excessive exercise as a major cause of oxidative stress. When we exercise moderately, the production of free radicals increases, but not significantly. When we exercise excessively,

however, the production of free radicals goes up exponentially. You can tell if you are exercising excessively by how long it takes you to recover. If you don't recover completely within twenty-four hours, you are on the verge of harming yourself with excessive exercise. An interesting fact about the now famous Tour de France is that it is estimated that every time a person completes this race, he/she takes 2-3 years off of their life expectancy. This is due to the enormous oxidative stress produced by this grueling contest.

Excessive Stress

Just like exercise, we are able to handle the modest increase in free-radical production found present with mild to moderate emotional stress. If we are under severe emotional stress, however, free-radical production again goes up exponentially and can cause significant oxidative stress. The hormones that mediate the stress reaction in the body -- cortisol and catecholamines -- will themselves degenerate into particularly destructive free radicals. A stressful life mass produces free radicals. How many times have you known a close friend or family member under stress who developed a first heart attack or serious illness? It is due to the oxidative stress associated with emotional stress.

Pollutants in Our Air, Food, and Water

People today are exposed to more chemicals and pollutants in air, food, and water than ever before. Drive into any major city and you can literally taste the air. The Environmental Protection Agency states there are well over 70,000 chemicals being used commercially in the United States. Many of these are used in the production of our food and many end up in our water supply. In 1988, the U.S. Department of Public Health warned that 85 percent of our drinking water is contaminated. All of these chemicals and pollutants that enter our body must be handled in some way. Some are metabolized and excreted. Some toxins are stored, especially in our fat. All of these toxins significantly increase the free radicals that the body produces.

Cigarette Smoke

One of the greatest causes of oxidative stress is smoke from cigars and cigarettes. We all know smoking is probably the greatest risk to our health. Many clinical studies have shown cigarette smoke causes tremendous production of excessive free radicals. There is also significant production of free radicals associated with secondary smoke. Laws are being passed every day to protect the public against being exposed to secondary smoke, and there is very solid clinical evidence this is important. Antioxidants have been shown to decrease the oxidative stress in smokers. However, there is no way to eliminate its devastating effect on the body other than quitting.

Sunlight

Sunlight has been shown to greatly increase free-radical production within the skin. We have all been fooled into a false sense of security by the use of sunscreens. The irony of

sunscreens is the fact that they protect you from the sun burning rays but not very well against the skin-damaging rays. Consequently, we actually spend more time out in the sun because we are not getting burned, but we are greatly increasing our risk of skin cancer. Make sure the sunscreen you use specifically states it offers adequate protection against both UVA and UVB sunlight.

Medications and Radiation

Medication is synthetic and a foreign chemical to the body. The body must eliminate it and in the process it produces excessive free radicals. Some of the greatest offenders are the chemotherapeutic agents. Several studies show much of their toxic effects to the body are related to oxidative stress. Radiation treatment causes tremendous increase in free-radical production and ultimately leads to oxidative stress no matter what part of the body is exposed to the radiation. Obviously, plain X-rays and CT scans produce increased amounts of free radicals but not to the same extent as radiation therapy.

Fatty Meals

A Big Mac is not only going to elevate your cholesterol but has recently been shown to significantly increase the number of free radicals. This has been shown to actually damage the lining of and may even cause spasms of your arteries. When individuals take high doses of antioxidants with these fatty meals, these effects are decreased.

Processed foods and alcohol

Boxed and canned foods frequently contain high levels of substances which produce free radicals that damage the cardiovascular system. Trans fats are among the greatest offenders in this regard. Alcohol is a potent generator of free radicals (although red wine contains antioxidants that partially counteract this effect).

The following is a partial list of some common external causes of free radicals:

Toxins

carbon tetrachloride
paraquat
benzo(a)pyrene
aniline dyes
Toluene

Drugs

adriamycin
bleomycin
mitomycin C
nitrofurantoin

chlorpromazine

Air pollution: Primary sources

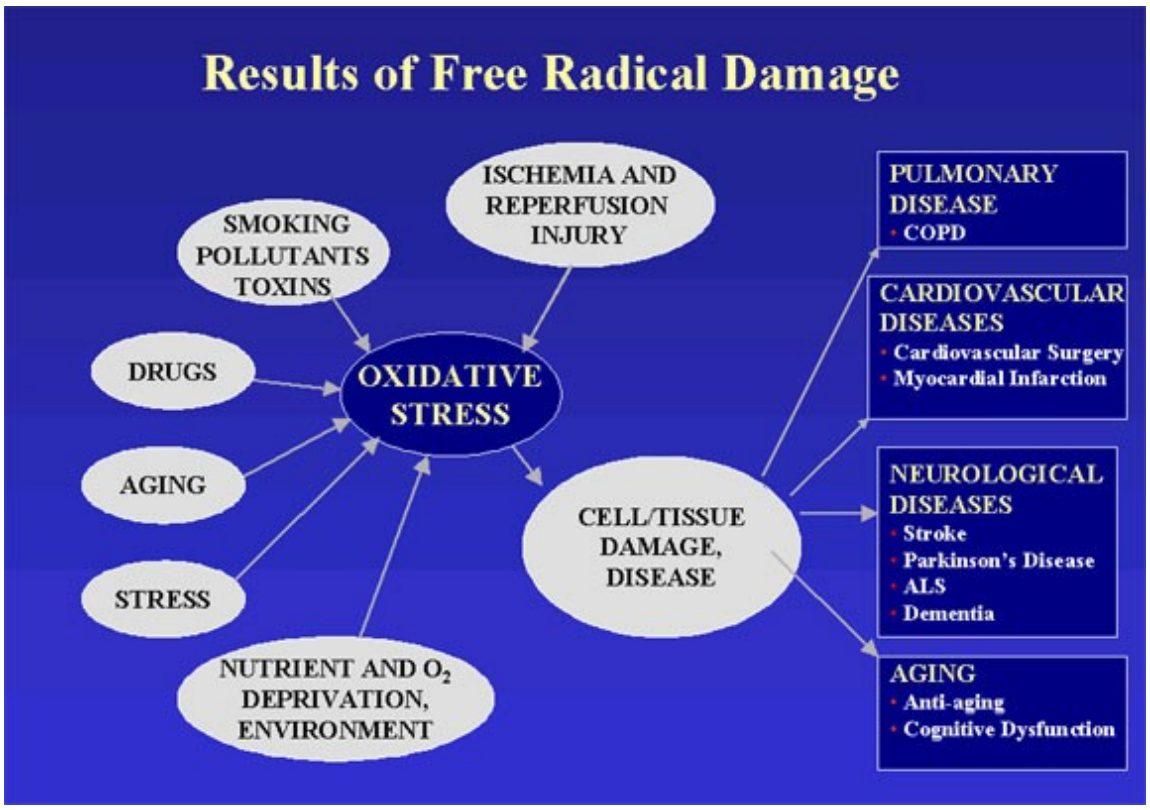
carbon monoxide
nitric oxide
passive tobacco smoke
aldehydes
alkyl nitrates

Radiation and sunlight

Ingested substances

alcohol
smoked and barbecued food
peroxidized fats in meat and cheese
deep-fried foods
trans fats in processed foods

The following pictorial displays the relationships between sources of increased free radicals, oxidative stress and disease.



The following illnesses have been linked to oxidative stress:

Cancer.
Arteriosclerosis, atherosclerosis.
Heart disease.
Cerebrovascular disease.
Stroke.
Emphysema
Diabetes mellitus and all its complications
Rheumatoid arthritis
Osteoporosis
Ulcers.
Sunburn.
Cataracts
Crohn's disease
Behcet's disease
Aging
Senility
And dozens more

Next week, we will discuss what to do about oxidative stress. Until then, remember, it is your life and it is your health.