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THE DEADLIEST AIR POLLUTION ISN'T BEING REGULATED OR EVEN MEASURED

By Peter Montague

In the U.S., the deadliest air pollution is not being regulated or even measured as it kills tens of thousands of people each year.

The culprit is the smallest particles of airborne soot, known as "ultrafines," which are emitted routinely by diesel engines, automotive traffic, garbage incinerators, and power plants burning coal, oil, natural gas, and biomass.[1,2]

Ultrafine particles kill in at least a half-dozen different ways, including (but not limited to) cancer, heart attack and stroke (initiating and worsening atherosclerosis), by narrowing the airways (contributing to chronic obstructive pulmonary disease (COPD) and asthma), and by causing a systemic inflammation response and initiating "oxidative stress," which drastically alters the chemistry inside cells and sets off a cascade of serious problems. Damaged lungs retain a higher proportion of ultrafines, compared to healthy lungs, and retaining more ultrafines causes more lung damage -- a positive feedback loop with negative consequences. For the past 20 years, new dangers from ultrafines have come to light each year, with no end in sight. [3,4,5,6,7,8,9,10,11,12,13]

The people most endangered by ultrafines are urban dwellers, especially the elderly and anyone with a chronic illness (e.g., asthma, diabetes, COPD, heart problems)[14,15] but there is evidence that commuters in their cars[16] and children at play[17] are also being harmed. Children exposed continuously to low levels of ultrafines can grow into adults with diminished lung function and shortened lives.[18]

Furthermore there is growing evidence that women are affected somewhat more than men,[19] and that people of color are affected more than whites,[20] women probably because of smaller lung volume and people of color probably because of stress piled on more stress in their lives.[21,22]

Finally, there is no observable safe level -- no threshold level below which symptoms disappear. Any exposure to ultrafines seems to cause some harm.[18] The only safe level of exposure is zero.

Research over the past 18 years has revealed again and again that the greatest damage from air pollution is coming from the very smallest airborne particles of soot, yet government regulators continue to focus attention on the larger and less harmful particles, which are easier to measure. It's like the drunk searching for his keys under a street lamp, even though he knows he lost them many blocks away. "The light's better over here," he explains.

Airborne particles are classified into three groups -- coarse, fine and ultrafine. Coarse particles are those that measure between 10

micrometers in diameter down to 2.5 micrometers. A micrometer is a millionth of a meter and a meter is about 39 inches. A human hair typically measures about 100 micrometers in diameter, so the largest particles are about 1/10th the thickness of a human hair. These coarse particles are usually referred to as PM10 (particulate matter 10).[1]

Your nose and throat can trap these large particles (on sticky surfaces, for example), to prevent them from entering your lungs. After they are trapped, you eventually excrete them.

"Fines" are particles that measure between 2.5 micrometers and 0.1 micrometers; they are typically referred to as PM2.5. The smallest of these particles are small enough to get into the lower portions of your lungs. There they may be removed by several clearance mechanisms, but very slowly. Their "half-life" in the human lung is five years, meaning that a certain dose today will have diminished by half five years from now.[23] At that rate, a dose today will stay with you for 50 years.

Some fine particles can cause serious harm before they are excreted because their surfaces are typically covered with organic chemicals and metals, which are carried into your airways. And some of these PM2.5 particles can pass directly into your blood stream, carrying their load of metals and organics with them, and distributing them throughout your body.

The federal government began setting standards for PM10 in 1987 and for PM2.5 in 1997 after several studies revealed that fines were killing an estimated 60,000 people each year in the U.S.[8] -- far more than were being killed by traffic accidents. A much larger number of people were (and are) being made sick with lung and heart problems. Corporations challenged the 1997 rules, which were finally upheld by the U.S. Supreme Court in 2001.[18]

But long before the government began to regulate "fines," many studies had revealed that the actual killing was really being done by the smallest particles of all, called "ultrafines," which the government has so far refused to regulate or even measure.[8]

Ultrafines vary in size from 0.1 micrometers down to 0.001 micrometers (or 100 nanometers down to 1 nanometer in diameter; a nanometer is a billionth of a meter). The largest of these particles has a diameter 1/1000th of the width of a human hair, and the smallest has a diameter 1/100,000th of a human hair. Relatively few such particles occur in nature, so our bodies have evolved no efficient means for protecting us against them.[1]

In typical urban air, ultrafines account for only 1 to 5 percent of all airborne particles by weight, yet a typical person breathing the air in Los Angeles will inhale 200 billion (2E11) ultrafine particles every day and retain half of those in their lungs.[26]

As particles get smaller, their surface area gets larger in relation to their volume (a physicist might say, as their diameter decreases, their surface-to-volume ratio increases). The very smallest particles, which are present in the largest numbers, have an enormous surface area compared to larger particles. This large surface area provides a

perfect place for airborne toxicants to glom on and be carried efficiently into the deepest portions of your lungs.[1]

Of course your lungs are in the business of transferring oxygen from the air directly into your blood stream. Unfortunately, they do the same thing with ultrafines. healthy lungs retain about of 50% of the ultrafines you breathe[26] and a substantial number of those are passed directly into your blood stream. While in your lungs, ultrafines cause an inflammation response by creating "free radicals" from oxygen, which then combine with your lung tissues in destructive ways.[13,4] Ultrafines in your blood stream provoke an immune response that can include coagulation (thickening) of the blood -- leading in some cases to heart attacks and strokes.

Current government regulations do not take into consideration the number of particles present in air -- only the total weight of the particles. So, for example, the government says it is OK for local air to contain 35 micrograms of PM2.5 in each cubic meter of air averaged over one hour, or 15 micrograms of PM2.5 in each cubic meter averaged over a year's time. A microgram is a millionth of a gram and there are 28 grams in an ounce.

The assumption of this approach is that the total weight of particles is related in some consistent way to the number of particles in the air. Unfortunately in the few cases where this assumption has been tested, it has found to be false.[15,24,25,26] The total number of particles in the air can vary independently of the total weight of particles in the air. This means that, if you want to know the level of danger from fine particles in the air, you need to count particles, not weigh them. [9,15]

Worse, regulating the weight of particles instead of the number of particles may actually make air pollution more dangerous. Reducing the number of large particles (which is the easiest way to reduce the weight of pollution, to comply with the law) can lead to an increase in the release of ultrafine particles because larger particles serve as a "magnet" for the smallest particles. As the larger particles are removed from air emissions, ultrafine particles have fewer "magnets" to hook onto and thus can enter the ambient air in greater numbers, increasing the danger to human health.

A writer in Science magazine observed in 2005, "Controlling only mass [of airborne particles], as EPA does now, might actually be counterproductive. For example, if larger PM2.5 particle levels go down but levels of ultrafines do not, "that could make things worse," [Mark W.] [Frampton](#) says. That's because ultrafines tend to glom onto larger PM2.5 particles, so they don't stay in the air as long when more larger particles are around."[8]

So the most dangerous forms of air pollution -- ultrafines -- which are killing tens of thousands of people each year, are not regulated and are not even being measured.

Worst of all, the "nanotechnology" industry is now ramping up manufacturing facilities to intentionally make ultrafines in ton quantities. Until recently, ultrafines have been created as an unwanted byproduct of combustion. But now ultrafines are being purposefully manufactured for use in tires, fuel cells, electronics, personal care products like sun screens, and many other products.[1,2] This will certainly create new occupational hazards -- and will certainly lead to release of ultrafines into the general environment, through products discarded and through spills, leaks and other glitches.

Do we know everything we need to know about the hazards of ultrafines? We do not. Do we know enough to act? We certainly do. As Jocelyn Kaiser summarized it in Science magazine in 2005, "Environmental and health groups, as well as many scientists, say that, as with tobacco smoke and lung cancer, policymakers can't wait for all the scientific answers before taking action to prevent deaths from dirty air." [8] Tens of thousands of lives stand to be saved each year by aggressive action to curb ultrafines. Prevention is possible -- and that's good news.[18]

With 20 years of data to rely on, it is long past time for ultrafines to be strictly controlled -- and controlled by number, not merely by weight.

Citizens concerned about new power plants, new diesel engines, or new incinerators have a right to insist on detailed information about ultrafine emissions. Will new technologies make things worse by emitting larger numbers of deadly ultrafines, even as they reduce the total weight of emissions? Given the available data, it's a fair question.

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