ADJUSTMENTS FOR HEALTH

The health of workers can have an effect on how they react to exposure to workplace chemicals. Exposure limits are set for “normal” healthy workers. Exposure research is usually done on healthy test subjects, animal or human. A less than healthy test subject can have an unexpected result that renders the research unusable. This produces good toxicological data; however, it can cause problems in a “normal” workplace where all workers may not be healthy. There has been some limited research on less than healthy subjects, usually having to do with medications for humans or animals.

The usual practice for the occupational hygienist is to investigate how conditions in the workplace affect worker’s health. Equally important is the investigation of how worker’s health can influence the individual’s reaction to environmental stresses. Unfortunately there is very little tangible evidence linking the major chemicals in the workplace with the existing health of the worker. Thus, the very conditions we are now concerned about are deliberately avoided in the research because it would confuse the findings.

One such factor is individual differences that may make some workers more susceptible to the toxic effects of workplace chemicals. There is no such thing as one dose that will affect all workers the same. This is demonstrated in the LD_{50} values for a chemical. The LD_{50} (Lethal dose, 50%), or LC_{50} (Lethal concentration, 50%) are the amounts of a toxic material required to kill 50% of the tested population. Half the population required a greater dose to kill it, and half the population tested will die with a smaller dose. Not all die with the same dose. As discussed below, there are many genetic variations that render some workers more or less susceptible to toxic materials, and these differences must be taken into account.

GENERAL COMMENTS

It is often assumed that an unhealthy or otherwise atypical target organ may not react the same as a normal organ on exposure to workplace chemicals. It seems logical that an unhealthy lung may be more affected than a healthy lung would. In other words, a worker who is not healthy should not be exposed to workplace chemicals to the same extent as a healthy worker. It is generally recognized by occupational hygienists that exposure at the TLV® to a substance that affects the liver would not be appropriate for a worker with a pre-existing liver condition.

The problem lies in connecting or linking existing medical conditions to chemicals that could aggravate that condition[1]. For example, asthmatic workers are more sensitive to acidic aerosols than are healthy workers. It appears that the irritant dose delivered to the larger bronchial airways is greater in asthmatics and bronchitics than in healthy individuals because of smaller airways in the former groups. Unfortunately, there are

very few guidelines that can be offered to hygienists in the field to help them make the appropriate adjustments. Table 1 is a list of health and genetic conditions and the pollutants that may have an increased risk as a result of that condition.

Table 1: **Health and Genetic Conditions and Affected Materials.**[(2)]

HEALTH CONDITION	**MATERIALS THAT MAY HAVE AN INCREASED EFFECT**
Kidney diseases	Excessive sodium in diet, fluoride, lead, other heavy metals
Liver diseases	Carbon tetrachloride DDT other insecticides PCBs
Asthmatic diseases	Respiratory irritants, nitrogen dioxide, ozone, sulfates, sulfur dioxide, acidic aerosols
Chronic respiratory diseases	Respiratory irritants, nitrogen dioxide, ozone, sulfates, sulfur dioxide
Heart diseases	Cadmium, carbon monoxide, fluoride, respiratory irritants, ozone, sulfur dioxide sodium
Diabetes	Wide range of renal toxins including heavy metals, organic solvents
G6PD (glucose-6-phosphate dehydrogenase) – a genetic condition that predisposes to spontaneous destruction of red blood cells, common in people of Mediterranean and African origin.	Oxidants such as ozone, nitrogen dioxide, chlorite, benzene, naphthalene, methylene blue, acetanilide, phenylhydrazine
Sickle cell trait, found in people of Mediterranean and African origin.	Aromatic amino and nitro compounds, carbon monoxide, cyanide
The thalassemias - missing genes that affect **the body's ability to produce hemoglobin and red blood cells.**	Lead, benzene
NADH (nicotinamide, adenine dinucleide) dehydroenase deficiency	Methemoglobin forming substances - Aromatic amines, Arsine, Chlorobenzene, Chromates, Nitrates, nitrites
Hypocatalasemia (low calcium levels)	Ozone, radiation, fluorides, phosphates
ALA (aminolevulinic acid) dehydrogenase deficiency (Porphyrias are diseases caused by enzymatic defects in the biosynthetic pathway of heme)	The enzyme is very susceptible to inhibition by heavy metals particularly lead.
GSH-Px (reduced gluthione peroxidase) deficiency	Environmental oxidants
Defect in glucuronidation (Gilbert's syndrome – a mild liver disorder)	Wide variety of xenobiotics including PCBs
Gout	Lead
Oxidation center defects	Numerous xenobiotics requiring oxidative metabolism for detoxification

HEALTH CONDITION	MATERIALS THAT MAY HAVE AN INCREASED EFFECT
OCT (ornithene carbamoyl transferase) deficiency	Insect repellant (DET)
Paraxonase	Parathion
Rhoadanese variant (an enzyme that detoxifies cyanide)	Cyanide
Sulfite oxidase deficiency hetrozygotes	Sulfite, bisulfite, sulfur dioxide
Inadequate carbon disulfide metabolism	Carbon disulfide
Alcohol dehydrogenase variant	Metabolize more quickly than normal
Wilson's disease (a rare inherited disorder that causes too much copper to accumulate in your liver, brain and other vital organs)	Copper, vanadium
Pseudocholinesterase variants	Organophosphate and carbamate insecticides, muscle relaxant drugs
IgA deficiency	Respiratory irritants
Serum - antitypsin deficiency	Respiratory irritants, smoking
Hyperlipidemia	Carbon disulfide carbon monoxide, smoking
Homocystinuria heterozygotes	Carbon disulfide, carbon monoxide, smoking
High aryl hydrocarbon hydroxilase inducability	Polyaromatic hydrocarbons
CF heterozygotes	Respiratory irritants
Renal nephropathy of diabetes	Heavy metals, organic solvents
Cystinosis	Heavy metals
Cystinurea	Heavy metals
Tyrosinemia	Heavy metals
Immunologic hypersensitivity	Isocyanates
Albinism	Ultraviolet radiation
PKU (phenylketonuria)	Ultraviolet radiation
Leber's optic atrophy	Cyanide
Nontasters of PTC	Substances that suppress the function of the thyroid gland by interfering with iodine uptake.
DNA repair and chromosome instability disease	Wide range of mutagens and/or carcinogens

The TLV® booklet (TLVs and BEIs – Threshold Limit Values) can help to link a workplace contaminant with a target organ or health effect. The basis for the TLV is given in the 6th column (TLV Basis), however, the Documentation should be reviewed to fully understand what effects the TLV is based on.

PHARMACOKINETIC MODELS

Pharmacokinetic models can be used to explain how the health status of the individual can affect an individual's reaction to an exposure for specific organs such as the kidney

or liver. This information can be used to adjust the TLV and the worker's exposure. The elimination of a material from an organ, like the elimination from the body follows a first-order process with a half-life[5]:

$$t_{1/2} = 0.693 / k \quad (1)$$

where: k = the fractional elimination constant for a material that describes the rate of elimination.

The more material in the body, the longer it will take to eliminate it. The amount of material in the body is the dose, which can be described as:

$$\text{Dose} = Cp \times V_d \quad (2a)$$

where: Cp = concentration of the material in the plasma.
V_d = volume of distribution which includes the volume of plasma and the body in equilibrium, and represents the amount of material available for elimination.

Rearranging 2a yields:

$$V_d = \text{Dose}/Cp \quad (2b)$$

The ability of an organ to remove a material from the plasma is described by the Extraction Ratio E:

$$E = \frac{C_a - C_v}{C_a} \quad (3)$$

where: C_a = arterial plasma concentration
C_v = venous plasma concentration

If the plasma flow through an organ is Q, then the rate of clearance of a material by that organ can be defined as:

$$Cl_{organ} = QE \quad (4)$$

The total rate of clearance of a material from the body is the sum of all organs of elimination, with elimination mainly being carried out by the liver, kidney, or lungs depending on the substance.

$$Cl_{Total} = Cl_{renal} + Cl_{hepatic} + \ldots \quad (5)$$

The fractional elimination constant k for an organ can now be defined in terms of the rate of clearance and the volume of plasma to be cleared so that:

$$k = Cl_{organ}/V_d \qquad (6a)$$

Substituting for Cl_{organ} the result is

$$k = QE/ V_d \qquad (6b)$$

Substituting for k in the definition of the half-life $t_{1/2}$

$$t_{1/2} = 0.693 \frac{V_d}{QE} \qquad (7)$$

From Equation 7, it can be seen that the length of time required to eliminate half of the material in the body by an organ depends on the volume of plasma to be cleared, the flow rate of the plasma, and the efficiency of the organ in question. Anything that can affect these factors, such as health status, will affect the half-life of the material in the worker. This will change the worker's exposure to the material. For example, if the half-life is increased (*i.e.*, it takes longer for the material to be removed from the body), the worker will be exposed to the material for a longer time while the material is being removed from the body. Table 2 below shows the amount of a material in the body as a multiple of the half-life.

TABLE 2: The portion of a material in the body as a function of the half-life.

Number of half-lives	Amount of Dose remaining in the body %	Amount of Dose Eliminated %
1	50	50
2	25	75
3	12.5	87.5
4	6.25	93.75
5	3.13	96.88

Q – Plasma Flow

If tissue perfusion is decreased, as in cardiac illness or if medications such as propanolol or cimetidine are taken, cardiac output is redistributed to the heart or brain. This reduces the flow to other organs, such as the liver and kidney. With reduced Q, the half-life of the material will increase, increasing the length of time the material in question will remain in the body.

One group of materials that can affect Q are those materials that affect the capacity of the blood to transport oxygen. Under these conditions, blood is routed to the heart or brain, with less to other organs such as the liver and kidney. Examples of such chemicals are shown in Table 3. Table 4 has examples of drugs that also affect cardiac output and plasma flow.

Table 3: Examples of Chemicals That can Affect Plasma Flow[8].

analine	carbon monoxide
trinitrotoluene	methylene chloride
toluene	

Table 4: Examples of Medications That can Affect Plasma Flow.

Class of medication	**Examples**	
Beta-blockers NOTE: may also cause symptoms of asthma	• acebutolol (Sectral) • betaxolol (Kerlone) • carvedilol (Coreg) • nadolol (Corgard) • pindolol (Visken) • Timolol (Blocadren)	• atenolol (Tenormin) • bisoprolol (Zebeta) • metoprolol (Toprol) • penbutolol (Levatol) • propranolol (Inderal)
Calcium-channel blockers	• Amlodipine (Norvasc) • Azelnidipine (Calblock) • Benidipine (Coniel) • Cinalong, Siscard) • Efonidipine (Landel) • Isradipine (DynaCirc, Prescal) • Lercanidipine (Zanidip) • Nicardipine (Cardene, Carden SR) • Nilvadipine (Nivadil) • Nimodipine (Nimotop) • Nitrendipine (Cardif, • Nitrepin, Baylotensin) • Pranidipine (Acalas) • Diltiazem (Cardizem)	• Aranidipine (Sapresta) • Barnidipine (HypoCa) • Clevidipine (Cleviprex) • Cilnidipine (Atelec) • Felodipine (Plendil) • Lacidipine (Motens, Lacipil) • Manidipine (Calslot, Madipine) • Nifedipine (Procardia, Adalat) • Nisoldipine (Baymycard, Sular, Syscor)
Centrally-acting sympatholytics	• clonidine • guanfacine	• guanabenz • α-methyldopa

If the heart or brain happens to be the target organ of the material, the material will have

an even greater toxic effect.

Unfortunately predictors for changes in Q are not readily available. However, it should be noted that when there is increased oxygen consumption, as under unusually heavy workloads, Q to the liver and kidneys can be reduced by as much as 25 percent. The changes in Q could be significant under some conditions, such as in a sensitive worker where the safety factor may be small.

E – Extraction Ratio

Effects Of Enzyme Production

Anything that affects the enzymes necessary for the metabolism or clearance of a material in the body will affect the extraction ratio. For example, a protein deficient diet reduces enzyme production and will decrease E and increase $t_{1/2}$. In other cases competition for the enzyme can reduce E and thus increase $t_{1/2}$ [6, 7]. Tables 5 (effects of chemicals) and 6 (effects of diet) show the cause of the metabolic change, the workplace chemical affected, and the effect itself.

Table 5: Effects of Chemicals or Conditions in the Workplace on Rates of Metabolism and Toxicity[8].

CHEMICAL OR CONDITION THAT COULD AFFECT WORKPLACE CHEMICALS	WORKPLACE CHEMICAL	EFFECT ON METABOLISM
A decreased oxygen carrying capacity (respiratory disease, pregnancy, heavy labor)	Carbon monoxide	Increased toxicity
Chronic exposure to Cadmium	Cadmium	Increased renal clearance
Toluene	n-Hexane, Trichloroethylene .	Reduced rate of metabolism
Methyl Ethyl Ketone, Methyl Butyl Ketone	n-Hexane	Reduced rate of metabolism
Ethanol	Carbon tetrachloride, chloroform, Bromotrichloromethane, Dimethylnitrosamine, Thioacetamide	Synergistic effect
Ethanol	MEK, Methanol, Trichloroethylene, Toluene, Xylene, Styrene	Reduced rate of metabolism
Perchloroethylene	Mehtyl chloroform	Reduced rate of metabolism
Organic solvents	Styrene	Reduced rate of metabolism

Ethylbenzene, benzene, Trichloroethylene	Toluene	Reduced rate of metabolism
Glucose, insulin, toluene, ethanol antabuse	Trichloroethylene	Increased rate of metabolism
Aspirin	Xylene	Reduced rate of metabolism
Ethylbenzene	Xylene	Reduced rate of metabolism

Table 6: Effect of Diet [(2)] on Rates of Metabolism and Toxicity.

DIET FACTOR	**WORKPLACE CHEMICAL AFFECTED**	**EFFECT**
Fasting	Many chemicals	Increases rate of absorption through gastrointestinal tract
Riboflavin deficiency	Aminoazo dyes, lead, ozone, hydrocarbon carcinogens	Enhanced carcinogenicity
Iron deficiency	Lead, cadmium, manganese, hydrocarbon carcinogens	Increased impairment of blood formation, resulting in increased risk to these materials.
Selenium deficiency	Paraquat, cadmium, mercury ozone	Enhanced lung toxicity
Poor calcium nutrition	Cadmium, fluoride, lead, strontium	Increased risk to these materials
Body fat	Chlorinated hydrocarbons	Material is sequestered in fat
Weight loss	Chlorinated hydrocarbons	Materials sequestered in body fat are released and made available to target organs
Protein deficient diet	Any material affected by liver microsomes (increased toxicity of pesticides and cadmium, reduced toxicity of carbon tetrachloride, other industrial solvents)	Cytochrome P-450 concentration in liver is reduced
Vitamin A deficiency	Aflotoxin, DDT, PCBs, hydrocarbon carcinogens	Increased risk to these materials
Vitamin C deficiency	Arsenic, cadmium, CO, chromium, DDT, lead, mercury, nitrates, ozone	Increased risk to these materials
Vitamin E deficiency	Lead, nitrite, nitrogen dioxide, ozone	Increased risk to these materials

Adaptation or habituation can also play a role in enzyme production. Exposure to subtoxic levels of a chemical can make a person more tolerant of succeeding doses of the same material. Repeated exposures to small amounts of arsenic can result in becoming tolerant of exposures up to 400 mg/day, an amount capable of causing serious illness or death in unacclimatized people. Other examples include alcohol and nicotine. The first experience with these materials can be quite different from later experiences.

This adaptive behavior is thought to be due to the response of the enzymes that process the chemical. These adaptive or inducible enzymes are not normally produced in the cell but are produced only when needed. As the concentration of the chemical increases, the inducible enzyme also increases. However, there is a limit to how much enzyme can be produced in response to a challenge.

Effects of Liver Health

As expected, the health status of the liver can affect $t_{1/2}$. Unfortunately, from the perspective of the practicing occupational hygienist, it is not possible to make general predictions of the effects of liver disease on hepatic transformations. In hepatitis or cirrhosis, changes may range from impaired to increased clearance. It appears that a quantitative basis for adjustment can only be made on assessment of clinical response and concentration in the plasma. It should be noted that 2.5% to 10% of workers are reported to have abnormal liver function tests. A lack of a predictive model could be a handicap in evaluating some individual reactions. In advanced disease the magnitude of impairment may range from two to five-fold, a significant change in the ability to handle an exposure.

It should be noted that a change in clearance rates through the liver may not always be harmful. If biotransformation results in detoxification, a reduction in $Cl_{hepatic}$ will be undesirable. If the biotransformation results in the production of more toxic materials, a reduction in $Cl_{hepatic}$ may advantageous to the host. For example, people who have a reduced aryl hydrocarbon hydroxylase level will have a reduced ability to convert PAHs such as benzpyrene to a potent carcinogen.

Where there is evidence of liver disease workers should not work with materials that are known to affect the liver.

Effects Of Kidney Health

If the health status of the kidney results in reduced clearance, a toxic material may not be readily removed from the body. The efficiency of clearance of a material can be estimated by comparing it to the clearance of creatinine which is eliminated at a constant rate through the kidneys. The clearance of the material (Cl) and the fractional rate constant (k) are proportional to creatinine clearance (Cl_{cr}). If the clearance rate of

creatinine is reduced, materials that are eliminated by the same route will also be reduced.

Creatinine clearance is best determined for the individual in question by a physician. A normal clearance rate depends the age, weight, and sex of the individual. Once the individual's actual clearance rate (Cl_{cr}) with suspected renal insufficiency is known it can be compared to the normal clearance rate (Cl). Then, acceptable dose with renal insufficiency (ri) can be estimated using Equation 8.

$$DOSE_{ri} = DOSE \times \frac{CL_{cr}}{CL} \qquad (8)$$

Substituting in Equation 5 ($Cl = Cl_{renal} + Cl_{nonrenal}$). The result is:

$$Cl_{ri} = Cl_{renal} \times \frac{Cl_{cr}}{Cl} + Cl_{nonrenal} \qquad (9)$$

The TLV can be adjusted for reduced renal clearance. If one assumes that the exposure guideline is proportional to dose, the guideline can be substituted into Equation 9 to yield a correction factor for the guideline when renal insufficiency is proportional to creatinine clearance. This is shown in Equation 10.

$$TLV_{adj} = TLV \times Cl_{ri} \qquad (10)$$

For example, 76 percent of lead dust (TLV of 0.05mg/m^3) is eliminated through the kidneys, and the remainder by other means. If a worker has a kidney impairment of 25 percent, as measured by Cl_{cr}, then the adjusted TLV to give a similar body burden would be:

a) If lead is primarily removed by the kidney, then

$Cl = Cl_{renal} + Cl_{nonrenal} = 100\%$

b) $Cl_{ri} = \{75\% \times 0.25\} + 24\% = 81\%$

Substituting into Equation 10, we calculate the adjusted TLV:

c) $TLV_{adjusted} = 0.05mg/m^3 \times 81\% = 0.04mg/m^3$

In the person with renal deficiency, this model provides the same average plasma level during exposure as would occur during a period of exposure to the TLV with normal renal function. This appears more conservative than the normal pharmacokinetic model that is based on the peak dosage levels.

Effects of Lung Health

Gas exchange through the lung serves as an important route of excretion for many materials. It should be noted that anything that affects gas exchange will affect both absorption and elimination through the lungs. It would appear then that materials that enter the body through other routes such as skin absorption and would normally be eliminated through the lungs would build up in the body when they are not eliminated as expected. Similarly, if the metabolites are eliminated through the lungs, they also will not be removed as expected. Table 7 is a list of some materials that are eliminated through the lungs.

TABLE 7: Some materials that are eliminated through the lungs.

CHEMICAL	FRACTION ELIMINATED THROUGH THE LUNGS
Acetaldehyde	5%
Acetonitrile	60-70%
Acrylic Acid	60%
Benzene	12%
1,3-Butadiene	27-77%
Captan	23%
Carbon Disulfide	5-30%
Carbon Monoxide	100%
Chloroform	dominant
Dichlorodifluoromethane	essentially all
1,1-Dichloroethane	70-86%
1,2-Dichloroethylene	dominant
Dichloromethane	Primary after biotransformation
Dichlorotetrafluoroethane	essentially all
Ethyl Benzene	5%
Ethyl Chloride	dominant
Hexachloroethane	65-72%
n-Hexane	10%
Methanol	<10%
Methyl Chloroform	97%
Methyl Ethyl Ketone	2-3%
Nitrobenzene	trace
Nitrous Oxide	dominant
Perchloroethylene	97%
Phenol	<1%
Selenium	trace
Silver	dominant

CHEMICAL	FRACTION ELIMINATED THROUGH THE LUNGS
Styrene	3%
Tetrahydrofuran	40%
Toluene	15-20%
Trichloroethylene	90%
Xylenes	5%

This route of elimination is most important for gases and volatile materials and metabolites. Lipid soluble materials passively diffuse from the blood into the air in the lung.

Anything that could affect gas exchange rates, such as an illness or other chemical exposure could reduce the rate that materials will be eliminated by this route. This will increase their effective half-life and their toxic potential.

Diseases that cause restrictive or obstructive patterns in air movement in the lungs or blood flow will affect gas exchange in the lungs. The production of mucus in the lungs (from asthma, cystic fibrosis, or bronchitis) can inhibit the movement of air in the lungs.

Lung function is severely decreased. Waste gas is trapped in the alveoli, and gas exchange can't occur. With emphysema, the delicate walls of the alveoli break down, reducing the gas exchange area of the lungs.

Some gases, vapours, mists, and dusts may be irritating to the lung and cause an inflammation of the lungs. This chemical pneumonitis is usually caused by gases or vapours that are soluble in the fluids in the lung. They dissolve into the fluids in the deeper parts of the lung and produce an irritation or react to produce an irritation to the lung. This irritation may result in the accumulation of fluid in the lung (pulmonary oedema). The following is a brief list of chemicals and groups of materials that can cause lung irritation.

Acid gases
Amines
Ammonia
Anhydrides
Chlorine
Dimethyl sulfate
Ethylene oxide
Mercaptans
Metal fumes
Oxides of nitrogen

Ozone
Phosgene
Propionyl chloride
Pyrolysis products of plastics and fluorocarbons
Sulfur dioxide

The Documentation® for acetic acid illustrates several issues related to the effects of chemicals on the lungs. Pickle workers were exposed to acetic acid vapours (vinegar) for short periods of time showed respiratory symptoms within 24 hours. The symptoms lasted for some time. This demonstrates that peak exposures for many of these materials are more important that the TWA. Symptoms are not immediate, and they can last for some time. This makes tracing cause and effect more difficult.

Also toxic substances can inhibit ciliary action (cigarette smoke) or can paralyze the cilia for extended periods of time. If the movement of mucus and particles out of the lungs is affected for lengthy periods of time the exchange of gases can be inhibited. At the same time, toxic dusts may not be removed as expected, leaving them in the body longer than expected.

CAUTION

These adjustments should be made with caution. The advice of a physician should be used in making this adjustment because the normal rate of creatinine clearance can vary from person to person. It must also be remembered that the data needed to make these adjustments may be considered confidential medical information.

In many cases, it will be adequate just to recognize a potential cause of the problem. Being able to quantify the adjustments necessary will be an added benefit.

Drug Summary

Where a patient has a repeated maintenance dose interval that is shorter than 3-4 half-lives of the drug, the drug will not have been eliminated before the next treatment, and the drug will accumulate in the body until a steady state has been reached. Thus the effective dose of a drug may not be the same as individual dose.

The impact of most drugs on workplace exposures is unknown. In some cases (aspirin on toluene) the effect is known, but the mechanism is unclear. Where it is suspected that a drug has an effect on the impact that a workplace chemical is having, the hygienist should work with the worker’s physician to determine if the drug and the workplace chemical use the same metabolic pathways, or could interact in some other fashion. Given the potential effects, it is surprising that the effects of workplace exposures on drugs has not been explored more fully. Also, these are not rare occurrences. For example, Jerome Z. Litt, M.D. has developed a list of 120 drugs that are known to cause photoallergenic, photosensitive, and phototoxic reactions. These

can affect outdoor workers and contain such items as ibuprofen, saccharin, and streptomycin.

Obesity and Workplace Exposures

Obesity is a large and rapidly growing public health problem both in the United States and worldwide. From 1976 through 1994, the prevalence of overweight children and adolescents in the United States almost doubled. According to the US Centres for Disease Control about 65% of the US population is either overweight or obese.

Depending on your definition, an obese person is about 25%-50% fat, a normal well-nourished person is about 10% - 20% fat.

Of particular interest here is the interaction between body fat and workplace chemicals.

Chemicals accumulate in fatty tissue based on their lipid solubility. The higher the oil:water partition coefficient, the more likely it is that the chemical will accumulate or be stored in fatty tissue. The higher the amount of body fat, the more chemical can be stored, and the less likely the person will be affected. Chemicals that are both metabolized and stored in fat have a low effective half-life.

The ability of a material to be stored can be beneficial. The material is absorbed into a temporary storage site during periods of peak exposure. In this way, the fat acts as a buffer absorbing the peak levels. Since the material does no harm when in storage, this is beneficial[1, 13]. Then, during periods of low exposure, the chemical can be released and metabolized. This will reduce the peak concentrations in the body and reduce the potential for toxic effects.

It would appear that body fat is a potential protective factor and low body fat levels may be a risk factor.

It should be noted that this storage and later release of fat soluble chemicals will possibly result in low concentrations of the material in the body the following day. This potential should be kept in mind when interpreting biological monitoring data.

It is extremely unlikely that the release of a toxic material under conditions of starvation or illness would be high enough to create an acute poisoning condition.[1] There would have to be a very large amount of the material stored, and the weight loss would have to be extraordinarily fast.

There are several obesity-workplace interactions reported in the literature. Three of interest to us are reviewed below.

Independent Risk Factors for the Same Disease.

Repetitive trauma and obesity are both risk factors for carpal tunnel syndrome. At this time it is unknown if these factors are additive, however, it is essential to exclude factors such as obesity before attributing it to occupation.

A second example is cardiac disease. High-paced work, shift work, high demand low control jobs and high job strain have been associated with cardiovascular disease. Obesity has also been identified as a risk factor for cardiovascular disease. Again, it is unclear if these are independent or additive risk factors.

In both cases an unexpected, carpal tunnel syndrome and cardiovascular disease may occur where workplace conditions by themselves would not be expected to have that effect where obese workers are involved.

Workplace and Obesity-Disease Relationships.
The relative risk of having asthma increases with increasing obesity. It has also been shown that morbidly obese asthmatics studied after weight loss demonstrates decreased severity and symptoms of asthma. It is likely; therefore, that obesity somehow either causes or exacerbates asthma. Obesity may also increase disease severity in subjects who already have asthma. In addition, obesity appears to alter the efficacy of standard asthma medications.

This may help explain why some workers may show symptoms where none are expected.

Occupational Exposures and Obesity Cause Two Interacting Diseases.
Obesity may cause one disease and occupational exposure may cause another disease and there may be some interaction between the two diseases. For example, work-related vibration can cause vibration-induced injury and obesity can lead to diabetes. The two conditions could affect each other. The impact of diabetes may compromise vascular tissues making them more susceptible to vibration-induced injury.

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