




# **ADJUSTMENT OF TLVs<sup>®</sup> TO ACCOMMODATE SPECIFIC CONDITIONS IN THE WORKPLACE**

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INTRODUCTION

- 
- Introduce Yourself
    - Name years of experience (# Surveys)
    - Who has adjusted TLVs
    - Any special Concern



Questions and comments are  
wanted

If you do not ask questions we will



# COURSE OBJECTIVE

- To review some of the conditions that affect TLVs
- Develop a practical approach to interpreting the TLVs



# COURSE OBJECTIVE

- Use the documentation
  - Reinforce TLV committee message - protect normal workforce/workplace
  - Reinforce TLVs as guidelines
  - Provide direction on what conditions are beyond the original intent of TLVs
  - Provide practical guidelines in adjusting TLVs
  - Demonstrate the significance of potential errors in not adjusting TLVs relative to other potential errors.

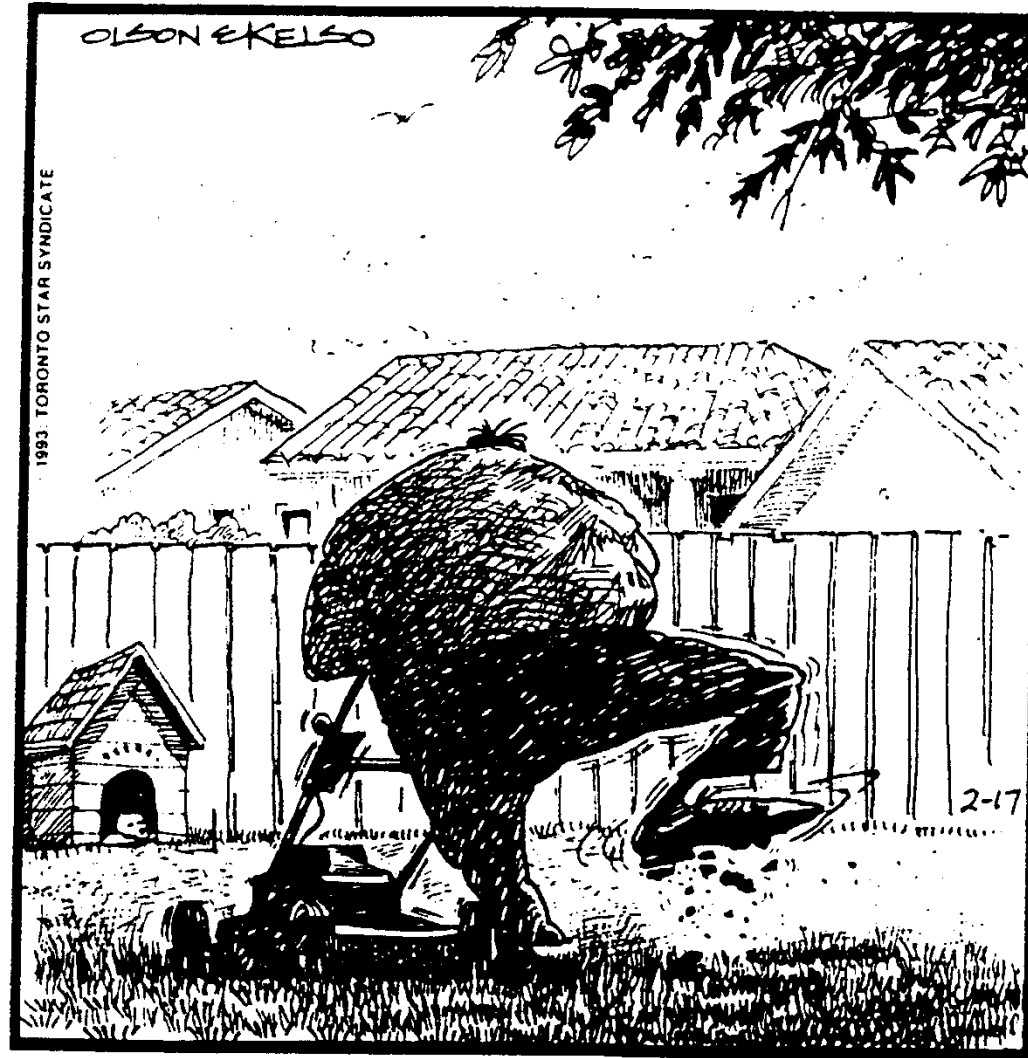
We will use common references, most are likely on your desk now



*“Read me.”*

*Bernard Shambaum.*

# HORRORSCOPE®



We will explore familiar surroundings. We may come across some fresh new surprises

INTRODUCTION

# NOTE:

This course is designed to help the OH to meet their professional obligations.

Not their legal ones.

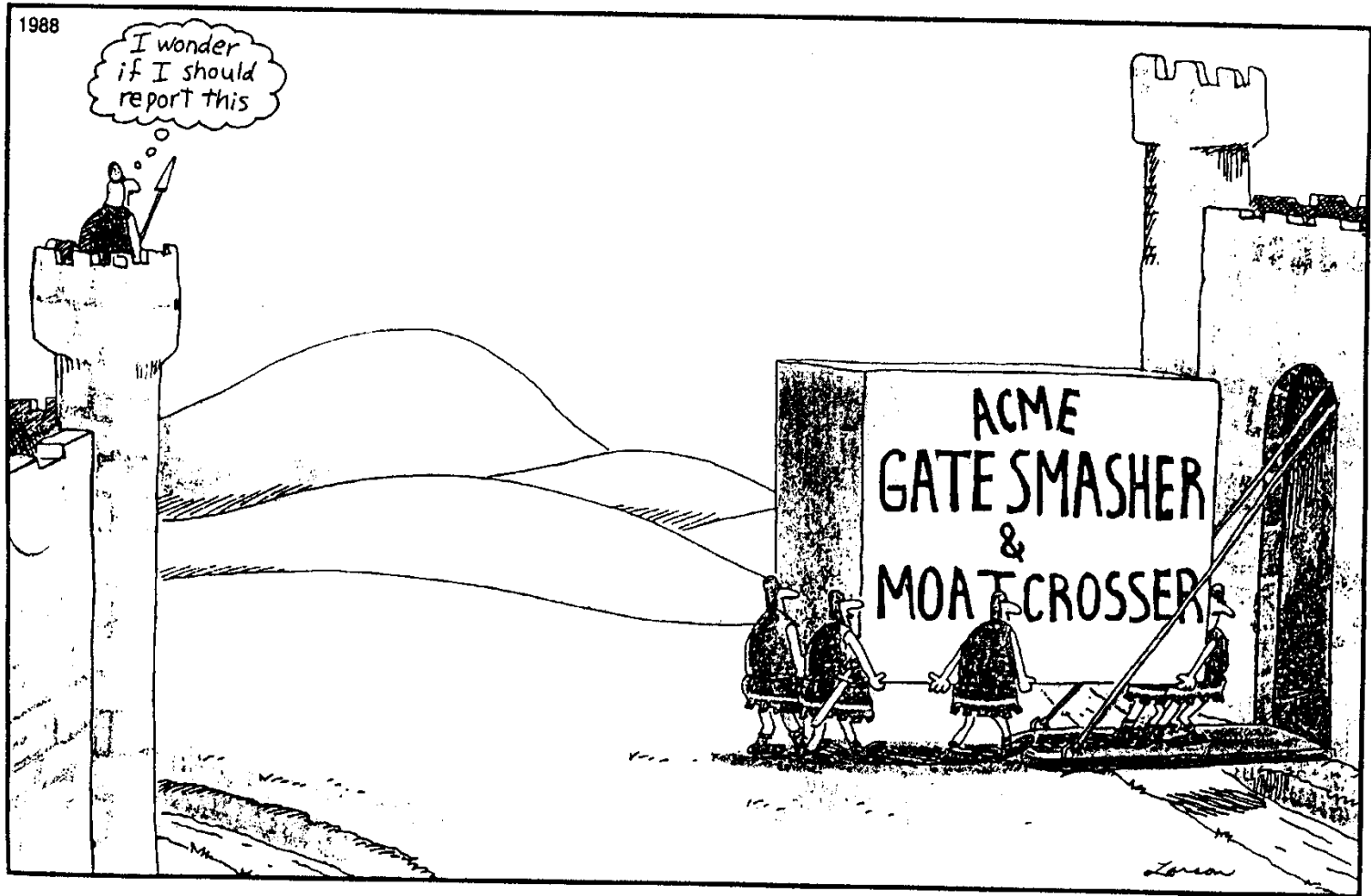




This will help to.....

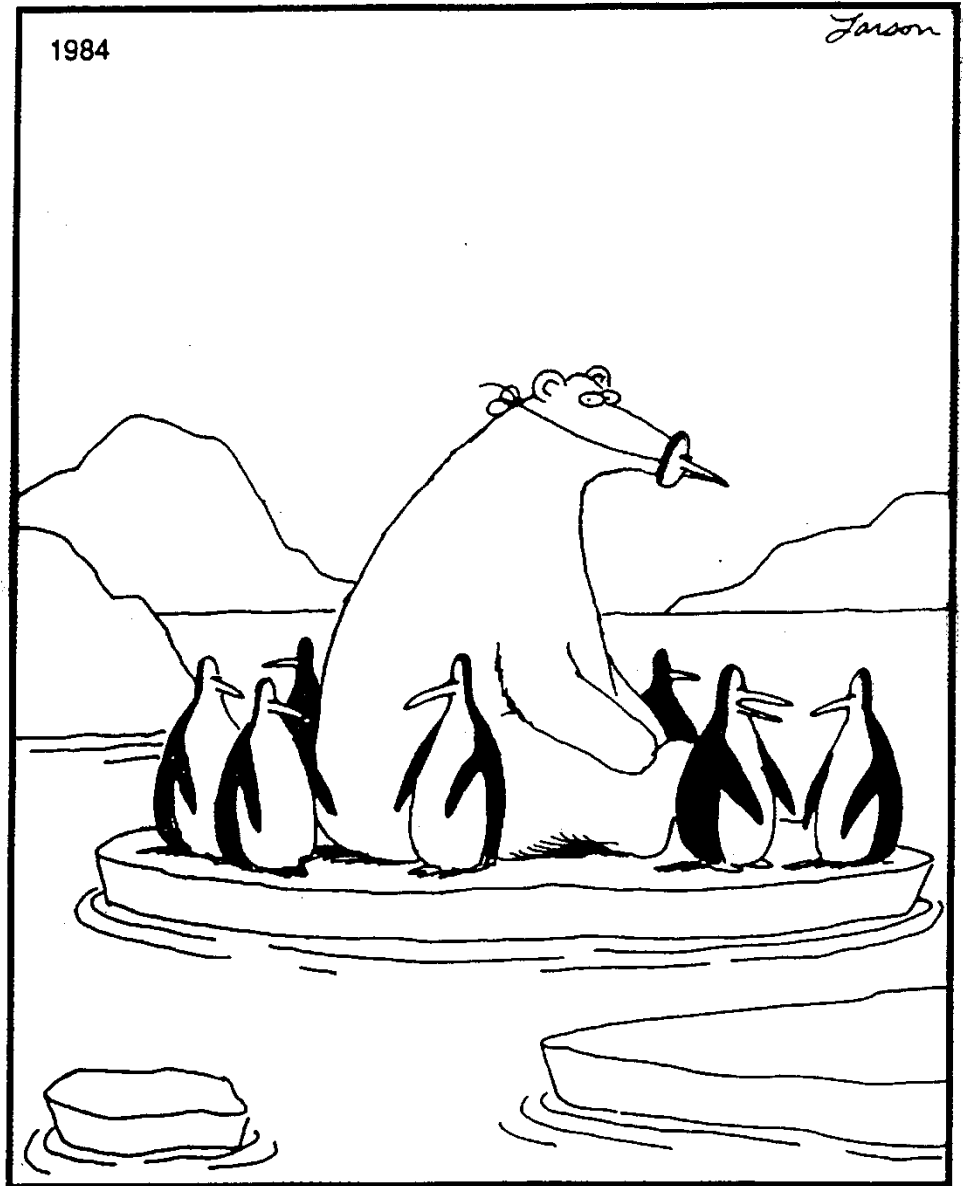
INTRODUCTION

# Anticipate Hazards



# Recognize Hazards


“And now Edgar is gone.....  
Something is going on around here.”





# REVIEW OF TLVs

- Airborne concentrations
- Levels to which nearly all workers may be exposed without adverse effect
- A small percent may experience discomfort
- A smaller percent may have a more serious reaction
- Not fine lines between safe and unsafe conditions



We are trying to address the  
**Nearly Alls**  
and the  
**Mays**

INTRODUCTION



# WHAT WE ARE NOT DOING

- Advocating raising TLVs
- Providing an increased level of safety/risk
- Providing absolute answers, but assisting in the application of the invisible 11 pages
- Second guessing the TLV Committee, but use the information they give us.

# Adjusting TLVs is not an exact science.

## Concentration in ppm

Country	Acetone	n-Butyl Alcohol	Carbon Monoxide	Carbon Tetrachloride
TLV	750	50	25	5
Australia	500	50	30	1
Federal Republic of Germany	1000	100	30	10
Sweden	250	25	35	2
United Kingdom	750	50	50	10

# Remember

- The goal is to protect
- Guidelines should be conservative in nature
- Any inexactness is allowed for with uncertainty factors



# Failure to adjust TLVs can result in.....

- Overestimating tolerance of the worker (conditions of the worker)
- Underestimating exposures (conditions of the workplace)



We must ask ourselves

**IS ACTION BETTER THAN INACTION?**



# Adjustment to TLVs for Specific Conditions

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# Goals

- TLVs have assumptions built into them
- Specific situation consistent with assumptions = no adjustment
- Specific Situation outside of those assumptions = adjust TLV to compensate for specific conditions



# You Can Do This

- Not Overly Complicated
- Use Readily Available Information
- Consistent with existing IH methods





# Pharmacokinetic

Changes levels of chemicals in the body

Levels rise during exposure

Levels drop when not exposed (away from work)



# One Compartment Model

Simple to use

Most often used

Provides results similar to  
more complex models

# Possible Indexes of Toxic Effect

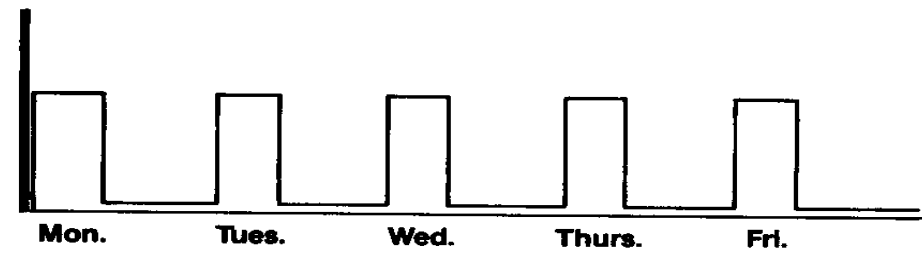
- Peak Body Burden \*
- Average Body Burden
- Residual Body Burden

If something bad is going to happen, its likely going to happen at the peak body burden



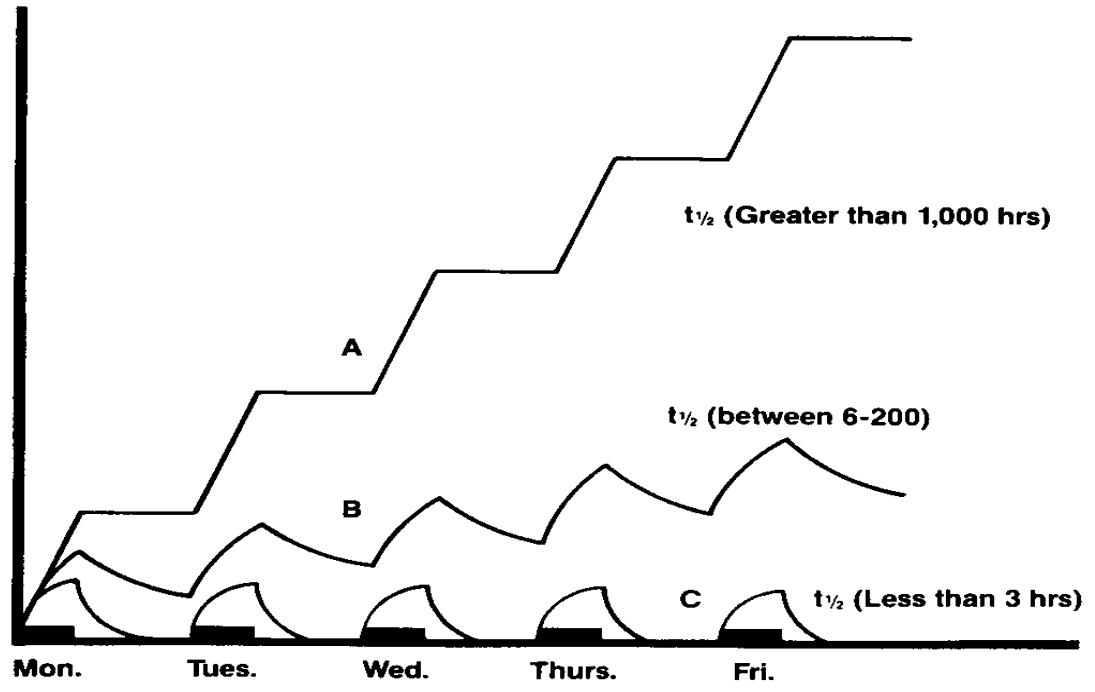


Toxicant Concentration in Air



INCREASING

Body Burden of Toxicant (mg/g)

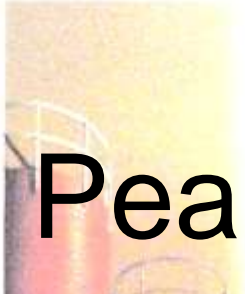


# Accumulation vs Elimination

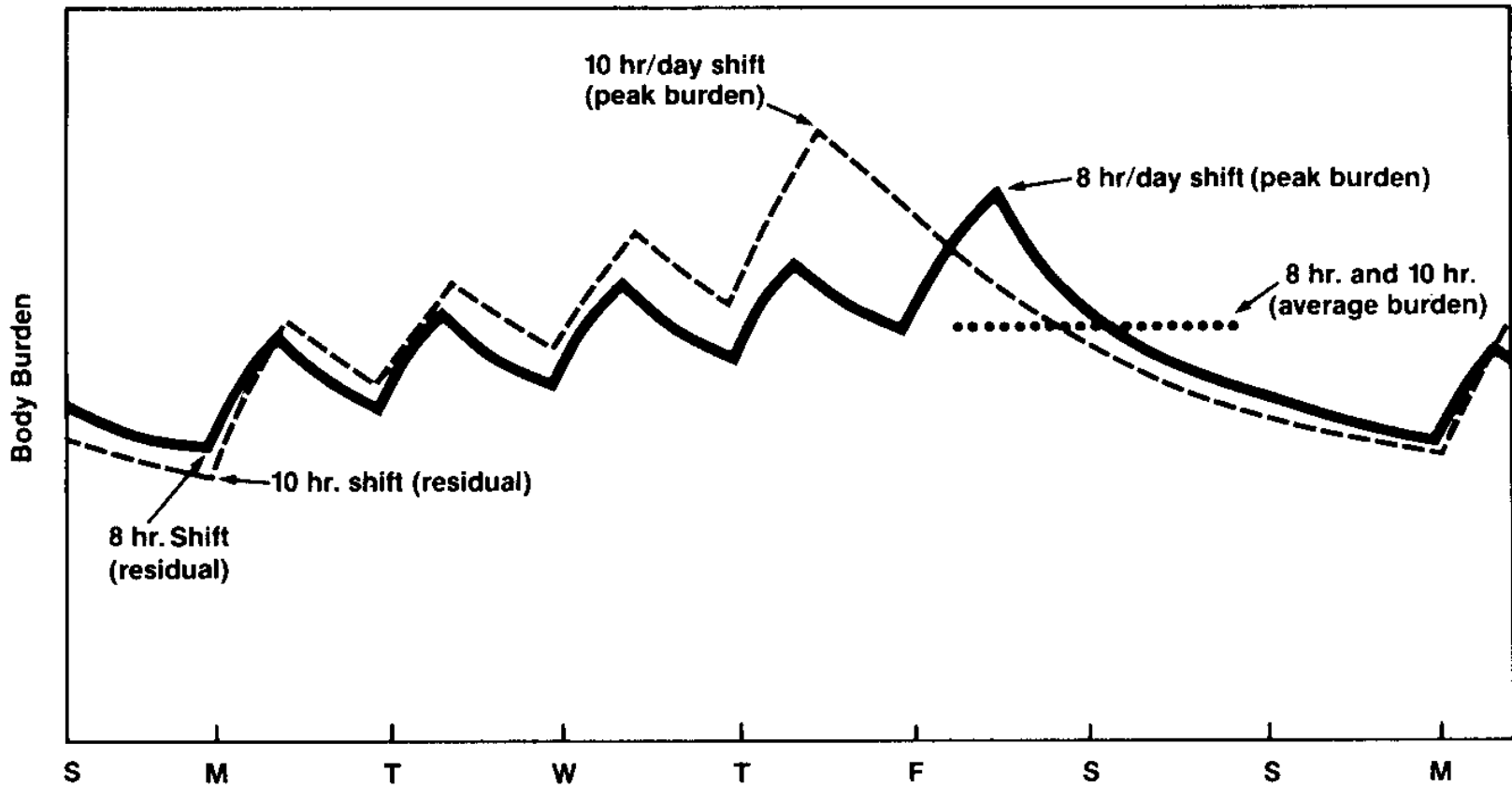
Balance between  
accumulation and elimination  
over time

Depends on times and half  
live of the chemical





# Peak Body Burden Over Time



# Goal

To compensate for condition not factored in the TLV

To provide the same peak body burden

To provide the same degree of risk/safety as usual



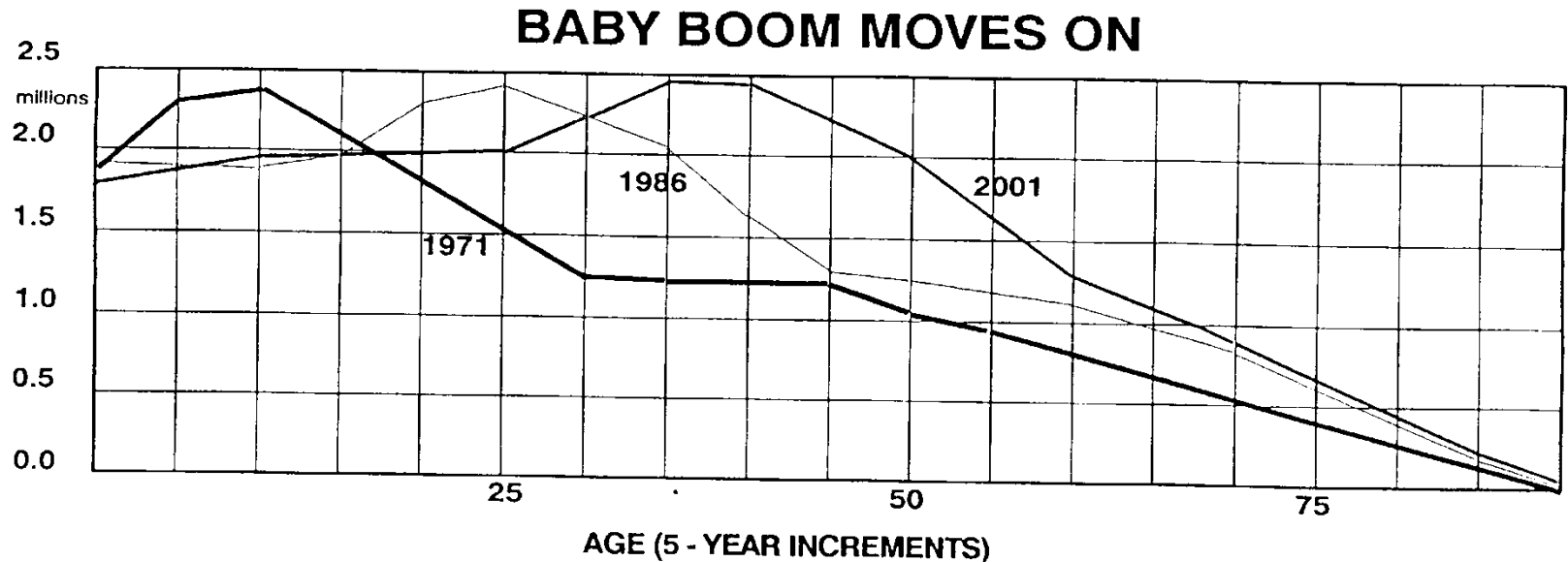
# CONDITIONS OF THE WORKFORCE

## ADJUSTMENTS FOR AGE



# Aging baby boomers will change the workforce demographics

The average age of workers has gone from  
34 in 1982 to  
36 in 1992 to  
39 in 2000 In Canada to  
45 soon in Australia / United States





# CHEMICAL HAZARDS

- Newborn and infant animals show more or less sensitivity than adults (biotransformation).
  - The range of sensitivity for newborn animals is from 0.002 - 15 times adult sensitivity
  - DDT is less toxic to newborn rats while organophosphates are more toxic




# CHEMICAL HAZARDS

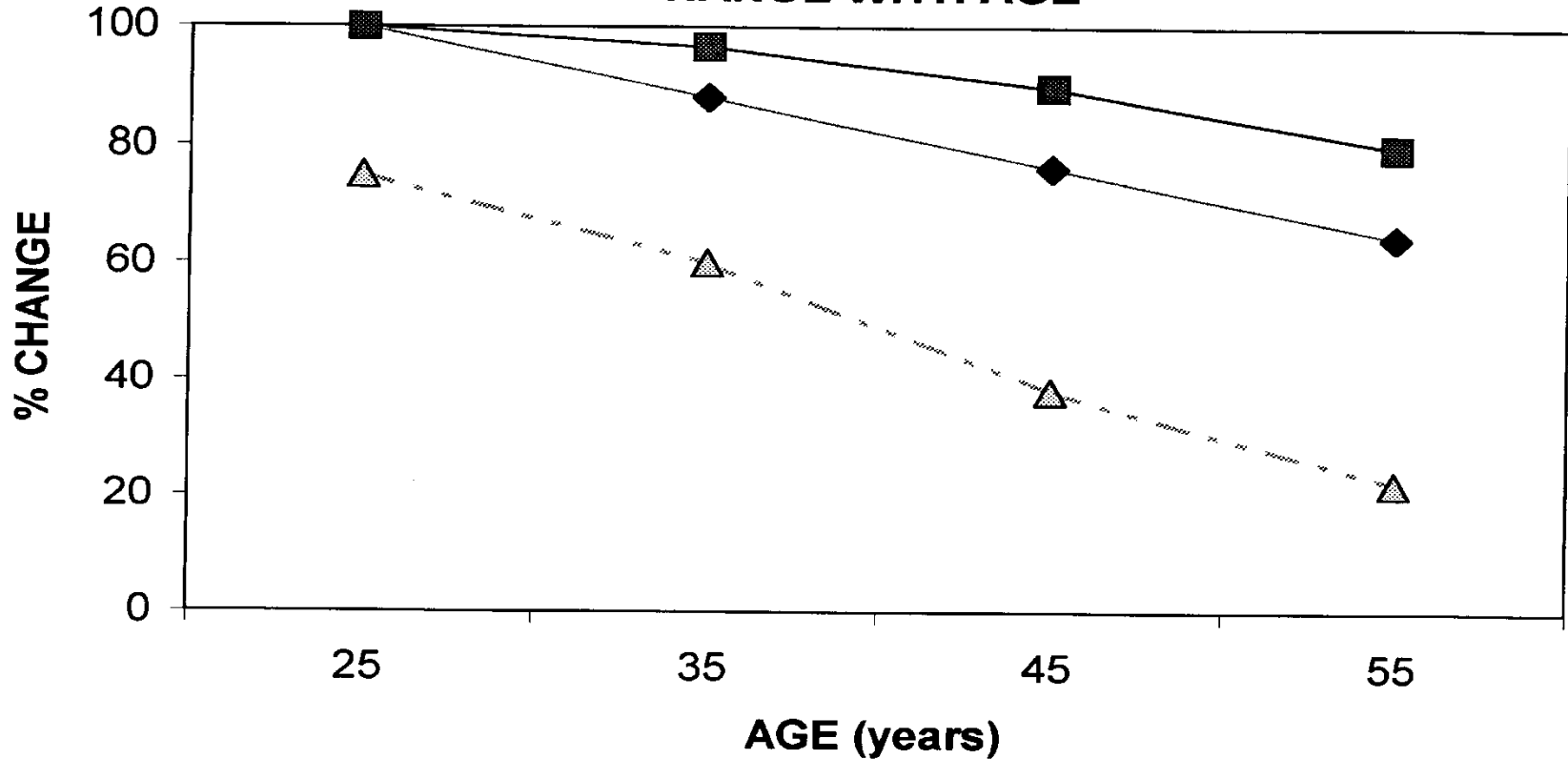
- The elderly show a decline in metabolic dependant clearance and aerobic capacity.
  - Related to reduced metabolic clearance due to reduced hepatic blood flow
  - Since the metabolism and excretion of solvents and metals are related to metabolism, it would suggest that exposure standards should be reviewed where older workers are present.
  - Biological monitoring, particularly for metals may be important to assess risk.

# PHYSICAL HAZARDS

- The older worker can adapt well if allowed to set own pace.
  - Due to reduced oxygen uptake in older workers (20 - 30% reduction between ages 30 and 65)

- 
- In general, there is little evidence on the effect of aging between extreme ages in the population and those that make up the workforce.
  - There is less of a difference between ages within the workforce.


## CHANGE WITH AGE



- ◆ VO2MAX (ml/kg/min)
- INCIDENCE OF HEARING IMPAIRMENT (% of population)
- △ REDUCTION IN VISUAL ACUITY (% acuity scores (20/20=100))

# Five leading chronic conditions (1987) shown as the expected number in 1000 persons

CONDITION	AGE		
	45-64	65-74	75 plus
Arthritis	273.3	463.6	511.9
Hypertension	252.0	392.4	337.0
Heart disease	184.7	423.7	473.3
Hearing impairment	135.6	264.7	348.0
Deformity or orthopaedic impairment	155.0	154.9	182.0



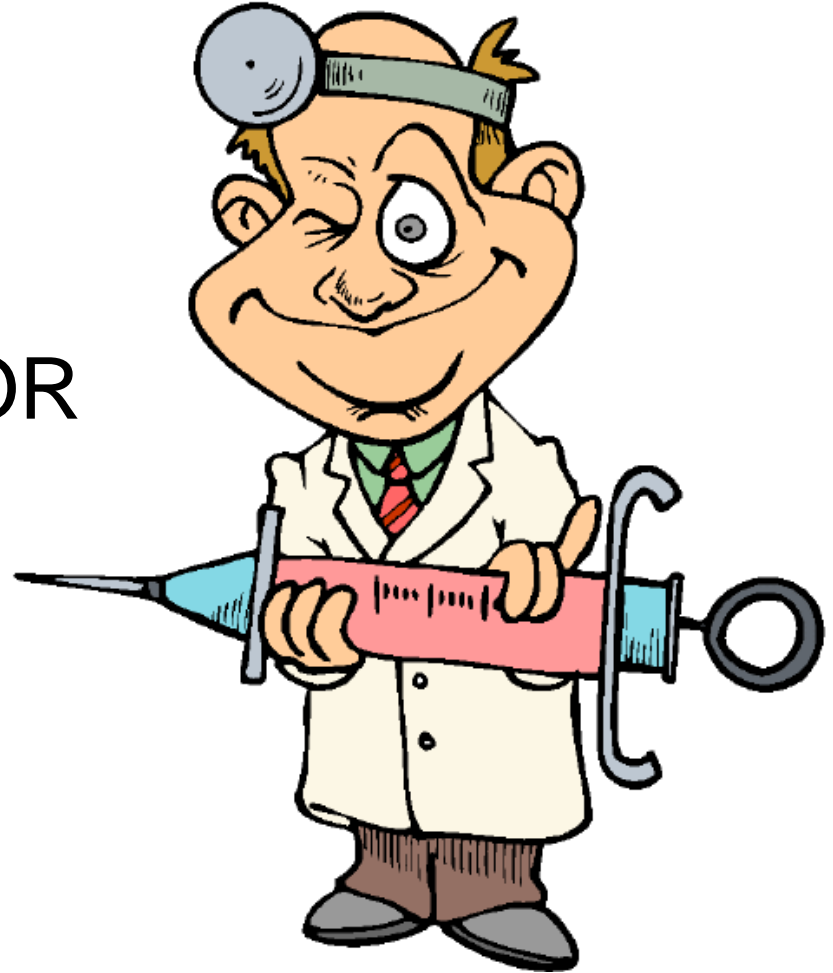
**Although there is little to suggest aging itself is a problem, the potential effects cannot be ignored.**

- The effects of degenerative diseases than can accompany age
- Effects of past workplace exposures
- The effect of drugs used to combat the above issues.

[next](#)

# CONDITIONS OF THE WORKFORCE

ADJUSTMENTS FOR  
HEALTH





The usual practice is to investigate how the workplace affects health

- Here we look at how health influences the effects of the workplace



# Our problems are:

- Most data is collected on healthy subjects.
- We must connect an existing medical condition with workplace exposures that could aggravate it.



# The Intuitive Model

- It is intuitive that.....
- If a worker has an affected organ (liver) any chemical or condition that affects that organ could have an exaggerated effect.



# Examples of Health Conditions

## HEALTH CONDITIONS

Kidney diseases

Liver diseases

Asthmatic diseases

Heart diseases

Sickle cell trait

## MATERIALS THAT MAY HAVE AN INCREASED EFFECT

Excessive sodium in diet, fluoride, lead.  
Other heavy metals

Carbontetrachloride, DDT, other  
insecticides, PCBs

Respiratory irritants, nitrogen dioxide,  
ozone, sulfates, sulfur dioxide

Cadmium, carbon monoxide, fluoride,  
respiratory irritants, ozone, sulfur dioxide,  
sodium

Aromatic amino and nitro compounds,  
carbon monoxide, cyanide

# The Desktop Guide (append D)

Health Code	Health Effect
1	Cancer
2	Chronic toxicity – suspected carcinogen or mutagen
3	Chronic toxicity – long term organ toxicity other than nervous
4	Acute toxicity -short term high hazard effects
5	Reproductive hazards –fertility impairment or teratogenesis
6	CNS disturbances -cholinesterase inhibition
7	CNS disturbances -nervous system effects other than narcosis
8	CNS disturbances -narcosis
9	Respiratory effects -respiratory sensitization, asthma
10	Respiratory effects -cumulative lung damage
11	Respiratory effects -acute lung damage / edema
12	Haematologic disturbances - anemias
13	Haematologic disturbances – methaemoglobinaemia
14	Marked irritation – eye, nose, throat, skin
15	Moderate irritation – eye, nose, throat, skin
16	Mild irritation – eye, nose, throat, skin
17	Asphyxiants
18	Explosive, flammable, safety, no adverse effects encountered when good housekeeping practices are followed.
19	Low risk health effects -nuisance particulates, vapors gases
20	Low risk health effects -odors antabuse
21	Dermal effects -dermal sensitization acne

# The Desktop Guide Examples

<b>HEALTH CODES</b>	<b>EFFECTS</b>	<b>EXAMPLES</b>
5	reproductive hazards	fetotoxicity, teratogen, reproductive impairment
6, 7, 8	central nervous system	narcosis, cholinesterase inhibition
9, 10, 11	respiratory effects	lung irritation, sensitization, edema
12, 13	haematologic disturbances	blood clotting,, anemia,, leukemia, bone marrow damage, methaemoglobinaemia
14, 15, 16	irritation of eyes, nose, throat, skin	eye damage,, skin contact allergy, corneal damage



# Pharmacokinetic Model

$$t_{1/2} = 0.693Vd/QE$$

$t_{1/2}$  = half life of the material

$Vd$  = amount of material in body for elimination

$Q$  = plasma flow through organ

$E$  = Extraction ratio, the ability of the organ to remove the material from the plasma



## Q = Plasma flow

- If flow to the kidneys or liver decrease (Q is decreased)  $t_{1/2}$  is increased.
  - Examples of workplace factors
    - aniline, carbon monoxide, toluene, trinitrotoluene
  - With reduced blood flow the brain and heart get preference over liver and kidneys
    - If brain or heart are target organs they will get an increased dose



## Q = Plasma flow

- Predictors for changes to Q are not readily available
  - increased oxygen consumption (increased workload)
  - With increased workload, Q can be reduced by 25% to liver and kidneys

# E = Extraction Ratio

Anything that reduced enzyme production  
affects E and  $t_{1/2}$

- workplace chemicals
- diet



# E = Extraction Ratio

## Other Chemicals

<b>If you have this</b>	<b>And are exposed to this</b>	<b>This will result</b>
Toluene	n-Hexane, Trichloroethylene .	Reduced rate of metabolism
Perchloroethylene	Mehtyl chloroform	Reduced rate of metabolism
Ethylbenzene	Xylene	Reduced rate of metabolism
Respiratory disease, pregnancy, heavy labor	Carbon monoxide	Increased toxicity
Ethanol	Carbon tetrachloride, chloroform, Dimethylnitrosamine, Thioacetamide	Synergistic effect

# E = Extraction Ratio

## Diet

<b>If you have this</b>	<b>And are exposed to this</b>	<b>This will result</b>
Fasting	Many chemicals	Increases rate of absorption through gastrointestinal tract
Iron deficiency	Lead, cadmium, manganese, hydrocarbon carcinogens	Increased impairment of hematopoiesis, increased risk to these materials.
Vitamin C deficiency	Arsenic, cadmium, CO, chromium, DDT, lead, mercury, nitrates, ozone	Increased risk to these materials



# EFFECTS OF LIVER HEALTH

- General predictions of change not always possible
  - hepatitis or cirrhosis can result in either impaired or increased clearance
  - in advanced disease, the magnitude of impairment may range from two to five fold.



# EFFECTS OF KIDNEY HEALTH

- Efficiency of clearance can be estimated by comparing it to creatinine clearance.
- Normal creatinine clearance = 100 ml/min
- $\text{Dose}_{ri} = \text{Dose} \times (\text{Cl}_{ri}/\text{Cl})$

A vertical image on the left side of the slide shows laboratory glassware, including a graduated cylinder and a beaker, with a yellow and orange light gradient background.

# EFFECTS OF KIDNEY HEALTH calculation

$$Cl_{\text{Total}} = Cl_{\text{renal}} + Cl_{\text{hepatic}} + \dots$$

$$Cl_{\text{ri}} = Cl_{\text{renal}} \times \frac{(\text{measured } Cl_{\text{cr}})}{100_{\text{ml/min}}} + Cl_{\text{other}}$$

$$TLV_{\text{adj}} = TLV \times Cl_{\text{ri}}$$

- If a worker has a 25% kidney impairment measured by  $Cl_{\text{cr}}$ , what should be the adjusted TLV for lead?



# **EFFECTS OF KIDNEY HEALTH calculation**

**If a worker has a 25% kidney impairment measured by  $Cl_{cr}$ , what should be the adjusted TLV for lead?**

**STEP #1 - From Appendix A - Routes of Elimination determine how the material is eliminated**

$$CI = CI_r(76\%) + CI_{\text{nonrenal}}(24\%) = 100\%$$

A vertical strip on the left side of the slide shows laboratory glassware, including a large red Erlenmeyer flask and a graduated cylinder, set against a blurred background.

# **EFFECTS OF KIDNEY HEALTH calculation**

**If a worker has a 25% kidney impairment measured by Cl<sub>cr</sub>, what should be the adjusted TLV for lead?**

**STEP #2 - Calculate the new clearance rate for a worker with renal insufficiency**

$$\begin{aligned} Cl_{ri} &= [76\% \times (75_{\text{ml/min}}/100_{\text{ml/min}})] + 24\% \\ &= 81\% \end{aligned}$$



# **EFFECTS OF KIDNEY HEALTH calculation**

**If a worker has a 25% kidney impairment measured by Clcr, what should be the adjusted TLV for lead?**

**STEP #3 - Recalculate new exposure limit**

$$\begin{aligned}\text{TLV}_{\text{adj}} &= 0.15 \text{ mg/m}^3 \times 81\% \\ &= 0.12 \text{ mg/m}^3\end{aligned}$$



# EFFECTS OF MEDICATION

- Similar to other workplace chemicals and diet
  - Common - 15 to 30% of workers take prescribed drugs
  - An additional 8% take nonprescribed drugs

# CAUTION

- Not only can an illness change a worker's reaction to a workplace exposure, so can the treatment of the illness.



# A drug can result in exposures to materials the same as those in the workplace

<b>Workplace Chemical</b>	<b>Drug with the same material</b>
Phenol	Antiseptics (phenol-camphor-petrolatum lotion) Throat lozenges Calamine loations Antacids
Fluoride	Fluoride supplements Decongestants Tooth paste/mouthwash Fluorosteroids
Aluminum	Antacids
Bismuth	Bismuth subsalicylate
Arsenic	Homeopathic medicines
Mercury	Chinese patent medicine



# Or the drug metabolites are the same or similar to those of workplace chemicals

<b>Workplace Chemicals</b>	<b>Drug With The Same Metabolite</b>
Analine	Phenacetin Acetanilide Phenazopyridine
Carbon disulphide	Antabuse

# DRUG ACTION

<b>Drug Action</b>	<b>Drug Effect</b>
Competes for enzymes (antabuse)	Inhibits biotransformation
Destroys or inactivates an enzyme (antineoplastic drugs)	Inhibits biotransformation
Affects absorption in GI tract (antacids)	Prevents absorption
Alters dermal absorption (ointments)	Acts as a barrier reducing absorption Acts as a reservoir increasing absorption
Reduces cardiac output or inhibits vasodilation	Reduces hepatic or renal flow and increases $t_{1/2}$
Reduces hepatic enzyme activity	Increases $t_{1/2}$
Affects urinary pH	Can affect some materials



# DRUG SUMMARY

- The impact of most drugs on workplace exposures is unknown.
- Work with physician to determine metabolic pathways.

## PERSONAL COMMENT

Given the potential effects, it is surprising that the effects of workplace exposures on drugs has not been explored more fully.