Principles of Occupational Hygiene

Victor Hoe Chee Wai

MBBS, MPH (Malaya), MPH (Occupational Health) (Malaya), CMIA, OHD, CHRA

Senior Lecturer

Occupational and Environmental Health Unit

Department of Social and Preventive Medicine

Objective

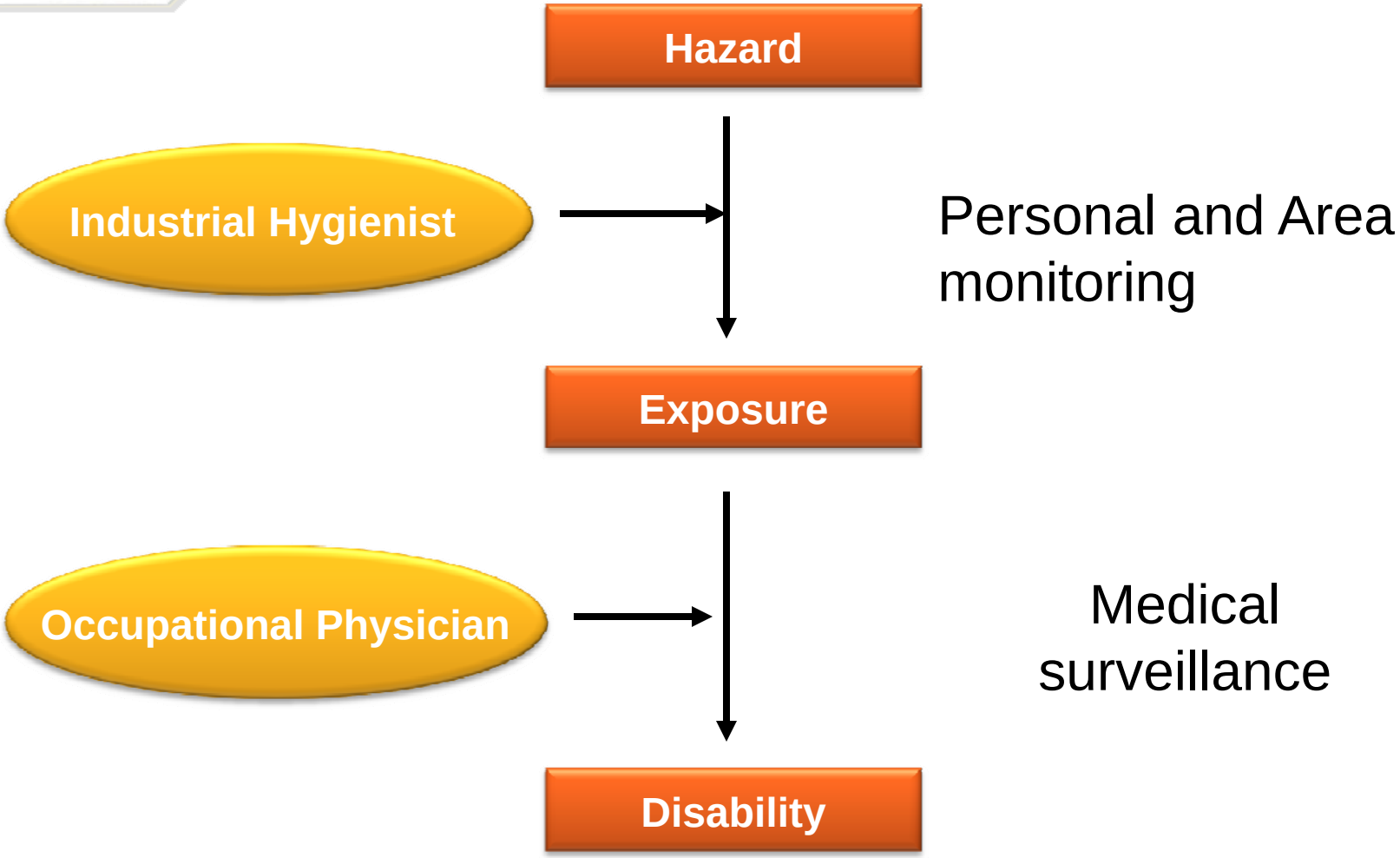
- To understand the
  - Principles of Occupational Hygiene
  - Exposure limits
  - Industrial hygiene survey
  - Medical surveillance in occupational health

Occupational Hygiene

- Hygiene is defined in the Concise Oxford English Dictionary as:
  - “the principle of maintaining health; practice of these”

Definition

- '*Occupational Hygiene is the discipline of* ***anticipating***, ***recognising***, ***evaluating*** *and* ***controlling*** *health hazards in the working environment with the objective of protecting worker health and well-being and safeguarding the community at large*'.



Exposure Limits

- Is the safe limit below which the substance will not cause any harm to the workers

- Limits for workers are based on
  - exposure of 8 hours a day X 5 days/week
- Limits for population are based on
  - exposure of 24 hours a day X 7 days/week

for Carcinogens

- "*no detectable exposure levels for proven carcinogenic substances*"
  - carcinogen policy published in 1976 by Edward J. Fairchild, II, Associate Director for Cincinnati Operations, (Annals of the New York Academy of Sciences, 271:200-207, 1976).

Exposure Limits

- ACGIH
  - TLV – threshold limit values
- NIOSH USA
  - REL – recommended exposure limits
  - **IDLH** - immediately dangerous to life or health concentrations
- OSHA USA
  - PEL – permissible exposure limits
- DOSH Malaysia
  - PEL – permissible exposure limits
  - Schedule 1 of OSH (USECHH) Regulation 2000
  - Based on the ACGIH-TLV

Threshold Limit Value (TLV)

- Airborne concentrations of substances that represents conditions under which it is believed that nearly all workers may be exposed day after day with no adverse effect.

Threshold Limit Value (TLV)

- Based on evidence from
  - Industrial experience,
  - Animal studies, or
  - Human studies

Threshold Limit Value (TLV)

- Devised by the
  - American Conference of Governmental Industrial Hygienists (ACGIH)
- TLV's are
  - advisory exposure guidelines, not legal standards
  - revised yearly with new evidence

Threshold Limit Value (TLV)

- Time Weighted Average (**TLV-TWA**)
  - average value of exposure over the course of an 8 hour work shift
- Short Term Exposure Limit (**TLV-STEL**)
  - concentration to which workers can be exposed continuously for a short period of time (15 minutes)
- Ceiling (**TLV-C**)
  - at no time should this exposure limit be exceeded

Biological Exposure Indices (BEI)

- BEIs represent the levels of determinants which are most likely to be observed in specimens collected from a healthy worker who has been exposed to chemicals to the same extent as a worker with inhalation exposure to the TLV.

Standards

- OSHA USA
  - PEL – permissible exposure limits
- DOSH Malaysia
  - PEL – permissible exposure limits
  - Schedule 1 OSH (USECHH) Regulation 2000
  - Based on the ACGIH-TLV

Ingredients of a Standard

- A standard is one that requires conditions, means, methods, operations, or processes reasonably necessary or appropriate to provide safe and healthy employment

Constraint in setting Standards

- Technical Feasibility
  - limits to technology
- Cost of Control
  - “What will it cost?”
  - Depends on perception of risk and acceptance of risk

NIOSH Standards

- …. exposure levels that are safe for various periods of employment, including but not limited to the exposure levels at which no employee will suffer impaired health or functional capacities or diminished life expectancy as a result of his work experience."

Permissible Exposure Limits (PEL)

- Specific levels of exposure normally tolerated in average day work (8 hours day or 40 hours week) before adverse effects on health occur
- many based on TLV of the ACGIH

PEL according to OSH (USECHH) Regulation 2000

- TWA – Time Weighted Average
- Maximum Exposure Limit - 15 minutes time-weighted average airborne concentration which is 3 times the 8hr TWA airborne concentration
- Ceiling limit – means the airborne concentration that should not be exceeded during any part of the working say

Dermal exposure

- The exposure level / standards uses only airborne concentration
- How about absorption thru dermal contact?
  - There is usually the notation of “SK” of “skin”
  - For example
    - Carbon Tertachloride CCl4 (skin) – TWA 5 ppm

Industrial Hygiene Survey

- The purpose of a hygiene survey is to identify and assess potential health hazards in the working environment.
- Need to know
  - the workplace and processes
  - nature and toxicity of the hazards present
  - extent of exposure and control methods

Industrial Hygiene Survey

- Involves identifying
- What hazardous substances are present
- Gathering information on the hazardous substances
- Inspecting the workplace
- Undertaking monitoring
- Assessing the risks to health posed by each hazardous substance.

Monitoring

- Monitoring is used where the degree of exposure cannot be adequately assessed by visual observations, or where control measures are to be assessed for adequacy.
- Monitoring can by way of:
  - Personal and positional (Area) monitoring;
  - Biological monitoring; and
  - Health Surveillance

Monitoring - Sampling

- Where to sample;
- Whom to sample;
- How long to sample;
- How many samples;
- When to sample; and
- Selection of monitoring equipment

Where to Sample?
Personal Sampling

- Personal sampling is the preferred method to determine a worker's exposure.
- Air sample is collected within the breathing zone of the worker, representing the air inhaled by the worker.
  - Usually within 20 – 30 cm diameter from nostril.

Where to sample?
Area sampling

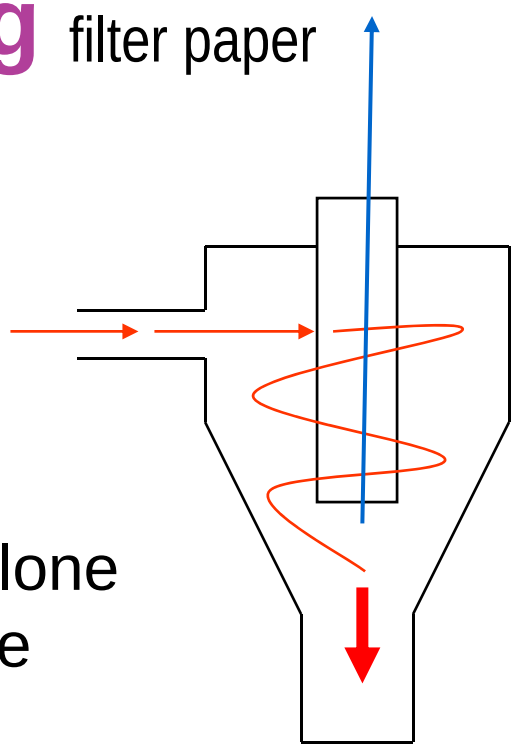
- Positional sampling is used to take air samples at fixed locations.
- used to:
  - assess control measures;
  - locate high concentration points in the workplace;
  - locate flammable or explosive points; or
  - undertake continuous monitoring, as is required in confined spaces

Active Sampling

- Collection of airborne hazards by forced movement of air using an air-sampling pump through the appropriate sampling media.
- The pump is used to collect and/or concentrate the chemical of interest onto the sampling media.

Respirable Dust Sampling

- Respirable dust are dust less than 10 µm which can be deposited in the lungs
- Uses a cyclone tube



Air sampling unit

Location of sampling unit for personal sampling

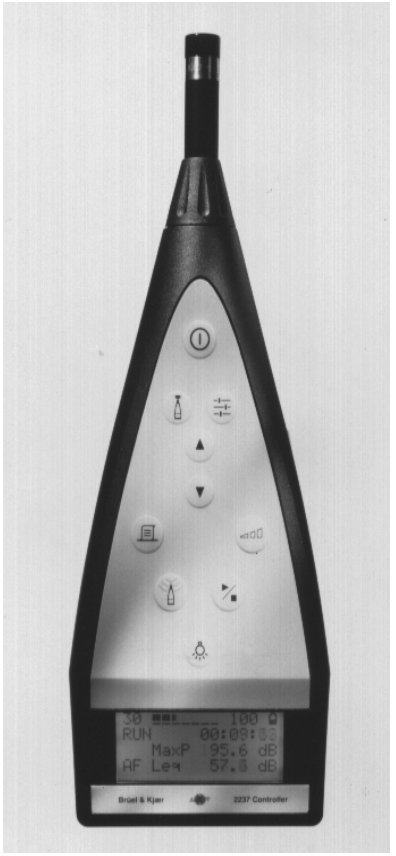
Passive Sampling

- Passive diffusion badge
  - Benzene
  - VOC
  - Ethylene Oxide

Personal Temperature Monitoring

Wet Bulb Globe Temperature

Type 2 Sound Level Meter



(Courtesy Brüel & Kjær.)

Dosimeter

- Personal monitoring of sound over a period of 8 hrs or stipulated time/noise dose

What equipment to use?

- Diffusion Badge
  - VOC, Benzene, Ethylene Oxide
- Active Sampling
  - Charcoal Tubes – VOC, Chemicals
  - Simple Active Filter – Dust, Fibres, Microbes
  - Cyclone Separators – to separate particles less than 10 μm (Respirable Portion – can reach the lower airway)

Medical Surveillance

- Medical surveillance is the ongoing systematic collection, analysis and interpretation of health and exposure data.
- Specifically it refers to examination of individuals for the purpose of detecting health effects.

Purpose of Medical Surveillance

- Detect existing disease risk factors
- Detect early ill-effects due to work exposure
- Ensure workers are not given jobs that aggravate existing health condition
- Protect people at special risk e.g. pregnant women

Indications for Surveillance

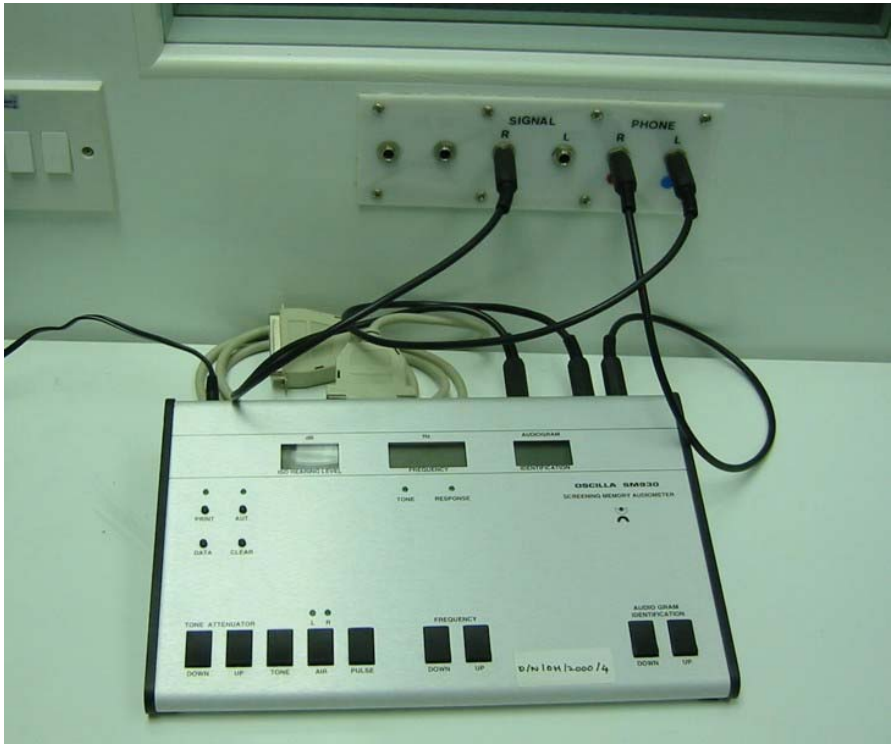
- Continuing potential for occupational exposure to hazardous agent
- valid technique available with adequate means of interpreting the findings

Medical Surveillance Procedures

- Medical examination
- Special investigations
  - Lung function test
  - Audiometry
  - Chest X-ray
  - Bladder cytology
  - Periodic eye tests
  - Colour Vision
  - Biological monitoring
  - Biological effect monitoring

Spirometer

Audio meter and booth



Biological Monitoring

- Biological Monitoring is the assessment of exposure to chemicals (substances) that are present in the workplace,
- Through the measurement of appropriate determinants in biological specimens from exposed workers.
- Provide an indication of exposure

Biological Monitoring

- Biological specimens commonly collected include blood, urine and exhaled air. Less commonly used are hair, nails and faces
- Determinants measured can be the chemical itself, its metabolite(s), or a characteristic reversible biochemical change induced by the chemical
- E.g.
  - Lead in Blood
  - Inorganic Arsenic in urine
  - Cholinesterase level for Pesticides

Biological Effect Monitoring

- Monitoring the effect of the substance on target organs
  - Lung Function Test
  - Liver Function Test
  - Renal Function Test
  - Haematological System