Basic Concepts in
Environmental Health and Toxicology

Lecture Notes

Slide 1 (title):
Basic Concepts in Environmental Health and Toxicology

Notations (opening comments):

Slide 2:
Objectives:
By the end of this class, students will be able to:

- *Define environmental health*
- *Name the four types of environmental health hazards and give two examples of each*
- *Discuss eight principles or concepts that are important in understanding and evaluating environmental health issues*

Additional Notations:

Speaker Notes:
What is environmental health? *(elicit student discussion)*

Slide 3:
Definition of Environmental Health*: Freedom from illness or injury related to exposure to toxic agents and other environmental conditions that are potentially detrimental to human health*

Speaker Notes:
This is the definition developed by the Institute of Medicine of the National Academy of Sciences in their 1995 report entitled "Nursing, Health and the Environment."

Additional Notations:

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Speaker Notes:
What do you think your role as a nurse might be in environmental health? (How would you, as a nurse, promote environmental health?)

Slide 4:
The Nursing Process in Environmental Health
Assess: *Environmental health history for the individual (including occupational health history for the individual worker); environmental assessment of the home, school, workplace and community*

Speaker Notes:
It's important to realize that the environmental health history for the individual has implications for others. If an individual is exposed to a substance at home or work, everyone sharing or visiting that home or workplace is exposed. Also, toxic substances can be carried from one setting to another on individuals. For example, children have been poisoned by parents who carried lead dust home on work clothes.

Additional Notations:

Slide 5:
The Nursing Process in Environmental Health
Plan*: Health education for individuals, families and communities (including referral sources), advocacy project, community organization project (including workplace projects)*
Implement *the plan or project*
Evaluate *by assessing exposure reduction*

Speaker Notes:
Examples of exposure reduction include use of alternatives to pesticides or mercury thermometers, or repainting windowsills to contain lead-based paint.

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Slide 6:

To find out more about…

Advocacy: *www.envirohealthaction.org*

Environmental health in health care settings: *www.hcwh.org, www.sustainablehospitals.org*

Exposure reduction-pesticides: *www.epa.gov/pesticides → "Concerned Citizens", www.birc.org*

Exposure reduction-mercury thermometers*: www.epa.gov/mercury →mercury fact sheets →mercury thermometers*

Exposure reduction-lead: *www.aeclp.org*

Speaker Notes:

What are some of the toxic agents and other environmental conditions that are potentially detrimental to human health? What are the environmental hazards in homes, workplaces, schools, and communities? What might be different exposures at different ages? *(Elicit class discussion, and use the following slide to wrap up the class discussion)*

Slide 7:

Environmental Health Hazards

Chemical (ex.: pesticides, industrial discharges), Physical (ex.: fire, explosions, injuries), Biological (ex.: microbes, poisonous plants and animals) and Nuclear/Radioactive.

Speaker Notes:

We'll be discussing toxicants in this lecture. Toxicants are chemical or physical substances that produce adverse biological effects. (The words "toxin"and "toxic" are frequently used synonymously with "toxicant," but a toxin is specifically a poison produced by living organisms.)

Additional Notations:

Slide 8:

Toxicology: *The study of the adverse effects of chemicals or physical agents on living organisms*

Speaker Notes:

Not all hazards are equally harmful, and the kind of harm varies. It's important to be able to evaluate different situations based on knowledge of the principles of toxicology. Let's look at some scenarios and discuss some key principles and concepts of toxicology.

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Slide 9:
Scenario #1:
Your neighbor calls you to say that her child broke a thermometer and ate the silvery-grey material inside. You know the silvery-grey material is mercury, and you have heard recently that pregnant women and children should limit consumption of fish because of mercury contamination. Does this mean that eating the material from the thermometer is a problem?

Speaker Notes:
Let's consider a few questions *(next 4 slides).*

Slide 10:
Food for Thought About Mercury
Do you think that the health risks from mercury in a thermometer might be different from the risks related to mercury in fish? What could be different?

Additional Notations:

Slide 11:
More Food for Thought About Mercury

- *With the mercury from the thermometer, what risks other than swallowing might be a problem? How else might the mercury be absorbed?*
- *Do you think there could be a difference in health effects depending on the route of exposure? (Hint: Is there a difference between the effects of a medication given orally, versus parenterally? Why isn't insulin given orally?)*

Additional Notations:

Slide 12:
Yet More Food for Thought…
Do you think there could be a difference in health effects related to the form of mercury in the thermometer, as opposed to fish? (Hint: Is there a difference between the oral form and parenteral form of the same medication? If you gave the oral form parenterally, would it have the same effect?)

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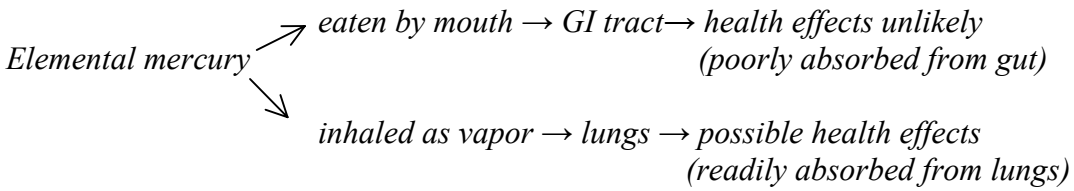
Slide 13:
One More Thought…
Do you think there could be a difference in the effects of mercury on children, as opposed to adults? (Are there differences between children and adults with regard to the effects of medications?)

Additional Notations:

Speaker Notes:
Let's discuss some of the environmental toxicology principles that are related to these questions.

Slide 14 :
***Principles/concepts*:**
Route of exposure *is significant*



Speaker Notes:
The silvery-grey material that is found in mercury thermometers and sphygmomanometers is elemental mercury. The effect of elemental mercury varies depending upon the route of exposure, just as the effect of a medication varies depending upon the route of administration. If elemental mercury is eaten by mouth and goes into the GI tract, a negative health effect is unlikely because it is not absorbed well from the GI tract. Most of it will be excreted in stool. (Note, though, that this excreted mercury will go into water via the sewage system.)

However, elemental mercury that is left in the environment vaporizes (moves into the air in tiny droplets). If this vapor is inhaled, it can cause pulmonary disease. It can also cause disease in other organs because it is readily absorbed through the lungs. Teaching people about proper cleanup of spilled mercury (such as mercury from a broken thermometer), and encouraging use of alternatives to mercury products, are important nursing activities.

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Slide 15:
Principles/Concepts:
*One **form** of a substance can have very different effects from another.*

Elemental mercury $\xrightarrow{\text{air}}$ *bodies of water → methylmercury → fish →people→ significant health effects (esp. neurotoxic);* readily absorbed from *all routes* (including placenta)

Speaker Notes:
Substances can be changed chemically (as well as physically) in the environment, the laboratory or the body. (Elements can be added to compounds, and compounds can be rearranged.) The resulting compound may be more or less toxic than the original one.

When elemental mercury gets into bodies of water, bacteria convert it to a very toxic compound called methylmercury. Elemental mercury can be discharged directly into water from industrial processes, or it can be carried in the air to bodies of water. Major sources of airborne mercury are combustion of coal, municipal and medical waste.

Methylmercury is taken in by fish, which are then eaten by people. It is especially toxic to the nervous system, and it is effectively absorbed by all routes. It crosses the placenta readily, and it is particularly toxic to the fetus. Therefore, the Environmental Protection Agency (EPA) and the Food and Drug Administration (FDA), as well as individual states, have issued advisories that instruct women of childbearing age, as well as young children, to limit their consumption of fish.

Additional Notations:

Slide 16:
Principles/Concepts:
*Effects may vary in **different populations** and **different individuals***

Speaker Notes:
For multiple reasons, fetuses and children may be at higher risk for toxic effects. Also, susceptibility varies from one person to another due to multiple factors including genetic variation, medical conditions, and exposure (or lack of exposure) to other substances (such as medication, particular nutrients, or other pollutants).

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Slide 17:

To find out more about…

Mercury: *www.epa.gov/mercury, www.hcwh.org, www.nih.gov →"Mad As A Hatter"*

Children's Environmental Health : *www.epa.gov/children, www.cehn.org*

Maternal Health: *S. Steingraber: Having Faith (HarperCollins, 2001)*

Slide 18:

Scenario #2:

A mother tells you that she arrived home last Wednesday to discover that the lawn care company had sprayed. There was a strong odor, and liquid could be seen on the grass and furniture. After playing outdoors that afternoon, her child developed nausea and vomiting, with some sweating but no fever. She also had mild tremors. Her pediatrician diagnosed her child with "flu" (GI virus). However, she is asking you if you think the pesticides may have had something to do with her child's illness.

Speaker Notes:

Let's consider a couple of questions about this scenario.

Slide 19:

Food for Thought About Pesticides

- *Do you think that pesticide poisoning (or poisoning by other environmental toxicants) could be misdiagnosed?*
- *If the child in this scenario did develop illness from the pesticides, why didn't her mother get sick?*

Speaker Notes:

Let's look at some toxicology issues related to this scenario.

Additional Notations:

Slide 20 :

Principles/concepts:

Environmental health effects may mimic other conditions.

Speaker Notes:

These other conditions may be more familiar to clinicians. A commonly used class of insecticide called organophosphates causes flu-like symptoms due to increased muscle and gland activity from accumulation of acetylcholine at the nerve synapses.

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Slide 21:
Principles/concepts:
Children's behavior may increase susceptibility to environmental toxicants.

Speaker's Notes:
Children may be more susceptible to environmental toxicants because of physiological differences (such as developing nervous systems). However, there are differences in behavior which also may increase risk. Children spend more time on or near the ground, where substances such as pesticides may accumulate. Their hand-to-mouth behavior also increases risk, as does their tendency to eat the same foods repeatedly (hence, exposure to a substance on a particular food, such as pesticide residues, is greater).

Additional Notations:

Slide 22:
To find out more about…
Pesticides: *www.epa.gov/pesticides, www.ace.orst.edu,*
www.psrla.org (→"Pesticides and Human Health")
J.R. Reigart & J.R. Roberts: Recognition and Management of Pesticide Poisonings (EPA, 1999). Available on line at: www.epa.gov/pesticides/safety/healthcare or call 703-305-7666

Slide 23:
Scenario #3:
Your aunt has just moved to a new town that has a chlorinated water supply. She is concerned about possible health effects of the chlorine. She hasn't gotten sick from it, but she really dislikes the taste and she feels concerned. She asks you what you know about this.

Speaker Notes:
Let's consider a few questions about this scenario.

Slide 24:
Food for Thought About Chlorinated Water
If this person hasn't gotten acutely ill from the chlorinated water, is it still possible that there is a negative health effect occurring? (Hint: Are side effects of medications always manifested in acute symptoms? Or do medications sometimes cause negative effects over time?)

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Slide 25 :

More Food for Thought About Chlorinated Water

Organic chlorine compounds (such as those formed in chlorinated water, and also in various manufacturing processes) rarely occur naturally. Are human-made substances more dangerous than natural substances ? Can you think of examples of toxic natural substances ?

Additional Notations :

Slide 26 :

Yet More Food for Thought About Chlorinated Water

How can we tell if a substance is causing chronic effects ? If you wanted to study the long-term health effects of chlorine in water, how would you go about it ? What would some of the problems be ?

Additional Notations :

Speaker Notes :

Let's look at some of the toxicological principles and concepts related to chlorinated water.

Slide 27:

Principles/concepts:

Adverse health effects may result from chronic low-dose exposure.

Speaker Notes:

These chronic effects often involve cancer or the nervous system.

Additional Notations:

Slide 28:

Principles/concepts:

Compounds that do not exist naturally (or rarely do) can be especially problematic.

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Speaker Notes:
Examples of such compounds are chlorinated organic compounds. They tend to be persistent in the environment and our bodies. They may mimic hormones like estrogen, and they are often associated with cancer. Chlorine in drinking water combines with other matter in the water to form chlorinated compounds called disinfection byproducts, and some of these DBP's have been associated with cancer and other adverse health effects.

Additional Notations:

Slide 29:
Principles/concepts:
Assessing risk from chronic exposure is complicated and difficult.
Epidemiological studies: assess health trends and associations
Risk assessment: combine toxicological research (often animal studies) with estimated exposures to determine estimates of risk

Speaker Notes:
Over time, people are exposed to many substances that could be disease-causing. We assess health trends and associations through epidemiological studies. We assess risk through toxicological research (often laboratory research on animals) combined with information about level of exposure of different populations.

In order to track exposures and related disease, we need surveillance systems. The system for reporting significant infectious diseases to the health department (and ultimately to the Centers for Disease Control) is an example of an effective surveillance system which allows us to accumulate and analyze data. Unfortunately, though, we have few surveillance systems in place to determine the incidence of environmental exposures and related diseases.

Additional Notations:

Slide 30:
To find out more about…
Carcinogens *(environmental cancer-causing substances)**:***
www.niehs.nih.gov (→National Toxicology Program→Report on Carcinogens)
www.epa.gov/children (→childhood cancer)
S. Steingraber: Living Downstream (Vintage Books, 1998)

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***Effects of chronic exposure to neurotoxins in children**: www.igc.org/psr (In Harm's Way), www.epa.gov/children (→developmental and neurological problems)*

Slide 31:

and…

***Chlorine and chlorinated compounds:** www.epa.gov (→browse topics→ alphabetical list→endocrine disruptors, disinfection byproducts, and toxicological profile→chlorine), www.niehs.nih.gov (→National Toxicology Program→factsheets [Safe Drinking Water])*

***Epidemiology** and **Risk assessment:** www.sis.nlm.nih.gov (→toxicology tutor), www.epa.gov/iris (→What Is IRIS?)*

Slide 32:

Another Good Environmental Health Resource** (with lots o' links)**:

www.enviRN.umaryland.edu

On-Line Continuing Education Units on Environmental Health:

www.nursingworld.org/tan → online CE → catalog → "Environmentally Healthy…" series

This material was developed at the Environmental Health Education Center of the University of Maryland School of Nursing. For more information, see envirn.umaryland.edu.

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