Pharmaceuticals in Drinking Water

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• Background on the Drinking Water Act
• Unregulated contaminantants
• Pharmaceuticals in drinking water
  • Sources
  • Treatment
  • Impacts
Safe Drinking Water Act (SDWA)

- Enforceable health standards for dw contaminants
- Public notification of water system violations
- Protects underground sources of drinking water
- State revolving loan fund for upgrades
- Assessment of all drinking water sources for vulnerability to contamination

Public Water Systems

- serve piped water to at least 25 people or 15 service connections for at least 60 days/year

  Community water systems
  Eg. Most cities

  Non-community water systems
  Eg. School with its own system
  Eg. Public Campgrounds
Water Testing:

EPA establishes minimum testing schedules for public drinking systems.

Increases in frequency if problems occur

Testing and reporting of results is not consistent across the country
Primary Drinking Water Regulations

Micro-organisms
   eg. Cryptosporidium, Coliforms

Disinfection Byproducts
   eg. Chlorite, Total Trihalomethanes

Disinfectants
   Eg. Chlorine (as Cl₂)

Inorganic Chemicals
   Eg. Metals, nitrate

Organic chemicals
   Eg. Pesticides, industrial by-products

Secondary Drinking Water Regulations

Non enforceable guidelines concerning contaminants that may cause:

   Cosmetic effects
     (skin or tooth discoloration)

   Aesthetic effects
     (taste, odor or color in water)
EPAs approach for evaluating new pollutants:

- Drinking water Contaminant Candidate List
- Regulatory Determination Priorities (based on occurrence and research priorities)
- EPA has also established a National Drinking Water Contaminant Occurrence Database to support decision making and new regulations
- And an Unregulated Contaminant Monitoring Regulation

Sources of pollutants

Point and non-point sources
Pharmaceuticals in DW
Sources:
Pharmaceutical industries
Hospitals, medical facilities
Households
medicines
Personal care products
Farm animals

Endocrine disruptors
Sources:
Hospitals, medical facilities, households
Pesticides (may leach into gw, are persistent and fat soluble)
Industrial byproducts (eg. Dioxins/ pcbs)
Evidence of pharmaceuticals in the environment

➢ 20 years ago

- aspirin, caffeine, and nicotine found in sewage treatment plants in U.S.
- USDA researchers found clofibric acid (cholesterol lowering drug) in groundwater infiltration basins

Studies which sounded the alarm:

- ~ 10 years ago, clofibric acid found beneath German treatment plant.
- mid 1990s, 30 of 60 pharmaceuticals tested for found in water samples
- Tulane University study: found low levels of drugs in Mississippi River, Lake Ponchetrain and in Tulane tape water
USGS study in 1999-2000

Tested for 95 pharmaceuticals, hormones and other organics

139 streams in 30 states.

- 82 found in at least one sample
- 80% of streams had 1 or more contaminant
- 54% of streams had > 5 contaminants
- 13% of streams had > 20 contaminants

Pharmaceuticals have now been found in treated sewage effluents, surface waters, soils and tap water.

- Up to 90% of oral drugs can pass through humans unchanged.
- Many do not biodegrade
- Some persist in groundwater for years.

General Findings:
Amount of pharmaceuticals released unknown, but…

- PPCPs released estimated to be ~ the same as amount of pesticides used each year.
- U.S. may account for ~ ½ of pharmaceutical use in world (based on sales)

Impacts:

- Mostly unknown
- Concentrations in parts per trillion (well below therapeutic doses)
- Concern about chronic exposure
  - hormone disruption
  - antibiotic resistance
Endocrine disruption:

Chemicals may:
- mimic hormones (eg. DES)
- block hormones (eg. DDE)
- trigger abnormal response (eg. Dioxin)

Most evidence from fish and wildlife studies
Links to human impacts not yet definitive

Possible problems include:
- lower sperm counts,
- increased rate of breast, testicular, prostate cancer,
- increased incidence of hyperactivity and learning

Developing embryos probably most at risk
80% of adults and 90% of children in U.S. contain residues of 1 or more pesticides

Mothers who drink water with higher levels of ammonium perchlorate have babies with elevated thyroid stimulating hormone (indicator of hypothyroidism).

Male health trends:

➢ Increased testicular cancer in England, Wales, other European countries
➢ Decreased sperm count world wide over last 40 years.
➢ Increase in reproductive abnormalities
➢ Fewer male babies born

Female trends:

➢ Breast cancer on rise
➢ Early puberty
Regional concerns:

- May be more critical in arid environments
  - GW recharge of treated sewage
  - Reuse of treated waste for irrigation
  - Natural streams contain greater percentage of effluent.

What to do:

Good news:
chemicals with similar properties will probably respond the same way to treatment.

But…
Conventional wastewater treatment is relatively ineffective

Drinking water treatment is variable
Drinking water treatment technologies:

**Highly effective techniques:**
- Advanced oxidation removes many compounds
- Membrane filtration and filtration with Granular activated carbon
- Nano-filtration and reverse osmosis (eliminated all drugs)

**Somewhat effective:**
- Oxidation (eg. Conventional ozone) effective in transforming selected pharmaceuticals

**Least effective techniques:**
- Chlorine (most common in U.S.)

Other approaches:

Control what gets into environment:
- Source control (medical disposal practices)
- Design more environmentally friendly drugs
- Minimize over use or misuse of drugs/chemicals
- Point of use treatment of drugs
- Add advance waste and water treatment technologies and source control at point of entry into environment.
EPA information:
http://www.epa.gov/esd/chemistry/pharma/