RADON - II

Health Effects

Carcinogenicity

Radon is a known human Carcinogens according to the World Health Organization's International Agency for Research on Cancer 1988 (#AARST, 2008). This is based on the strong evidence of lung cancers in underground miners. Data from National Cancer Institute 19955 studies found that, of radon-exposed underground miners, about 40% of the 2,700 lung Cancer deaths occurring in 65,000 miners are due to radon. Among non-smokers, 70% of the lung cancer deaths are believed to be due to radon, compared to 39% of the lung cancer death from cigarettes smoking (#AARST, 2008). It is also a cause of squamous cell carcinoma, small cell carcinoma, adenocarcinoma, and large cell carcinoma (#UMN.

Chronic Exposure

While there are subtle differences in route of exposure between mines and homes, it is important to note that persons living in homes with radon above the Environmental Protection Agency (EPA) action level of 4 pCi/L could also accumulate radon in concentrations similar to underground miners. The primary adverse health effects associated with chronic exposure to radon is lung cancer. Emphysema, pulmonary fibrosis, chronic interstitial pneumonia, silicosis, and respiratory lesions are other respiratory health effects that can be associated with chronic exposure (#UMN). Radon exposure causes no acute or sub-acute health affects, but risk increases as exposure time increase. Highly troubling is the fact that radon exposure causes no acute or subacute health effects, no irritating effects, and has no warning signs at levels normally encountered in the environment, so people often have no idea they are being exposed (#UMN).

As an inert gas, radon has a low solubility in body fluids which leads to a uniform distribution of the gas throughout the body (#UMN). Exposure to this gas, and its solid decay product, polonium-218, and -214, also result in health risks such as Cancer. Once the decay products are inhaled into the lung, they undergo further radioactive decay and release small burst of energy in form of Alpha Particles, which cause DNA breakage or the production of free radicals (#UMN). Radon not only causes lung cancer, but is also likely to have toxic effects related to the health and survivability of an embryo or fetus .

Additional Concerns

- Radon also has the potential to generate genotoxic effects - higher incidence of chromosomal aberrations.
- Radon has been linked with teratogenic effects.

Mechanism

The mechanism in which radon decay products cause Cancer is through its ability to emit Alpha Particles. TheseAlpha Particles consist of two positive charges, or protons, and two neutrons bound together into a particle identical to a helium nucleus. This is a highly ionized form of radiation, and is known to have low penetration with the ability to travel only short-distances in the body (#UMN). However, if alpha radiation enters the mouth or nose, it may causeCancer in the lungs or other organs. Alpha Particles are emitted by radioactive nuclei such as Uranium or Radium in a process known as alpha decay (#Webelement). When an alpha particle is emitted, atomic mass decreases due to the loss of a proton and the atom then becomes a new element.

An example of this is when Radium becomes radon gas due to alpha decay. These Alpha Particles are highly charged and consist of a proton and no electrons. They have the tendency to attach to the first surface come in contact with damaging the living tissue (#UMN). Most of the epithelial cellular damage is not from radon itself, but from decay products deposited in the airway of the lungs. These subsequently emit Alpha Particles resulting in continued irradiation of lung tissues (#NetLibrary). By breaking the chemical bonds that hold molecules together,Radiation can damage human DNA, the inherited compound that controls the structure and function of cells (#UMN). Radiation may damage DNA directly by displacing electrons from the DNA molecule, or indirectly by changing the structure of other molecules in the cell, which may then interact with the DNA (#NetLibrary).

Additionally, the alpha particle is able to transverse cell nuclei in a linear pattern and deposit energy in a fashion known as Linear Energy Transfer (LET). This refers to the energy transferred per unit of path traveled by the ionizing particle (#University of Minnesota, 2008). Since Alpha Particles travel short distances and are slow, their efficiency in transferring energy and affecting genomic change is very high, as reflected by their LET. Once deposited, this energy causes DNA alterations, cell cycle stress, and occasional cell death (#NetLibrary).

Absorption, Distribution and Site of Toxicity

The primary route of exposure to radon and its daughter ions is via inhalation (#AARST, 2008). As described in the previous sections, charged radon particles can easily bind to available surfaces, including walls, floors, clothing, and "aerosolized" particles such as dust and other particulates. Once bound to aerosolized particles, the charged ions can easily be transported throughout the environment via wind, and more importantly, can be inhaled by respiring animals and humans4. The radon daughter ions can be inhaled either as free particles or particles that are attached to dust. Because they are ionized, these progeny preferentially attach to the respiratory epithelium, particularly the bronchi, and is the site of most lung cancers (#NetLibrary).

Most of the radon gas inhaled will be exhaled (due to the relatively short half-life of radon gas) before it can decay and deposit a significant radiation dose to the lung tissue (#University of Minnesota, 2008). The radon deposits on the mucus lining of the respiratory tract through impaction, sedimentation, and diffusion. If the radon is in the uncharged gaseous phase, it can be absorbed into the blood stream through the stomach or intestinal walls and distributed throughout the body (#UMN). The majority of radon absorption following ingestion in water occurs in the stomach and small intestine. Greater than 90% of the absorbed dose is eliminated by exhalation (#UMN).

History

Radon, named after Radium, was discovered in 1900 by Friedrich Ernst Dorn. He was studying the natural radioactive decay of radium, and trying to put together details about what was happening to the mass when he detected the presence of a radioactive gas. Dorn initially called the gas "radium emanation". William Ramsay and Robert Whytlaw-Gray named it niton, meaning "shining," and determined that it was the heaviest gas.

General toxicity related to radon exposure in living organism was discovered in 1984 with the case of Stanley Watras. Watras was an employee at the Limerick Nuclear Power Plant in Pennsylvania. After he noticed that the radiation alarms on his way to work often went off when he passed by, he searched for two weeks for the mysterious source of contamination. Later, he determined that he was the source of high radiation, and that this was due to a high radon level in his home (#Frontline, 1997).

Radon naturally emanates from the ground all over the world, particularly in regions with soils containing granite or shale (#AARST, 2008). The primary source of radon-related radiation comes from mines, tunnels or caves, where it diffuses through rocks and concentrates in underground openings. The element can then diffuse rapidly and attach to the first surface encountered, which in humans is usually the respiratory tract (#ALA, 2008). On average, one atom of radon is found in 1 X 1021 molecules of air, and is typically located in areas with cold and hot springs.

Prevention

A variety of methods can be used to reduce radon in homes and buildings. The EPA recommends reducing levels to 4 pCi/L or less (#ALA, 2008). Sub-slab depressurization, sealing cracks, house pressurization, natural ventilation and heat recovery ventilation are other methods used to reduce radon in homes (#UMN). Pipes and fans remove radon gas from beneath the concrete floor. Further more, homes can be built by using radon-resistance features. To ensure continued effectiveness of the radon mitigation system installed, the user should retest the building at least every two years as required or recommended by state or local authority (#AARST, 2008). Retesting is also recommended if the building undergoes significant alteration.

Source : http://www.toxipedia.org/display/toxipedia/Radon