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Ethylene-oxide: A challenge for hospitals

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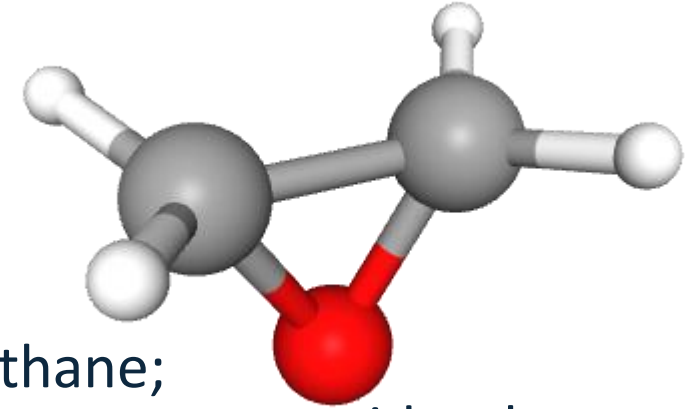
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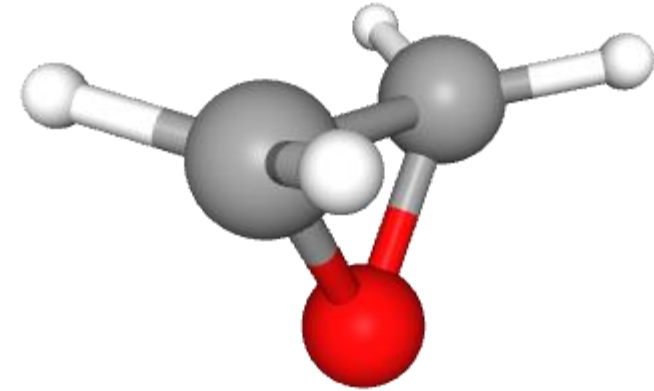


Characteristics of EtO



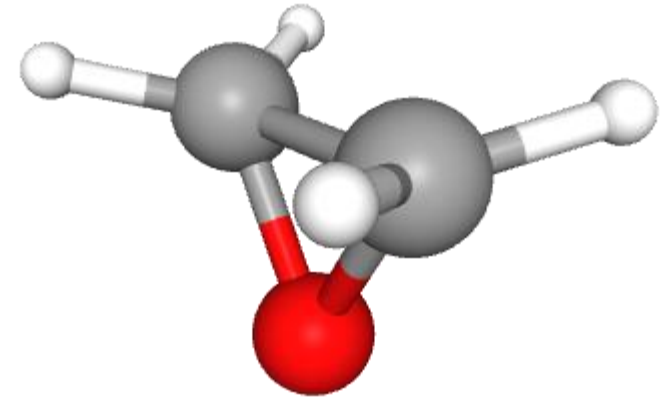
- CAS 75-21-8; EINECS 200-849-9
- Dihydrooxirene; dimethylene oxide; EO; 1,2-epoxyethane; epoxyethane; ethene oxide; EtO; ETO; oxacyclopropane; oxane; oxidoethane
- Flammable, colourless gas
- Soluble in water, benzene, acetone, ethanol, ether
- High odour threshold
- Readily taken up by the lungs and absorbed into the blood (75–80%)
- Half-life in the human body: 47.6 min
- Irritating, sensitising (as hapten), headache, loss of hair, peripheral neuropathy
- Direct-acting alkylating agent: adducts with proteins and DNA

Uses of EtO



- Production 20 million tonnes (2009)
- Used as raw material to make glycols
- Sterilising agent, fumigant, insecticide (0.05% ↔ exposed persons)
 - EU restriction/ban as pesticide and in plant protection product
 - Wide range of concentrations in hospitals (globally, 1982-2002)
 - The more recent measurement the lower concentration
- Hungary (2019): 465 exposed persons (sectors not specified)

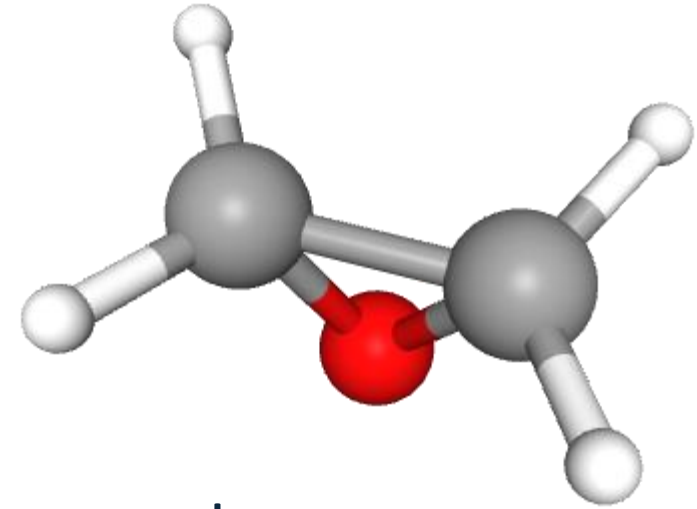
1991 – the cluster emerges

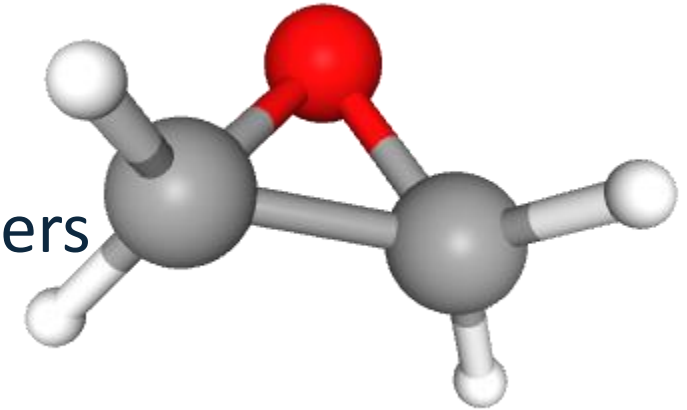


- Report of a cluster of breast cancers in a county hospital in Hungary.
- Characteristics: females at the paediatric ward
- Possible exposures
 - X-ray
 - Radon
 - EtO
- IARC 1985: EtO causes Lympho-haematopoietic malignancies (only)

The story unfolds

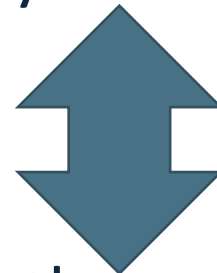
- More workers contracting malignancies
- 17 malignancies diagnosed between 1986 and 1998 among the ~200 workers of the ward
- Eight cases fatal
- Committees were called (Hungarian Academy of Sciences)
- Press attention
- Lawsuit





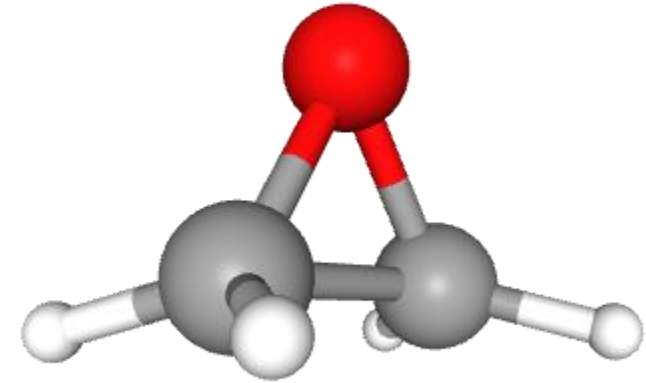
The shadow of the past

- Strict national standards on operating the sterilisers
- OEL: 1 mg/m³ (maximum concentration)
- Women must not be employed where the OEL is exceeded



- Airborne concentrations in the working area up to ~400 mg/m³
- 46% of machines were placed improperly
- (National Sanitary and Epidemiological Inspectorate 1983-1984)

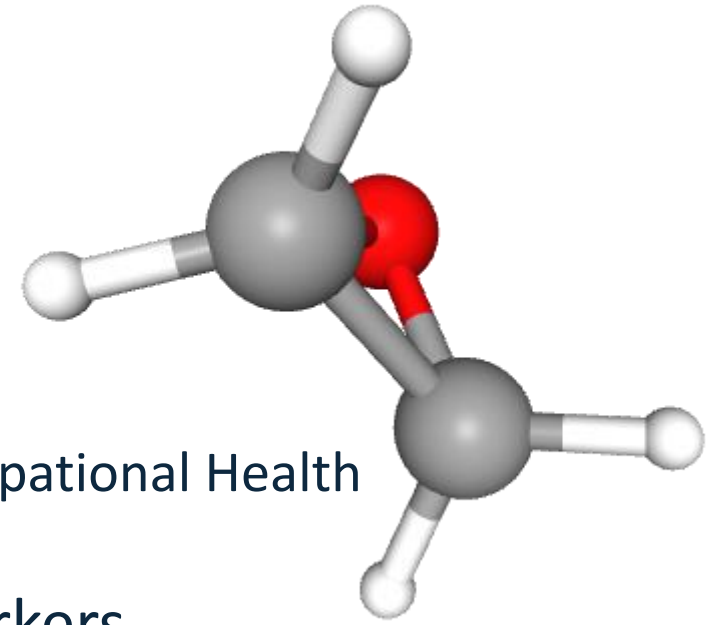
Cytogenetics



- Chromosomal aberrations were high among hospitals workers , especially those who were exposed to EtO
- Aberration rate decreased when removed from exposure to EtO
- Breast epithelial cells are highly susceptible to EtO
 - below cytotoxic concentrations
 - in vitro (DNA damage by comet assay)
 - just like lymphoblasts and lymphocytes

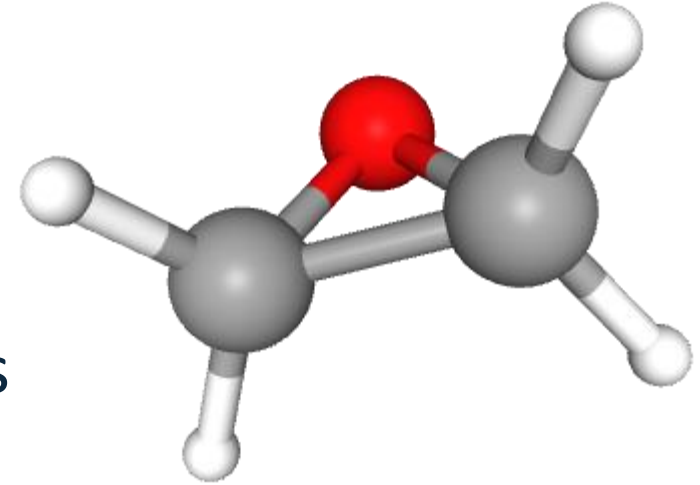
Nationwide surveys

- Questionnaires among hospital workers
 - Co-ordinated by the National Public Health Service
 - Designed and analysed by the National Institute of Occupational Health
 - High coverage and response rate
- Increased rate of abortion among EtO-exposed workers
 - Higher rate in those employed in the worst work hygienic environment
- High rate of breast cancers among EtO-exposed workers
 - Confounders: age, obesity, family history
 - Highest odd ratios: weekly duration, lifetime exposure, lifetime duration, location of sterilisers, exhaust
 - X-ray dosimeters did not show elevated exposures
 - However, bad practices might have been common

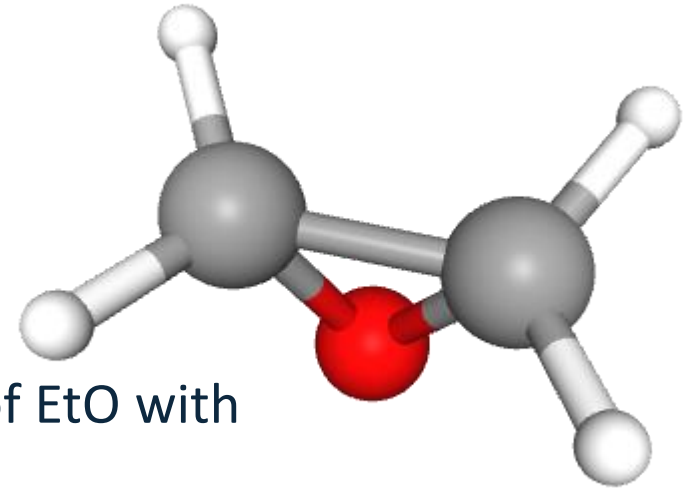


Conclusion

- EtO could be the single or a substantial co-factor of the breast cancer cases among exposed hospital workers
 - proven exposure, appropriate latency period
- The role of exposure to X-rays still emerges
- Co-exposure can be in line with current cancer development theories
- All cases were registered as occupational disease by the order of the Minister
- EtO have been replaced by advanced technologies in the 90-ies

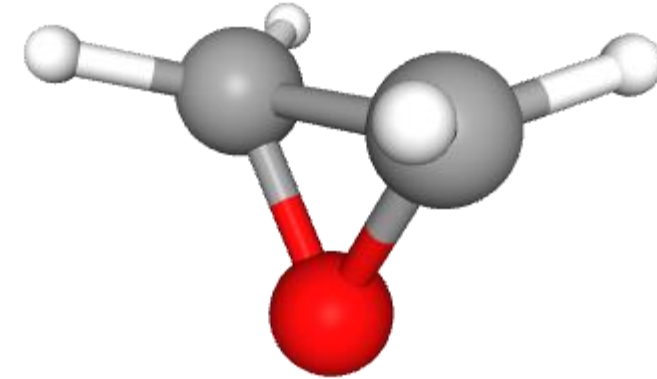


Global follow-up



- IARC 2008-2012
 - Limited evidence in humans for a causal association of EtO with
 - lympho-haematopoietic malignancies and breast cancer.
 - Not supported: stomach, pancreas, brain.
 - Sufficient evidence in experimental animals for the carcinogenicity of EtO.
 - Ethylene oxide is carcinogenic to humans (Group 1).
- Directive (EU) 2017/2398
 - „Ethylene oxide meets the criteria for classification as carcinogenic (category 1B)“
 - EU BOEL 1,8 mg/m³ (1 ppm) 8hTWA skin notation applicable from 17 January 2020.
- EPA USA 2018
 - „EtO was found to be carcinogenic to humans by inhalation, posing a potential human health hazard for lymphoid and breast cancers.“

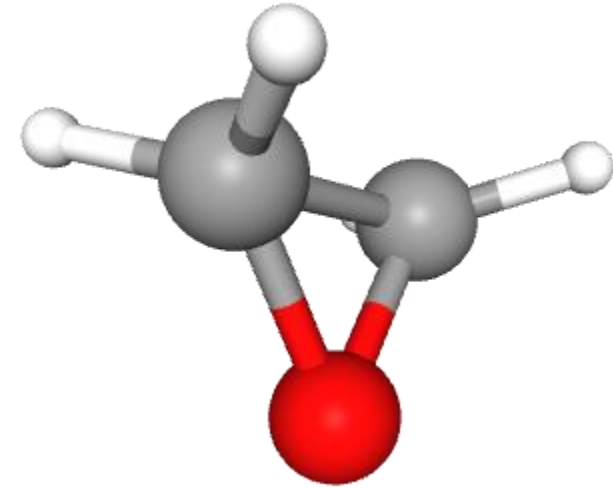
The ill health of health care



- Low resources
- Priority on the service
- Poor leadership
- Low awareness
- Helper attitude sacrificing own safety and health

Lessons learned

- Standards and legislation are not enough
- Inspection is not enough
- No sector can be exemption from health and safety
- Proper risk assessment and management processes
- OSH knowledge and awareness on every level
- Leadership and OSH in the management
- Good practice (in EtO and beyond): substitution, fume hood, centralisation, limiting personnel, education and PPEs



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The 3D figures were downloaded from PubChem.

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HVALA
THANK YOU