

Microbiological aspects of the process of radiation sterilization with the emphasis of virus sterilization possibility

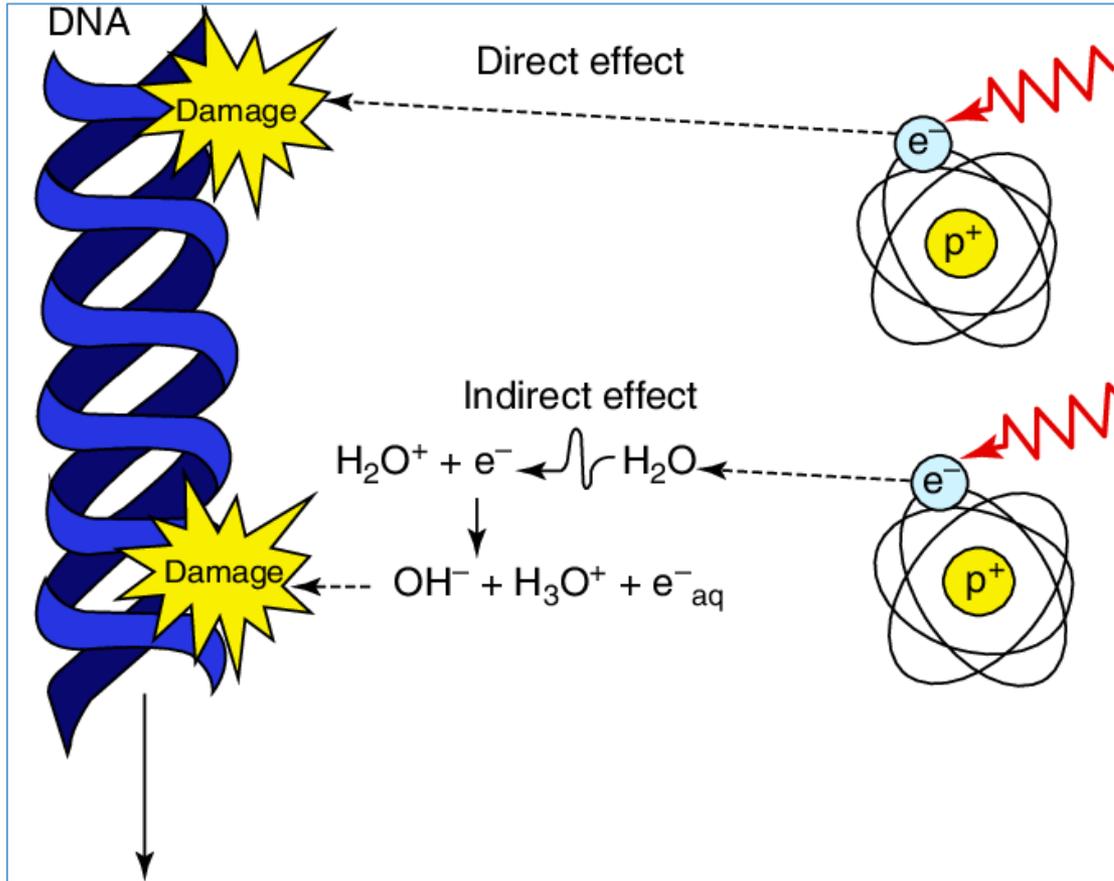
Sylwester Sommer,
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Swimmaaj Wiki



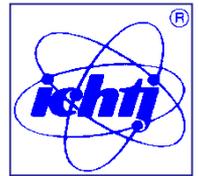
DNA damage by ionising radiation



Moreels 2020

Sparsely ionising radiation:
 Direct action = 20 %;
 Indirect action = 80 %.

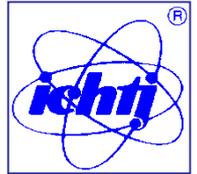
Radioresistance



| | D ₁₀ (kGy) |
|-----------------------------|-----------------------|
| Humans | 0.007– 0.01 |
| Bats | 0.15 |
| Molds | 0.03 – 0.5 |
| Escherichia coli | 0.25 |
| Vegetative form of bacteria | 1-2 |
| Bacterial spores | 3-7 |
| Viruses | 5-9 |
| Deinococcus radiodurans | 10-12 |

D₁₀ – dose killing 90 % of individuals;

Effective radiation sterilization



Microorganisms are definitely more radioresistant than higher organisms.

Usually dose between 10 and 30 kGy of electrons, X-rays or gamma radiation is used in radiation sterilization.

Successful sterilization depends on dose, oxygen conditions, temperature, water content of microorganisms, level of microorganism contamination, microorganism radiation resistance.

4 pillars of microorganisms radioresistance:

Physical protection
from radiation – „protective layers”

Chemical protection from radiation
– antioxidant defense

Effective DNA repair systems

Tolerance for genomic instability
and cellular cleansing

DNA damage and repair



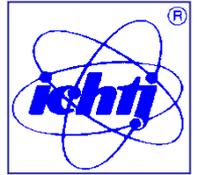
Tom Ellenberger Wiki 2016

Ionising radiation cause variety of DNA damages:

- base damage;
- nucleotide damage;
- single strand breaks;
- double strand breaks;
- complex damage.

DNA damages are effectively repaired by highly complex repair systems, which are evolutionary conserved from bacteria to mammals.

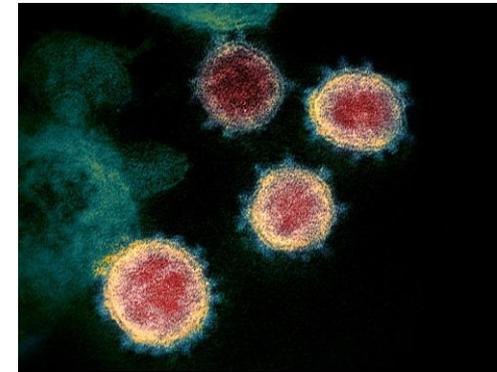
What about viruses?



- Viruses are more radioresistant than bacteria and even than bacteria spores;
- It is not clear how ionising radiation sterilize viruses, probably damages genetic material, protein coat (envelop) and capsid;
- Usually there is no need to use radiation method in purpose to inactivate the viruses, but with progress of Covid-19 pandemic change of stock which is sterilized is obvious from single use medical devices and grafts more to personal protective equipment (PPE);
- In case of viruses 20 kGy is enough for virus inactivation (1) but higher doses are taken into account as well (2).

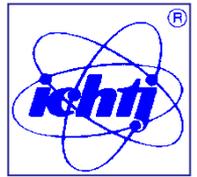
1. European Centre for Disease Prevention and Control, 2020b. Cloth masks and mask sterilisation as options in case of shortage of surgical masks and respirators. Available on 8th April 2020 at <https://www.ecdc.europa.eu/en/publications-data/clothmasks-sterilisation-options-shortage-surgical-masks-respirators>.

2. COVID-19 Pandemic: Radiation Sterilization of PPE (personal protective equipment). IAEA presentation 2020.



NIAID, Wiki 2020

Conclusions

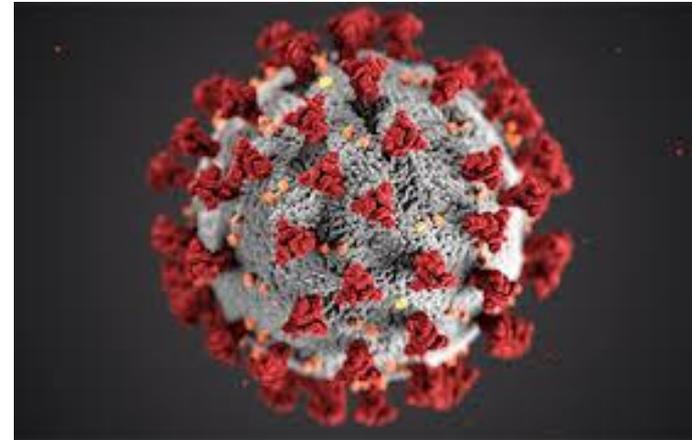


- Radiation sterilization is used to kill or deactivate microorganisms;
- Most of microorganisms (but not prions) contain genome consist of nucleic acid, as higher organisms;
- Ionizing radiation destroys DNA and this is the way for killing microorganisms.

Low dose of radiation chest therapy – is it possible and effective in case of Covid-19?



Michael Goodyear 2017 Wiki



CDC/ Alissa Eckert, MS; Dan Higgins, MAM, 2019 Wiki

Low-Dose Whole-Lung Radiation for COVID-19 Pneumonia: Planned Day-7 Interim Analysis of an Ongoing Clinical Trial.

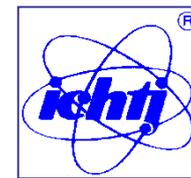
C.B. Hess, Z.S. Buchwald, W. Stokes, J.M. Switchenko, T.H. Nasti, B.D. Weinberg, J.P. Steinberg, K.D. Godette, D. Murphy, R. Ahmed, W.J. Curran Jr, M.K. Khan.

medRxiv preprint doi: <https://doi.org/10.1101/2020.06.03.20116988.t>

How radiation can impact on immune response for Covid-19 infection



Zarateman. 2014, Wiki

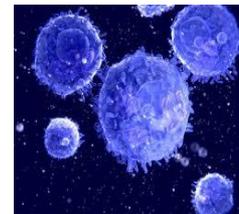


IL-1 β , IL-6 and TNF-alpha

transforms



Wiki



Wiki



Mikael Häggström, M.D. 2018, Wiki

Covid-19 pneumonia



Toglenn, 2019, Wiki

lymphocytes

IL-4, IL-10

macrophages pro-inflammatory phenotype M1

virus Covid-19

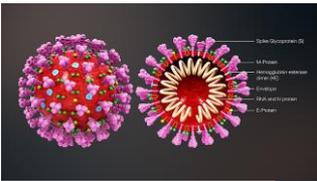
macrophages anti-inflammatory phenotype M2



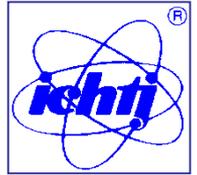
Wiki

activates

<https://www.scientificanimations.com>
2020, Wiki



Conclusions



- ❖ For today there is 39 mln people infected with Covid-19 and there is over 1 mln fatalities all over the world;
- ❖ There is no vaccination, no clear medication against Covid-19;
- ❖ Respiratory problems are the key point during infection and we know that the immune system plays role;
- ❖ The single dose of radiation helps in control of Covid-19 pneumonia – 10 clinical trials all on the world: USA, Spain, Italy, India and Iran.
- ❖ Low dose of radiation (0.5 – 1.5 Gy) is used for both lungs and there is no adverse symptoms of irradiation visible;
- ❖ Method is cheap, easy and can be applied all over the world.

**Unethical not to Investigate Radiotherapy
for COVID-19 - Jerry M. Cuttler**



*Thank You very much
for Your attention*