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Carbon Nanomaterials as Promising Carriers of Cytostatic Drugs in Cancer Chemotherapy: Pilot Study

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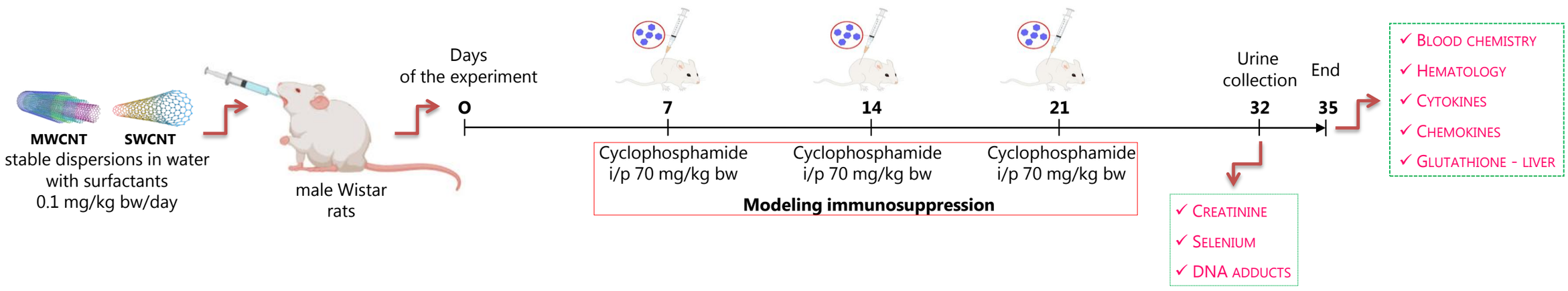
Carbon nanomaterials (CNMs), such as single-walled (SWCNT) and multi-walled (MWCNT) carbon nanotubes, are considered promising agents for the delivery of pharmacological drugs to target organs, including antitumor chemotherapy and theranostics. However, the question arises about CNM's possible effect on the general toxic and immunotoxic effects of cytostatic preparations when they are administered mutually. This work aimed to study the combined effects of cyclophosphamide (CP) intoxication and CNMs oral administration in male Wistar rats.

Study design



Results

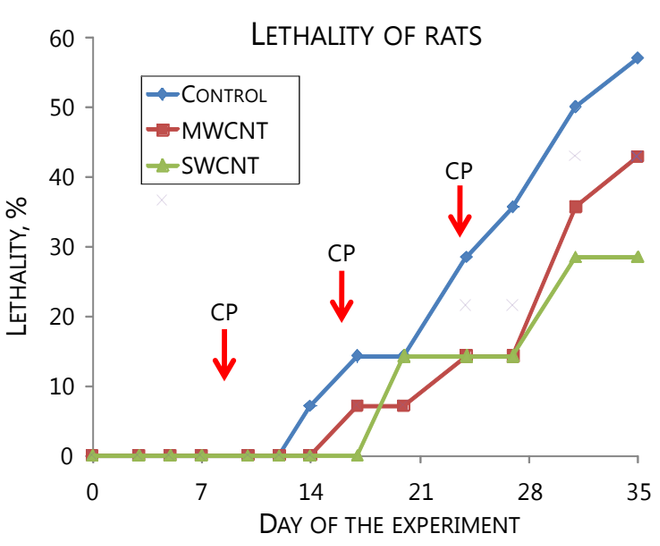


Fig. 1. *Lethality of rats receiving intraperitoneal injections of CP and carbon nanomaterials with drinking water. Lethality is given as a percentage of the number of animals in the group.*

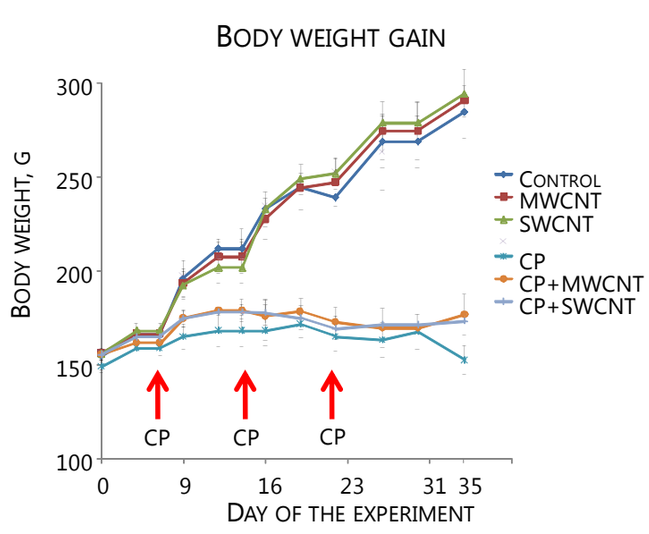


Fig. 2. *Dynamics of changes in body weight of rats. Red arrows - the day of the introduction of CP*

- MWCNT reduces the increased mass of the kidneys and brain under the action of CP
- MWCNT reduces the increased excretion of selenium in the urine under the action of CP
- MWCNT normalize leukocyte levels in the blood
- MWCNT reduces elevated levels of cytokines IL13, IL17A, IL6, IFN-г, IL4, TNF-a, and chemokine MIP-3a
- SWCNT normalize the activity of glutathione peroxidase-1 of erythrocytes (GPX)
- SWCNT reduces elevated levels of cytokines IL13, IL17A, IL6, IL4 and IL7

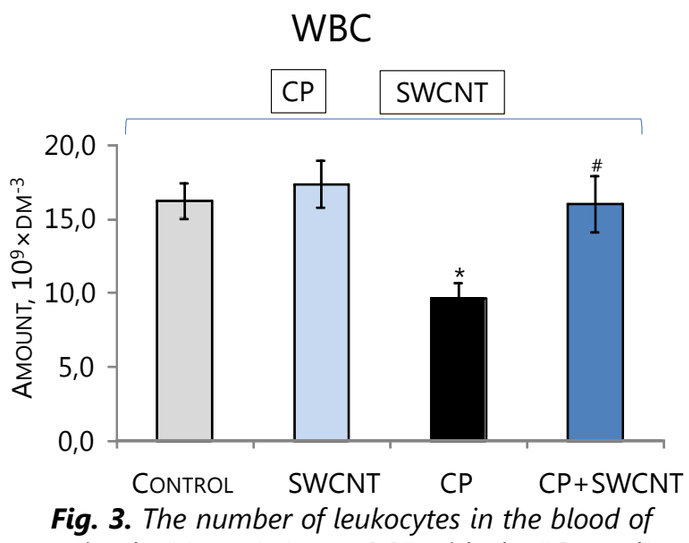


Fig. 3. *The number of leukocytes in the blood of animals (M ± m). * - p<0.05 with the "Control" group. # - p<0.05 with the "CP" group. Horizontal bracket above the charts - the distribution is heterogeneous according to the specified factor p<0,05 ANOVA*

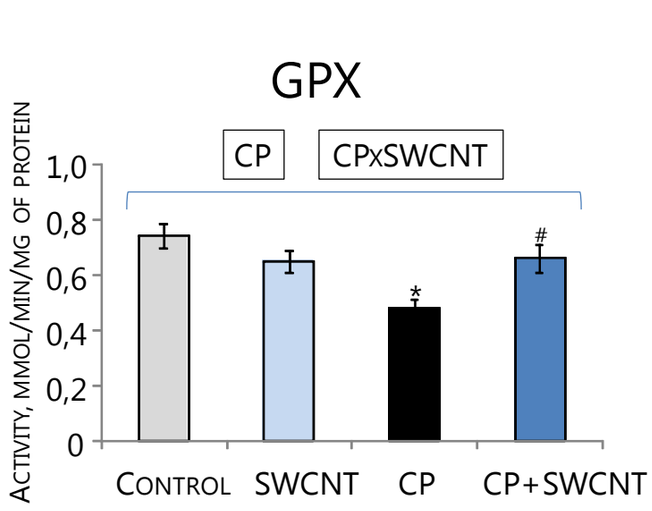


Fig. 4. *Activity of glutathione peroxidase of erythrocytes. * - p<0.05 with the "Control" group, # - p<0.05 with the "CP" group*

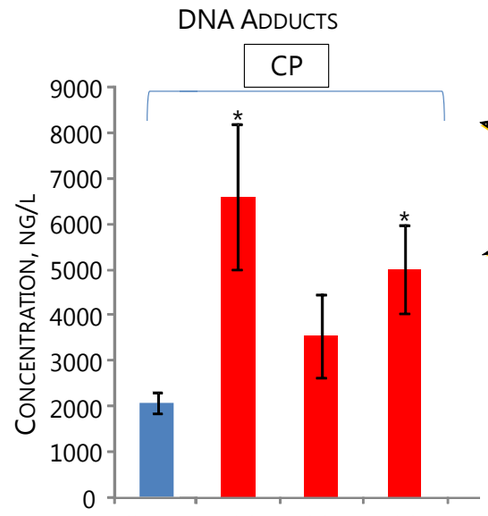


Fig. 5. *Quantitative expression of 8-oxo-2'-deoxyguanosine in the daily urine of rats. * - p<0.05 with the "Control" group.*

Suppression of the immunotoxic effect of CP

More:

Conclusion. It has been shown for the first time that the combined introduction of carbon nanomaterials – multi-walled and single-walled carbon nanotubes together with the alkylating cytostatic agent cyclophosphamide (CP) into the rat body significantly reduces the mortality of animals caused by the action of CP, as well as suppresses the manifestations of its immunotoxic effect, which is reflected in the weakening of lymphopenia and recovery close to normal values levels of cytokines, chemokines/growth factors, including IL-4, IL-13, IL-17A, IFN-γ, IL-18, GM-CSF, GRO-KC, IL-12p70, IL-1β, IL-7, TNF-α, and VEGF. The experimental data show that carbon nanotubes have the ability to significantly block the development of a "cytokine storm", which determines the main part of the most severe side effects of CP when used in chemotherapy of malignant tumors. This creates certain prospects for the use of carbon nanotubes as carriers of cytostatic drugs, which can increase selectivity and reduce the number of complications during chemotherapy.