

Nanostructured carbon adsorbents for medical protection against chemical-biological-radiological-nuclear (CBRN) hazards

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When a terrorist attack against civil population is considered, it is important to have in stock some generic, universal means of protection which could be efficient in neutralising effects of CBRN warfare hazards. Medical grade activated carbons are a unique group of materials which were successfully used to decorporate radionuclides from the human body in the aftermath of the Chernobyl catastrophe, and prevent accumulation of radionuclides in first aid responders by prophylactic use of oral adsorbents. In modern terms, Chernobyl can be considered as a 'dirty bomb' on a very large scale. Taking into account that activated carbons adsorb most toxic organic substances and, according to the position statement issued jointly by the American and European Associations of Clinical Toxicology, use of oral activated carbon is the treatment of choice for patients with acute poisoning, particularly if the nature of the toxic agent is unknown. In more severe cases of acute poisoning with chemical or radioactive agents direct blood purification by activated carbon has been successfully used. Medical activated carbons used at present, however, have limitations in terms of their ability to adsorb and neutralise large molecules such as biotoxins and radiotoxins. This poses a particularly big problem in blood purification. Activated carbons used in West have poor haemocompatibility which is improved by coating carbon granules with semi-permeable membranes. The coating improves biocompatibility but at the same time reduces adsorption efficiency of carbon especially for large molecules. We have developed activated carbons produced by pyrolysis and activation of porous phenol-formaldehyde resins, which have large mesopores capable of accommodating molecules with molecular mass of 7–50 kDa. These uncoated carbons have shown haemocompatibility equal to or better than that of commercial coated carbons. Experiments *in vitro* and *ex vivo* proved efficiency of novel nanostructured carbons in removing inflammatory cytokines, lipopolysaccharide, exotoxins and botulinum toxin from the blood stream. Mechanisms of protective action of activated carbon in the treatment of patients exposed to CBRN agents will be discussed.