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In Cancer Immunotherapy and Biomedicine, High Hydrostatic Pressure is a Challenge

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Commentary

For more than a century, High Hydrostatic Pressure (HHP) has been known to have an impact on biological systems. In this review, we discuss HHP technology and how it affects macromolecules and eukaryotic cell physiology. We talk about how HHP is used in cancer immunotherapy to destroy tumour cells so that whole cell and dendritic cell-based vaccines can be made. We go on to discuss the current state of HHP utilisation in biomedicine, particularly in orthopaedic surgery and for viral, microbial, and protozoan inactivation in the development of vaccines against infectious diseases.

The air pressure on Earth ranges from 0.1 MPa at sea level to 110 MPa at the Mariana Trench's Challenger Deep, which is 11 km below sea level. Hydrostatic Pressure (HP) is an essential environmental metric since oceans cover more than 70% of the Earth's surface. The standard pressure unit (SI) is Pascal (Pa) (1bar = 105 Pa), hence the average hydrostatic pressure is 0.4 K bar, or 40 MPa. Based on its influence on biomolecules, cellular processes, and survivability, HHP can be split into two types: "physiological HHP" (100 MPa) and "nonphysiological HHP" (>100 MPa).

The first investigations on hydrostatic pressure were undertaken mostly by physiologists and oceanographers around the end of the nineteenth century. Hite described the inactivation of bacteria in milk at 650 MPa in 1899. The effects of HHP on physiological processes of eukaryotic cells and macromolecules have been widely investigated since the middle of the twentieth century, mostly employing frog and sea urchin eggs, chondrocytes, epithelial cells, and, most crucially, cancer cells. In the 90s, the HHP technology was further developed in Japan, where it was initially utilised to preserve and prepare food without the use of thermal treatment or preservatives. Because it has no effect on vitamins or other pharmacologically active compounds, as well as odours and smells, HHP is gaining popularity as a food preservation method. HHP technology is currently widely employed for a variety of functions, including food preservation and sterilisation, as well as in the pharmaceutical and biotechnology industries, where it can be used to sterilise human bone transplants and produce anticancer vaccines.

The goal of this brief review is to describe high-pressure biotechnology's pharmaceutical and medical applications, which have the potential to improve human health and disclose new therapeutic alternatives for cancer patients. The application of HHP in cancer immunotherapy for whole cell or dendritic cell-based vaccine production will be given special attention. The physical principle of pressure conversion based on Le Chatelier's concept is used to generate HHP in the majority of cases. A HHP-generating equipment is made up of a high-pressure generator, a pressure control panel (which can be incorporated or not), and a high-pressure vessel. The cells/biological sample is placed in a container, which is often a tube with a flexible membrane-containing cap that allows for proper pressure conversion to the sample. To prevent cross-contamination, the tube containing the cells/biological material is sealed in a tiny plastic bag filled with a physiological solution. The sealed bag is inserted into the chamber of a high-pressure vessel that is filled with a pressure-transfer medium, generally water. Aside from the most prevalent use of static HHP for biological inactivation, dynamic or pulsed pressure inactivation has also been researched. Static and dynamic high pressures, but not pulsed high pressure, have been proven to effectively inactivate yeast.

Long-term anti-tumor responses are a fundamental limitation of most solid tumour therapies now in use, prompting the development of new and multimodal therapeutic methods. HHP technology is a promising method for developing whole cell or DC-based vaccines. Similarly, HHP inactivation of bacteria and viruses could be a potential solution for developing novel vaccines or revitalising tissue in orthopaedic surgery. However, unlike the use of HHP in cancer immunotherapy, which has been tested in various cancer indications, these two applications are still in their preclinical stages for possible clinical usage [1-5].

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