The Kanzius Machine

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THE TOPIC OF A "MAGIC BULLET" THAT ONLY TARGETS CANCEROUS CELLS IS A RECURRING ONE. WHAT FOLLOWS IS A COMPREHENSIVE SUMMARY OF THE PRINCIPAL MECHANISM FOR ONE OF THE MOST PROMISING NON-INVASIVE CANCER TREATMENTS TO BE PIONEERED IN MODERN TIMES.

John Kanzius is a radio engineer from Pennsylvania who, after being diagnosed with leukemia, designed a device that may have implications for the future of cancer therapy. The instrument has been dubbed "The Kanzius Machine", and is currently undergoing extensive research and development under the leadership of Dr. Steven Curley, a hepatic cancer surgeon of the University of Texas (Curley, 2009).

The concept of this therapy is predicated on the insertion of metallic nanoparticles into cancerous cells, which are then excited with the use of electromagnetic radiation in the form of radio waves. Radio waves excite the particles, causing their electrons to become elevated to higher energy levels. As these electrons "fall back down" to their stable energy levels, they emit the energy in the form of highly localized bursts of heat, which destroy the cell. The type of wave used is radio frequency (RF), a label encompassing all electromagnetic radiation of frequency 9 KHz – 1990 MHz (Petrucci et al., 2007). Since exposure to radio waves in their usual form is harmless, the Kanzius machine increases the intensity of these waves, thereby generating sufficient energy to produce an effect, but not enough to cause radiation poisoning (Klune et al., 2007). At first, the machine relied on radio waves generated by a device that required a 'dispersal pad' placed against the patient's skin. This was the a cause for some concern about the skin possibly being burned when the pad became hot during treatment. Kanzius subsequently developed a system to generate higher energy waves without the need for equipment in contact with the skin (Klune et al., 2007). Since this is done at a current that is considered safe, the development increases the plausibility of further use of the machine in *in vivo* cancer therapy.

"...ability to target and kill only cancerous cells in the body..."

The nanoparticles being used are called Single Walled Carbon Nanotubes (SWNTs), that are tiny carbon structures that measure a maximum of 25 nm in length (Chen & Haddon, 1998). In order for treatment to be effective, it is estimated that the temperature of the cells must be raised to approximately 50 degrees Celsius (Klune et al., 2007). It was originally thought that these particles were too small to respond to the radiation and therefore not generating enough heat to make the therapy effective; however, it has since been shown that exposure to intensified RF waves causes them to spontaneously self-arrange into linear structures that are capable of achieving adequately high temperatures (Klune et al., 2007). Although not directly related to cancer therapy, it is notable that the Kanzius machine is one of the first experimental ventures to bring this property to light (Curley et al., 2007). Because of the use of heat in this cancer treatment, it is commonly called Thermotherapy. It is this ability to target and kill only cancerous cells in the body -- unlike other cancer treatments like chemotherapy -- that makes the Kanzius Machine so attractive as a possible treatment.

As it stands, the Kanzius treatment will only be applicable to localised tumours, which must be injected with nanoparticles and irradiated. Though this is valuable, Dr. Steven Curley, one of the leading researchers in this new form of treatment, claims, the current approaches are simply insufficient and "if we can't target the microscopic cells this is not going to be a cure" (Simon, 2008). Cancer is most dangerous after metastasis, but the therapy currently has no mechanism for treating cells

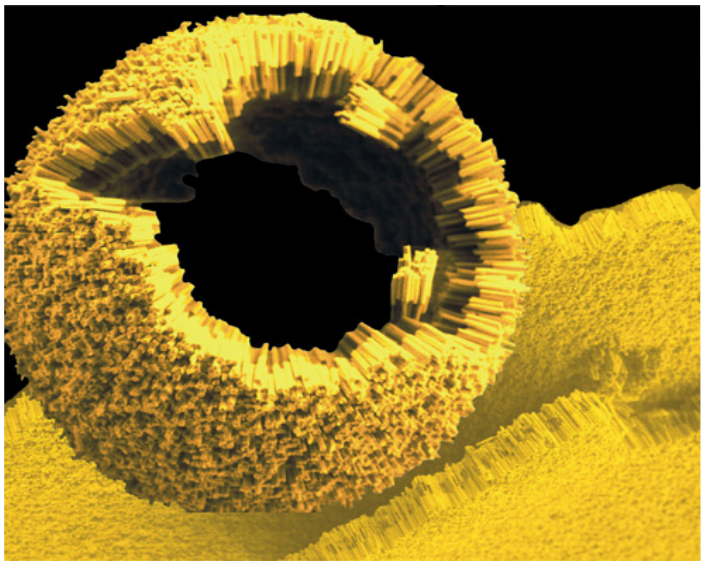

Figure 1 Gold-polymer nanorods can assemble into spheres and be used to deliver drugs (Weiss, 2008).

that have metastasized throughout the body. The next step is to develop a mechanism for specific targeting of cancerous cells. Achieving target specificity would pose difficulties given that cancer cells are essentially like any other cell in the body, except that they proliferate ectopically and at increased rates. Therefore, most of the antigens expressed by cancer cells are also expressed by other body cells. These self-antigens are not normally recognized as harmful by the immune system, and this unchecked disease progression is the hallmark of cancer (Egeblad &Werb, 2002). The goal of scientists today is to find tumour specific antigens to target for nano-particle delivery. Fortunately, the variety of differentiation states in cancer cells provides multiple investigative pathways to look for tumour specific antigens. The hope is that the therapy will permit the conjugation of a nano-particle to an antibody specific for cancerous cells. The problem with this is that most of the antigens that a cancer cell will present can also be found on other somatic cells. These self-antigens are not normally recognized by the immune system.

Current studies suggest that there will be a need to tag the metal particles with eight to ten antigens that correspond to receptors on the cell surface that may be overexpressed in some cancers, but these trials remain in the early stages (Klune et al., 2007). Theoretically, overexpression by cancer cells would render them more likely to bind to the metal, though this targeting method is not entirely specific.

Unfortunately, there is little data regarding the toxicity of the metallic compounds. It has been suggested that the cells may instigate a severe inflammatory response in attempt to oxidize the foreign compounds. Some research suggests that gold (Figure 1) may be a suitable alternative, because it has similar properties but has already been approved for treatment of other conditions, most notably rheumatoid arthritis (Klune et al., 2007).

Further investigation is also required due to possible side effects, one of which is that metallic particles will end up in the blood stream and eventually in the lymphatic vessels after cell death (Klune et al., 2007). These vessels may be damaged as RF therapy continues, causing significant harm to the patient.

Current testing has been done via insertion of metallic particles in solution, then insertion in cultured cells, and finally on rats to simulate an *in vivo* situation. Presently, it appears that viable treatment may be limited to tumours at least five cm in diameter. Twenty-four hours after exposure *in vivo*, researchers noted increased neutrophils and tissue necrosis (Klune et al., 2007). This again highlights the need for target specificity if this therapy is to ever become viable. Both Kanzius and Curley, as well as their research teams and other experts reviewing the data admit that human clinical trials are still years away.

NB: The results of the most current research are awaiting peer-review.

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