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New weapon in fight against cancer

A virus-packed blood cell that attacks cancers from within has added a new weapon to its armoury — and it’s all down to timing.   
   
Mathematicians at The University of Nottingham have worked with scientists at the University of Sheffield and Keele University to apply mathematical modelling to a revolutionary cancer treatment to optimise outcomes.

‘Arming’ white blood cells, or macrophages, with viruses carrying anti-cancer genes and injecting them into the bloodstream to attack cancerous cells within the body was a major breakthrough when it was discovered by researchers in the University of Sheffield and York.  
   
These virus-infected macrophages seek out areas of tumours where there is very little oxygen (i.e. it is said to be ‘hypoxic’).

The engineered macrophages then become ‘drug factories’, attacking the tumour from within.

The research team in Sheffield also discovered that inserting microscopic magnets into these white blood cells and applying a magnetic field near the tumour significantly boosted the number of these therapeutically ‘armed’ macrophages that were taken up by malignant tumours.  
   
Now, in a study funded by the BBSRC (Biotechnology and Biological Sciences Research Council) and published in the latest edition of the American Association of Cancer Research’s prestigious journal Cancer Research, mathematicians at The University of Nottingham have worked with this research group in Sheffield (and another in Keele) to use state-of-the-art mathematical models to predict the effects of this new treatment on tumours and to predict the optimum timing of such a treatment protocol.   
   
Mathematical modelling is increasingly being used to understand the complex biological processes that need to be overcome in treating cancer.

Now it has been used to demonstrate how treating tumours with these macrophage-based gene therapies could be used alongside more traditional treatments, such as chemotherapy.  
  
Markus Owen, Associate Professor in Applied Mathematics at The University of Nottingham, said: “Our results show that combining conventional and macrophage-based therapies can produce greater anti-tumour effects than expected simply by adding their individual effects.

Importantly, we also predict that the timing of combined therapies is crucial — if you get the timing wrong, these benefits are lost.”  
   
The experimental research was carried out in a laboratory at the University of Sheffield.

Its head, Professor Claire Lewis, said: “Another exciting prediction from this interdisciplinary research is that, if we use magnetic nanoparticles to further enhance macrophage delivery, the disorganised nature of tumour blood vessels means that this enhancement depends mainly on the strength of the applied magnetic field, rather than its direction.

This may be important in the treatment of non-superficial tumours where generating a specific orientation of a magnetic field may prove difficult.   
   
“This research demonstrates that mathematical modeling can be used to design, and maximise the efficacy of, combined therapeutic approaches in cancer.”  
   
The study brought together expertise from many UK institutions: mathematical modelling at The University of Nottingham, tumour targeting at the University of Sheffield, and magnetic nanoparticles at Keele University, and was supported by funds from the Biotechnology and Biological Sciences Research Council (BBSRC) and Engineering and Physical Sciences Research Council (EPSRC). 