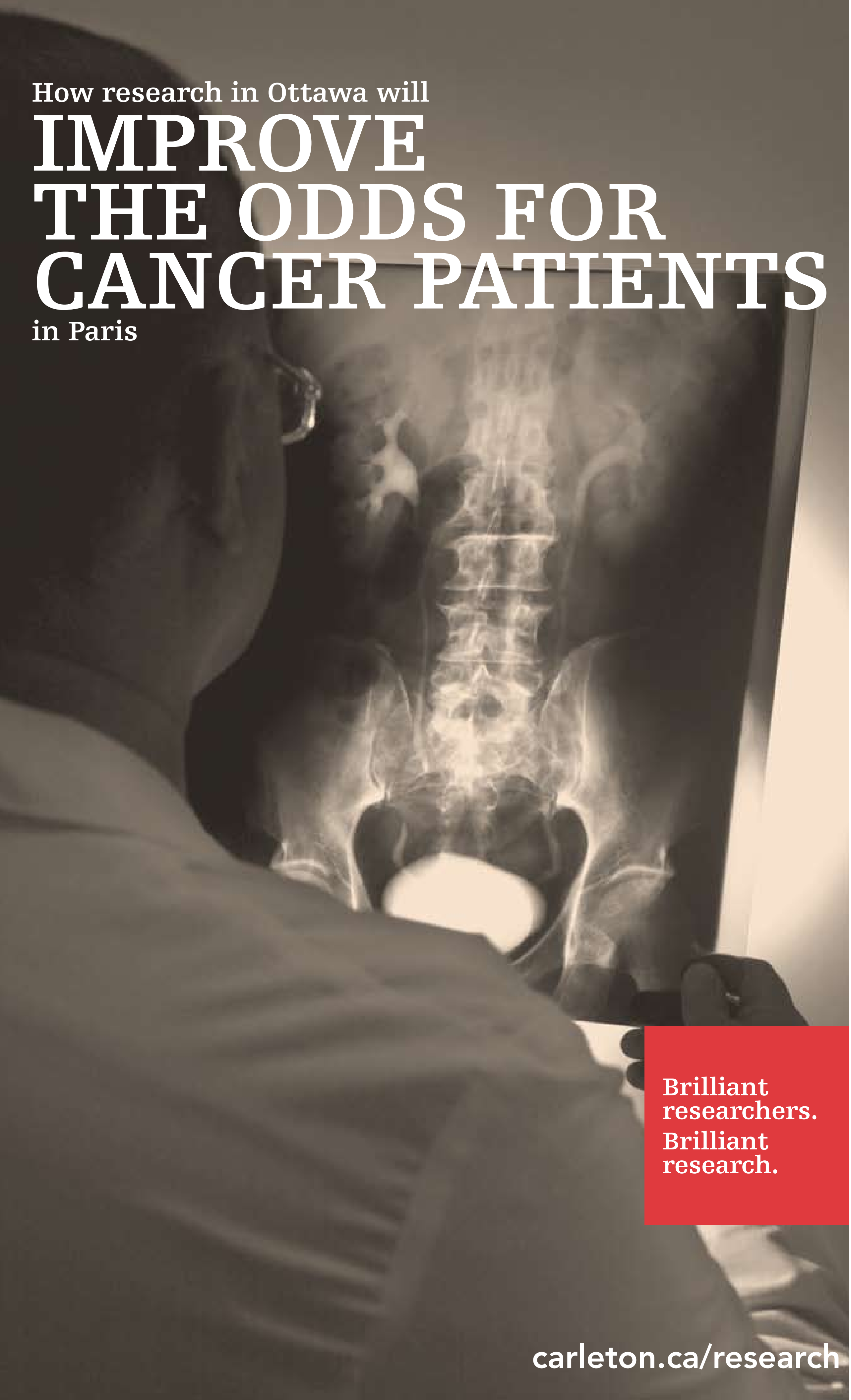

How research in Ottawa will

IMPROVE THE ODDS FOR CANCER PATIENTS

in Paris

Carleton UNIVERSITY

Canada's Capital University

Brilliant researchers.
Brilliant research.

David Rogers, PhD
Carleton University's
Canada Research Chair in
Medical Physics

carleton.ca/research

Brilliant researchers. Brilliant research.

Research snapshot

Purpose
To develop Monte Carlo techniques for the simulation of radiation transport and apply them to radiation problems in radiotherapy for cancer patients.

Scope
The development of a fast Monte Carlo program to calculate the dose delivered in brachytherapy.

Thesis
The improved calculation and measurement of ionizing radiation in radiotherapy and diagnostic imaging can improve clinical outcomes.

Outcome
The commercialization of a new technique for calculating the dose in cancer patients undergoing radiation therapy and the application of new techniques to accurately measure radiation in clinics.

Selected publications
- Almond, P.R., P.J. Biggs, B.M. Coursey, W.F. Hanson, M.S. Huq, R. Nath, and D.W.O. Rogers. "AAPM'S TG–51 Protocol for Clinical Reference Dosimetry of High-Energy Photon and Electron Beams." *Medical Physics 26* (1999), pages 1847-1870.
- Rogers, D.W. O. "Fifty years of Monte Carlo simulations for medical physics." *Physics in Medicine and Biology, 50th anniversary special issue 51*, R287-R301.

Grad student projects
Randy Taylor,
second year, Master's of Science
Development and benchmarking of a fast Monte Carlo code for brachytherapy
Dan La Russa,
second year, PhD in science
Use of Monte Carlo techniques to study the fundamentals of ion chamber dosimetry

Honours
- Farrington-Daniels Award of the American Assn. of Physicists in Medicine (AAPM) for co-authoring the best article in the journal *Medical Physics* (2003, 1999, 1991)
- 2001 Federal Partners in Technology Transfer (FPTT) Team Award for Technology Transfer from the Canadian government

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Improving the odds: using random numbers to improve radiation therapy

Monte Carlo—it's a name that most of us link with gambling. David Rogers, however, associates the name with a computing technique that uses random numbers in a calculated way to improve the success of external beam radiation therapy in treating cancer.

According to Rogers, a radiation physicist and Carleton University's Tier I Canada Research Chair in Medical Physics, determining the dose delivered in a radiotherapy treatment is related to several factors[1]. They include the amount of energy coming from the radiation source and the scattering of the radiation particles in the body, which is random for individual particles, but predictable for large numbers.

"The combination of the unpredictable diffusion of trillions of individual particles can be accurately predicted using probability theory and lead to successful radiotherapy," he explains. "However, while our technique—called Monte Carlo—uses random numbers, the results are not at all chancy. They have a statistical uncertainty instead of the measurement uncertainty inherent in science."

MONTE CARLO SIMULATION

It has been challenging to develop a universal method to determine the correct dose of radiation—the amount that will destroy all the cancer cells and minimize the risk of damaging healthy cells. Radiotherapy teams now routinely plan treatment and identify the right amount of radiation.

Critical to this simulation is computer software based upon the Monte Carlo technique.

Rogers says that in principle, Monte Carlo calculations are very simple because the codes allow physicists to simulate one photon or electron track through a patient at a time. "We might suppose that a single photon enters the body sideways at a certain angle and then use a random number to figure out how far this photon would travel before interacting with the body. We then use another random number to tell us what this original particle might do next: bounce off matter and then scatter in a certain direction."

The software repeats this process for millions of particles and builds a representative sample that can predict how much energy is deposited and where it will be distributed within a given patient. Improvements in the speed of computers and computer algorithms mean that although it used to take up to 6,000 hours to do similar calculations, they can now be done in five minutes.

MORE ACCURATE DOSES

Rogers is best known for developing Monte Carlo codes that simulate the radiation beams coming from an electron accelerator—a common source of radiation for radiotherapy. In 1999, he and a group drawn from cancer clinics and standards labs in Canada and the U.S. published a measurement protocol which is now used by clinical medical physicists almost everywhere in North America to determine how long to irradiate in order to deliver the required dose to the patient.

Currently, he is working on Monte Carlo algorithms that will improve brachytherapy wherein a radioactive source is implanted in the body. "Just as we have increased the accuracy of external radiation treatments and thus improved the chances of successful treatment, we can also improve the effectiveness of brachytherapy. This means that for certain types of cancer, patients can receive a treatment that is placed at the cancer site and is, therefore, less harmful to healthy tissue."

[1]The amount of radiation is quantified by measuring the dose in an irradiated tank of water which allows the measuring devices to be inside the tank. To calculate where the dose is delivered inside a real patient requires a second step in which the CT scan of the patient is used with a dose calculation algorithm.

"...patients can receive a treatment that is placed at the cancer site and is, therefore, less harmful to healthy tissue."

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