



An Introduction to the *International Journal of Particle Therapy's* Special Issue on Carbon Therapy

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In 2015, Martin Jermann, Secretary of the Particle Therapy Cooperative Group, reported in the *International Journal of Particle Therapy (IJPT)* that 137 931 patients had received particle therapy across the globe by the end of 2014, including 118,195 who received proton therapy and 15 736 who received carbon therapy [1]. He also provided data revealing an increasingly steep rise over the 60-year history of particle therapy in both the number of facilities operating and patients treated. Of the 46 facilities operational at the end of 2014, 20 had opened after 2004.

Although policies and mechanisms for the funding of medical technology adoption vary globally, all nations struggle with healthcare costs. Given that particle therapy facilities are substantially more expensive than conventional x-ray facilities, the increasing use of particle therapy is all the more remarkable. In the U.S., growth thus far has been restricted to proton therapy facilities, but is nevertheless significant given the Sisyphean cycle created by the current U.S. healthcare environment (see **Figure 1**).

First, reimbursement (coverage) for the cost of treatment requires clinical evidence of efficacy and safety. Recently, it is not only evidence of efficacy and safety that is required for coverage of a new modality, but also evidence of comparative effectiveness and/or evidence of a less costly treatment alternative compared to already established therapeutic alternatives. Second, this type of clinical evidence requires outcome analyses of treated patients—comparative effectiveness research (CER) requires that great numbers of patients are treated and followed long enough for simultaneous assessment of the important outcome endpoints of disease control, toxicity, quality of life, and survival, ideally after treatment on randomized trials which prospectively compare the new modality to the established standard; such an outcome comparison may require 10 to 20 years of follow-up. Third, the building of a critical mass of facilities to generate this kind of CER evidence requires pro formas based on predictable reimbursement patterns. Public or philanthropic financing of facilities (as occurs in other nations) could break this nearly impenetrable cycle; yet such financing is difficult and would likely involve too few programs to generate the required clinical evidence. Given this conundrum, the remarkable growth in particle therapy facilities attests to the compelling rationale and available clinical efficacy and safety data.

While most of the interest in particle therapy to date has been in the use of proton therapy, a strong interest has emerged in the use of carbon therapy as evidenced by the rapid growth in carbon therapy facilities in Japan, new facilities in China, Germany, Italy, and Austria, and plans for such facilities in the U.S. In fact, 6 of the 8 currently operational carbon therapy facilities were opened in 2006 or later. The problems of financing and generating evidence with carbon therapy are amplified compared with proton therapy, making the growing interest in carbon therapy all the more remarkable and deserving of our attention.

The associate editors of *IJPT* thus determined a special issue devoted to worldwide efforts in carbon therapy to be of value. While far from answering all the important

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Editor's Note

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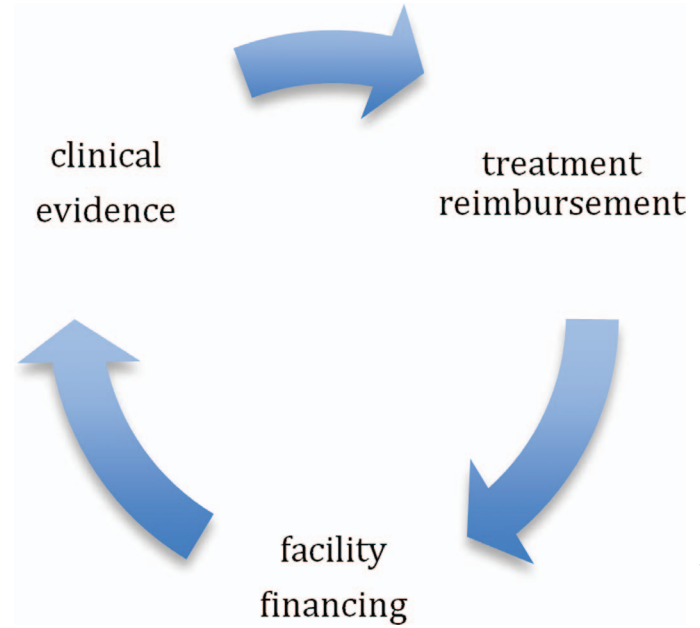
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Figure 1. The Sisyphean cycle created by the current U.S. healthcare environment.



questions regarding carbon therapy, this issue will provide a global picture of the carbon therapy plans and progress, including the 20-year experience of the world’s first carbon program, as well as discussions of the complexities of estimating dose distribution with Monte Carlo techniques, basic DNA injury and repair mechanisms, the “relative biologic effectiveness” of carbon therapy, and a comparative review of protons, carbon ions, and other ions beyond carbon that may be clinically useful. We hope that future issues of *IJPT* will attract additional work in carbon therapy, further elucidating the basic biologic and immunologic effects of carbon.

IJPT is grateful for the services of three outstanding guest editors in this endeavor: Dr. Hak Choy, from the University of Texas Southwestern in North America, Dr. Marco Durante, from the GSI Helmholtz Centre for Heavy Ion Research in Europe, and Dr. Tadashi Kamada, from the National Institute of Radiological Sciences in Asia. In addition to providing a global perspective, we hope that this issue will be timely and provocative.

ADDITIONAL INFORMATION AND DECLARATIONS

Conflicts of Interest: The author has no conflicts of interest to disclose.

Reference List

1. Jermann M. Particle Therapy Statistics in 2014. *Int J Particle Ther.* 2015;2:50–4.