Peertechz

Global Journal of Cancer Therapy

cancertherapy@peertechz.us

CLINICAL GROUP

ISSN: 2581-5407 DOI: https://dx.doi.org/10.17352/gjct

Short Communication

Photodynamic therapy in a pleural cavity using monte carlo simulations with 2D/3D Graphical Visualization

Beeson K[1], Parilov E[1], Mary Potasek[1]*, Zhu T[2], Sun H[2] and Sourvanos D[3]

[1]Simphotek, Inc, 211 Warren St, Newark, NJ 07103, USA

[2]Perlman School of Medicine, University of Pennsylvania, Philadelphia, Pennsylvania, USA

[3]Department of Periodontics, School of Dental Medicine, University of Pennsylvania, Philadelphia, Pennsylvania, USA

Received: 17 September, 2022
Accepted: 28 September, 2022
Published: 29 September, 2022

***Corresponding author:** Dr Mary Potasek, Simphotek, Inc, 211 Warren St, Newark, NJ 07103, USA, Tel: 609-802-1429; E-mail: mpotasek@simphotek.com

ORCID: https://orcid.org/0000-0002-5317-5117

Cancer therapy using Photodynamic Therapy (PDT) has been investigated for some time [1,2] and now it is a growing area of interest in clinical trials [3]. Monte Carlo (MC) simulations were used for early laboratory studies [4,5] for analysis in PDT. Various improvements in the MC method have advanced the field in recent years. For example, Yassine, et. al. [6] have optimized PDT with custom cylindrical diffusers; Cassidy, et.al. [7] have developed a robust MC method; whereas, Fang and Yan [8] and Young-Schultz et. al. [9] ported MC to Compute Unified Device Architecture (**CUDA**) that run on Graphics Processing Units (**GPU**). To date, there is a lack of very fast (a few minutes or less) computational methods for treatment planning in the clinic. Simphotek (**Stk**) [10-12] and other references in [13], including references therein, have developed various MC-based methods that can simulate the light fluence in PDT in near real-time.

The Perlman School of Medicine (**PSM**) has investigated PDT in the pleural lung cavity of several patients in a Photofrin-mediated study [14] and developed an IR navigation system for clinical use [15,16]. The analysis of the PDT dose data for 19 patients has been published recently [3]. However, due to the large surface area of the pleural lung cavity, a series of multiple stationary light sources is needed. **PSM** is currently developing an 8-detector system for treatment in the pleural cavity. While multiple fixed detectors can be used for dosimetry at a few locations, an accurate simulation of light fluence and fluence rate is still needed over the entire cavity. This makes it difficult for treating physicians to visualize the multiple light fluence/fluence rate simulations. As a the result, **Stk** extended its GPU-based MC simulation tool, as a part of Dosie™ simulation software, for modeling the light transport in intracavity PDT (**icav-PDT**) to include a dose-cavity visualization that allows a user to inspect the dose maps in real-time over the treated cavity in 3D.

As being a part of an emerging PDT Explicit Dosimetry System (**PEDSy**), the performance of this new Stk's CUDA-based implementation, called PEDSy-MC, has been demonstrated on a life-size lung-shaped custom-printed phantom for testing the icav-PDT navigation system at the **PSM** [15,16]. Fluence calculations completed in under a minute (for some cases) or within minutes have been achieved [17]. In addition, results within a 5% error of the analytic solution for multiple detectors in the phantom were accomplished. Research supported by [18].

References

1. Dougherty TJ, Gomer CJ, Henderson BW, Jori G, Kessel D, Korbelik M, Moan J, Peng Q. Photodynamic therapy. J Natl Cancer Inst. 1998 Jun 17;90(12):889-905. doi: 10.1093/jnci/90.12.889. PMID: 9637138; PMCID: PMC4592754.

2. Wilson BC, Patterson MS. The physics, biophysics and technology of photodynamic therapy. Phys Med Biol. 2008 May 7;53(9):R61-109. doi: 10.1088/0031-9155/53/9/R01. Epub 2008 Apr 9. PMID: 18401068.

Citation: Beeson K, Parilov E, Potasek M, Zhu T, Sun H, et al. (2022) Photodynamic therapy in a pleural cavity using monte carlo simulations with 2D/3D Graphical Visualization. Glob J Cancer Ther 8(1): 034-035. DOI: https://dx.doi.org/10.17352/2581-5407.000045

3. Zhu TC, Sun H, Ong YH, Morales RH, Dimofte A, Busch T, Singhal S, Cengel KA. Real-time PDT Dose Dosimetry for Pleural Photodynamic Therapy. Proc SPIE Int Soc Opt Eng. 2022 Jan-Feb;11940:1194002. doi: 10.1117/12.2612188. Epub 2022 Mar 4. PMID: 35573026; PMCID: PMC9104001.

4. Wilson BC, Adam G. A Monte Carlo model for the absorption and flux distributions of light in tissue. Med Phys. 1983 Nov-Dec;10(6):824-30. doi: 10.1118/1.595361. PMID: 6656695.

5. Wang L, Jacques SL, Zheng L. MCML--Monte Carlo modeling of light transport in multi-layered tissues. Comput Methods Programs Biomed. 1995 Jul;47(2):131-46. doi: 10.1016/0169-2607(95)01640-f. PMID: 7587160.

6. Yassine AA, Lilge L, Betz V. Optimizing interstitial photodynamic therapy with custom cylindrical diffusers. J Biophotonics. 2019 Jan;12(1):e201800153. doi: 10.1002/jbio.201800153. Epub 2018 Sep 27. PMID: 30178604.

7. Cassidy J, Nouri A, Betz V, Lilge L. High-performance, robustly verified Monte Carlo simulation with FullMonte. J Biomed Opt. 2018 Aug;23(8):1-11. doi: 10.1117/1.JBO.23.8.085001. PMID: 30098135.

8. Fang Q, Yan S. MCX Cloud-a modern, scalable, high-performance and in-browser Monte Carlo simulation platform with cloud computing. J Biomed Opt. 2022;27(8). doi: 10.1117/1.Jbo.27.8.083008. PubMed PMID: 34989198; PMCID: PMC8728956.

9. Young-Schultz T, Brown S, Lilge L, Betz V. FullMonteCUDA: a fast, flexible, and accurate GPU-accelerated Monte Carlo simulator for light propagation in turbid media. Biomed Opt Express. 2019;10(9):4711-26. Epub 20190821. doi: 10.1364/boe.10.004711. PubMed PMID: 31565520; PMCID: PMC6757465.

10. Potasek M. Simphotek: Shedding Light on New Cancer Treatments. Scientia. 2019. doi: 10.33548/SCIENTIA434.

11. Karl B, Evgueni P, Mary P, editors. Validation of Dosie combined Monte Carlo and photokinetic simulations for the analysis of HPPH-mediated photodynamic therapy on mice. ProcSPIE. 2019.

12. Beeson KW, Parilov E, Potasek M, Kim MM, Zhu TC. Validation of combined Monte Carlo and photokinetic simulations for the outcome correlation analysis of benzoporphyrin derivative-mediated photodynamic therapy on mice. J Biomed Opt. 2019 Mar;24(3):1-9. doi: 10.1117/1.JBO.24.3.035006. PMID: 30873764; PMCID: PMC6416474.

13. Wang S, Dai XY, Ji S, Saeidi T, Schwiegelshohn F, Yassine AA, Lilge L, Betz V. Scalable and accessible personalized photodynamic therapy optimization with FullMonte and PDT-SPACE. J Biomed Opt. 2022 Apr;27(8):083006. doi: 10.1117/1.JBO.27.8.083006. PMID: 35380030; PMCID: PMC8978262.

14. Ong YH, Kim MM, Finlay JC, Dimofte A, Singhal S, Glatstein E, Cengel KA, Zhu TC. PDT dose dosimetry for Photofrin-mediated pleural photodynamic therapy (pPDT). Phys Med Biol. 2017 Dec 29;63(1):015031. doi: 10.1088/1361-6560/aa9874. PMID: 29106380; PMCID: PMC5952607.

15. Kim MM, Zhu TC, Ong YH, Finlay JC, Dimofte A, Singhal S, Glatstein E, Cengel KA. Infrared navigation system for light dosimetry during pleural photodynamic therapy. Phys Med Biol. 2020 Apr 14;65(7):075006. doi: 10.1088/1361-6560/ab7632. PMID: 32053799; PMCID: PMC8114850.

16. Zhu TC, Ong Y, Kim MM, Liang X, Finlay JC, Dimofte A, Simone CB 2nd, Friedberg JS, Busch TM, Glatstein E, Cengel KA. Evaluation of Light Fluence Distribution Using an IR Navigation System for HPPH-mediated Pleural Photodynamic Therapy (pPDT). Photochem Photobiol. 2020 Mar;96(2):310-319. doi: 10.1111/php.13166. Epub 2019 Oct 22. PMID: 31556122; PMCID: PMC7093257.

17. Beeson K, Parilov E, Potasek M, Zhu TC, Sun H, Sourvanos D, editors. A Monte Carlo simulation for Moving Light Source in Intracavity PDT. Proc SPIE Int Soc Opt Eng , submitted 2023.

18. National Institutes of Health (NIH) Number (R01-EB 029998-01A1) and National Institute of Dental & Craniofacial Research (NIDCR) Number (T90DE030854)

Citation: Beeson K, Parilov E, Potasek M, Zhu T, Sun H, et al. (2022) Photodynamic therapy in a pleural cavity using monte carlo simulations with 2D/3D Graphical Visualization. Glob J Cancer Ther 8(1): 034-035. DOI: https://dx.doi.org/10.17352/2581-5407.000045