

## Evaluating the Impact of Tissue Heterogeneity Corrections in a Commercial Treatment Planning System (TPS), Prowess Panther with Non-IMRT Techniques

Duong Thanh Tai, Truong Thiet Dung, Dinh Thanh Binh, Mai Quynh Anh, Nguyen Van Hai

Duong Thanh Tai, Truong Thiet Dung, Dinh Thanh Binh, Department of Radiation Oncology, Dong Nai General Hospital, Bien Hoa, Vietnam

Duong Thanh Tai, Mai Quynh Anh, Faculty of Physics & Engineering physics, University of Science, Ho Chi Minh, Vietnam  
Nguyen Van Hai, Dalat Vocational training College, Vietnam

**Conflict-of-interest statement:** The author(s) declare(s) that there is no conflict of interest regarding the publication of this paper.

**Open-Access:** This article is an open-access article which was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>

**Correspondence to:** Duong Thanh Tai, Dong Nai General Hospital, Viet Nam.

Email: [thanhtai\\_phys@yahoo.com](mailto:thanhtai_phys@yahoo.com)

Telephone: +84 945569139

Received: October 20, 2016

Revised: February 16, 2017

Accepted: February 20, 2017

Published online: March 31, 2017

### ABSTRACT

**AIM:** The aim of this study is to compare between the dose differences in calculating using the algorithms without and with heterogeneity correction on the treatment planning system.

**MATERIALS AND METHODS:** 25 plan of patients with lung cancer and 11 patients with breast cancer were treated with three-dimensional conformal radiotherapy (3D-CRT). For each patient, 2 treatment plans were generated using the same beam configuration. Per each treatment plan, the algorithms used in this study were divided into two plans: (1) In plan 1 was calculated using the Fast photon Effective algorithms; (2) In plan 2 were calculated using the Fast

photon algorithms. Both of plans were generated by Prowess panther 4.6 (Prowess, Chico, CA).

**RESULTS:** The average differences using heterogeneity correction and inheterogeneity correction were 1.5-2.9% for patients with lung cancer, 2.1-3.4% for patients with breast cancer.

**CONCLUSIONS:** The results indicated that the difference between using heterogeneity correction is not significant in calculation dose for 3D-CRT plans.

**Key words:** Tissue heterogeneity corrections, treatment planning, 3D-CRT

© 2017 The Author(s). Published by ACT Publishing Group Ltd. All rights reserved.

Tai DT, Dung TT, Binh DT, Anh MQ, Hai NV. Evaluating the Impact of Tissue Heterogeneity Corrections in a Commercial Treatment Planning System (TPS), Prowess Panther with Non-IMRT Techniques. *International Journal of Radiology* 2015; 4(1): 124-127 Available from: URL: <http://www.ghrnet.org/index.php/ijr/article/view/1862>

### INTRODUCTION

Radiation therapy technique is one of possible approaches to treat cancer at most of hospitals all over the world. In external radiation therapy gamma rays often produced by medical linear accelerators (LINAC) to radiate into cancer tumors. The various energies of gamma rays can be earned to use in three types of techniques: 3D-CRT, intensity modulated radiation therapy (IMRT) and volumetric modulated arc therapy (VMAT). 3D-CRT is one of the most commonly used in the treatment of cancer, in which radiotherapy treatment planning is one of the most important steps in the radiotherapy. Dose calculation in radiotherapy is done using the algorithms used in treatment planning system (TPS). A uniform treatment plan, the algorithm assumes that patients have homogeneous tissue density; on the other hand, in a heterogeneous planning the algorithms will be added to the different densities of tissue called a correction factor<sup>[1,2]</sup>. This correction factor was generated from the electron density of the matrix which was derived from a matrix of CT values because it is the linear relationship

between electron density and CT values obtained<sup>[3,4,5]</sup>. To make a correction factor, this study using an algorithm with heterogeneity correction is available in treatment planning system Prowess Panther (Prowess, Chico, CA). A hypothesis was suggested that the dose between 2 groups were different.

## MATERIALS AND METHODS

### Patients

25 plan of patients with lung cancer and 11 patients with breast cancer were treated in the Dong Nai General Hospital by a Linear Accelerator Primus 5497 using two photon energy levels: 6 MV and 15 MV with radiotherapy technique 3D-CRT. All plans of patients were randomly selected for this study.

### Dose calculation algorithm

There are many models of dose calculation algorithm, for photons, Prowess panther v4.6 has two models: (1) Conventional Calculations; (2) Convolution Calculations.

In this study, a model of conventional calculation was used to calculation dose distribution in patients. It is integrated in the software treatment planning Prowess panther. This model has two algorithms: Fast Photon and Fast Photon Effective.

### Treatment Planning

The CT images of all patients were taken on Siemens SOMATOM (Siemens Medical System, Germany) with slice thickness of 3 mm for the planning purpose. All CT images were transferred to the treatment planning system Prowess Panther. Each patient was performed two treatment plans with two different algorithms, but the same in physical

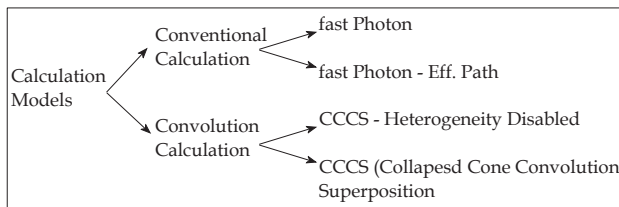


Figure 1 Models of dose calculation algorithm.

parameters: beams, energy, etc... The treatment goals for these plans meet plan acceptance criteria for critical structures according to the RTOG-0225 protocol. Total of dose is 60 Gy with lung cancer and 50 Gy with breast cancer; fraction dose of 2 Gy.

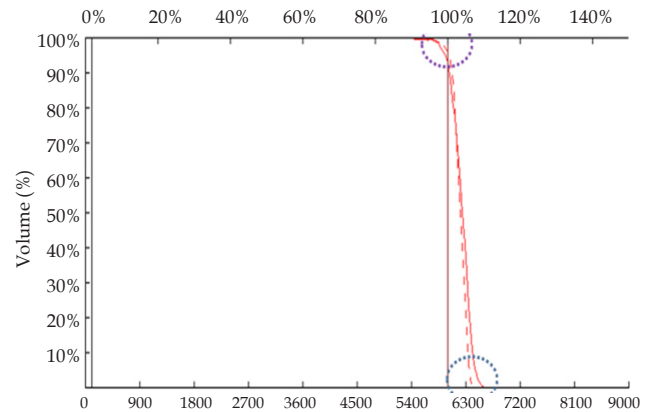


Figure 3 DVH of plan 1 (solid) and plan 2 (dashed).

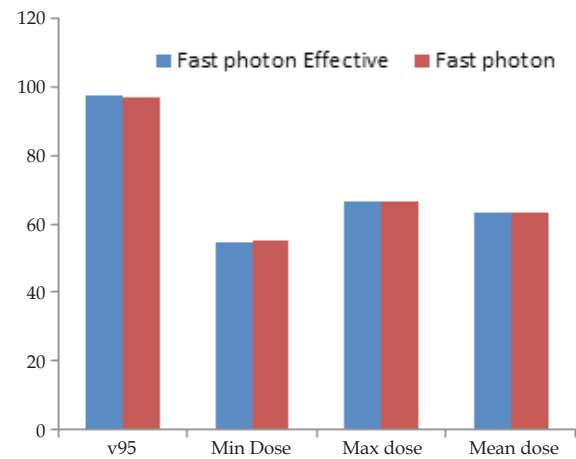


Figure 4 Compare between Fast photon and Fast photon Effective.

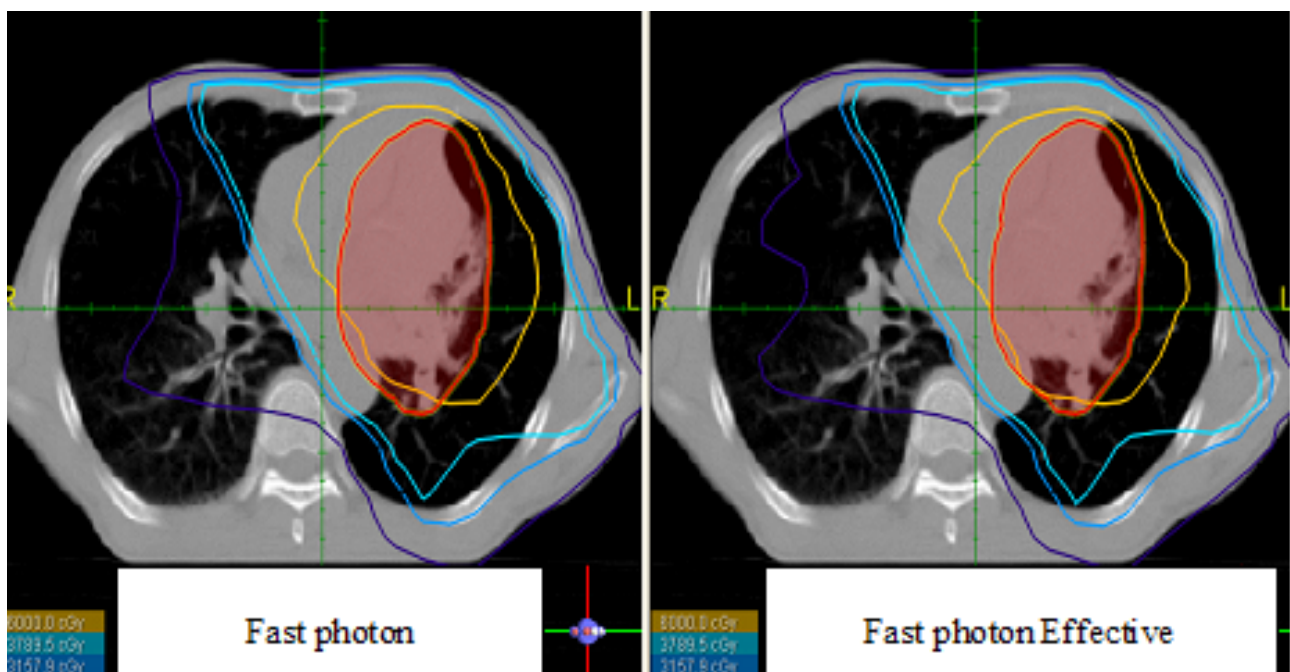


Figure 2 Isodose line between two plans: Fast photon and Fast photon Effective.

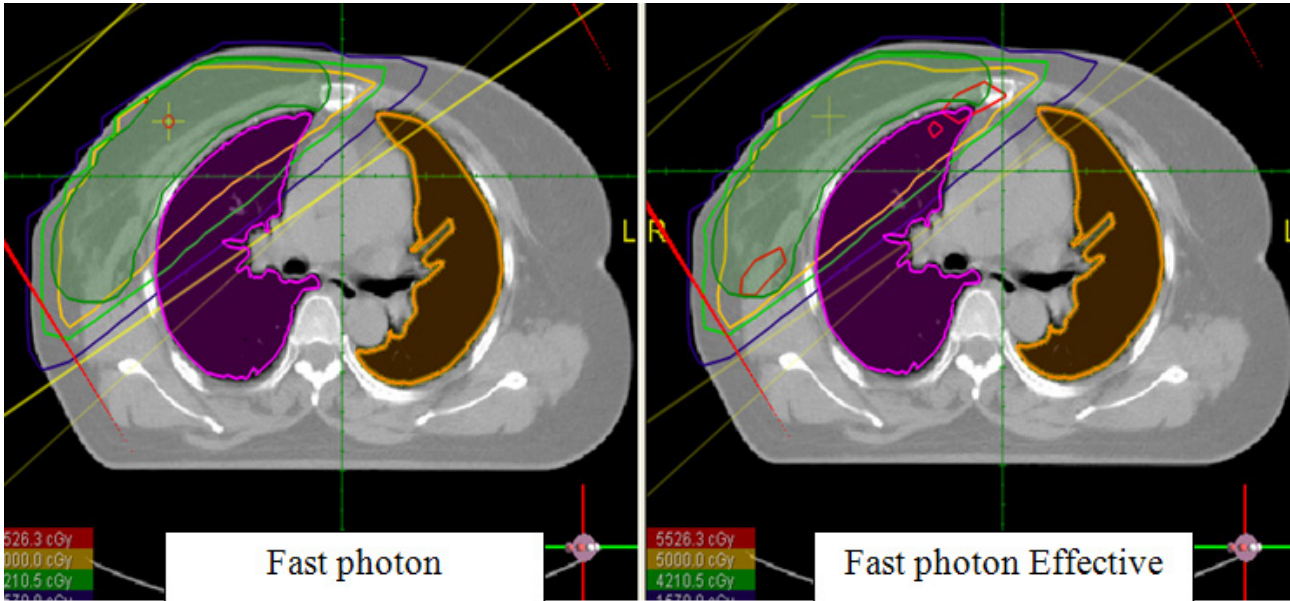


Figure 5 Isodose of two plans: Fast photon and Fast photon Effective.

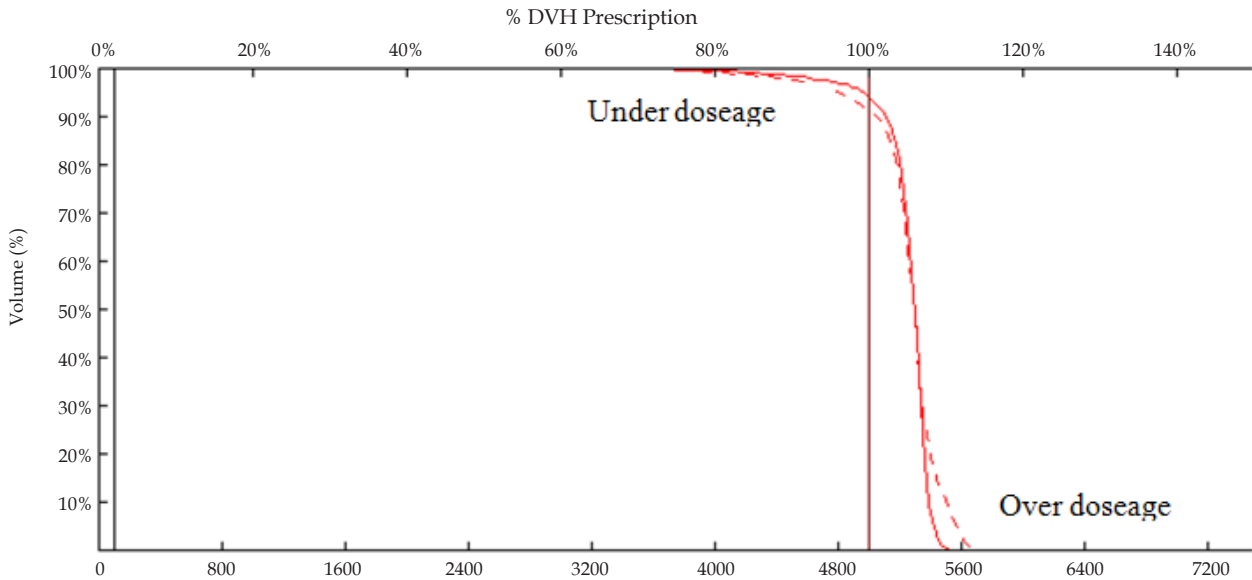


Figure 6 DVH: plan 1 (solid line) and plan 2 (dashed).

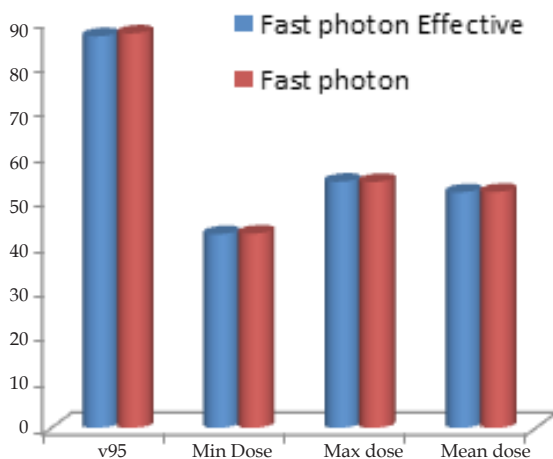


Figure 7 Compare between Fast photon and Fast photon Effective.

## RESULTS AND DISCUSSIONS

Dose calculation algorithm is one of the main steps in the radiotherapy procedure<sup>[6,7]</sup>. This study was to compare the accuracy of different inhomogeneity correction algorithms for external photon beam dose calculations. For this purpose, two plans of each patient have been calculated with two different algorithms. In plan 1 was calculated using the *Fast Photon Effective with the identity of the tissues*; in plan 2 were calculated using the *Fast Photon without the identity of the tissue*. The results of the two algorithms in dose calculation are shown in Table 1, 2 and Figure 2, 3, 4, and 5. Figure 3, 5 shows the isodose line between two algorithms in PTV, but small isodose (< 20%) there are differences between the two algorithms. Figure 2, 4 shows the curve DVH between the two algorithms are not difference, but there is small different at the maximum and minimum dose values.

Table 1 and table 2: The average difference between the two algorithms is 1.5-2.9% for patients with lung cancer and 2.1-3.4% for patients with breast cancer.

**Table1** Percentage difference between the two plans lung cancer radiotherapy.

Plan	V95 (%)	Min Dose (%)	Max Dose (%)	Mean Dose (%)
Plan 1 vs Plan 2	2.57 ± 0.82	2.98 ± 0.95	2.18 ± 0.68	1.58 ± 0.45

**Table 2** Percentage difference between the two plans for breast cancer radiotherapy.

Plan	V95 (%)	Min Dose (%)	Max Dose (%)	Mean Dose (%)
Plan 1 vs Plan 2	2.88 ± 0.79	3.48 ± 0.65	2.61 ± 0.58	2.14 ± 0.57

**Case 1: Lung cancer**

20% Isodose line between Fast photon and Fast photon Effective clearly different, Fast photon Effective dose to healthy lung tissue receiving more than Fast photon.

There is small difference between the two algorithms The average difference between the two algorithms is in the range of 2-3%. This difference was not significant.

**Case 2: Breast cancer**

The results from figure 7 show that there is no significant difference between two algorithms for this case.

**CONCLUSIONS**

One of the major factors in TPSs is the accuracy of dose calculation algorithm. Therefore, it is important to understand these algorithms. In results of this study, we found that the difference between using heterogeneity correction on prowess panther is not significant in calculation dose for 3D-CRT plans. Therefore in dose calculation using the identity of the tissue or does not need to be consideration carefully in conjunction with suitable doses indicated. In this article, we have just stopped at the doses examined in the tumor (PTV) including the parameters: V95, maxdose, mindose, meandose for two cases of breast cancer and lung cancer. Further research directions, next to the survey differences in dose in the tumor, we will conduct further surveys at agencies doses and additional parameters such as V5, V10, V20, MU.

**REFERENCES**

1. Batho HF, Lung corrections in cobalt 60 beam therapy, *J Can Assoc Radiol.* 1964; **15**(2):79-83. [PMID: 14173312]
2. Chang DT, Olivier KR, Morris CG, Liu C, Dempsey JF, Benda RK, The Impact of heterogeneity correction on dosimetric parameters that predict for radiationmpneumonitis, *Int J Radiat Oncol Biol Phys.* 2006; **65**(1):125-31. [PMID: 16427214]; [DOI: 0.1016/j.ijrobp.2005.09.047]
3. Chang D, Liu C, Dempsey JF, Palta JR, Kopea J, Louis D, Predicting changes in dose distribution to tumor and normal tissue when correcting for heterogeneity in radiotherapy for lung cancer, *Am J Clin Oncol.* 2007; **30**(1): 57-62. [PMID: 17278896]; [DOI: 10.1097/01.coc.0000251222.36417.3b]
4. Tania De La Fuente Herman, Heather Gabrish, Terence S. Herman, Maria T. Vlachaki,I and Salahuddin Ahmad, Impact of tissue heterogeneity corrections in stereotactic body radiation therapy treatment plans for lung cancer, *J Med Phys.* 2010; **35**(3): 170-173. [PMCID: PMC2936187]; [DOI: 10.4103/0971-6203.62133]
5. Ding M, Kavanagh BD, Schefter T, Stuhr K, Newman F, The Influence of heterogeneity on tumor and normal lung dosimetry in stereotactic body radiation therapy for lung cancer treatment, *Int J Radiat Oncol Biol Phys.* 2005; **63**(1):511-512. [DOI: 10.1016/j.ijrobp.2005.07.867]
6. Morrill SM, Langer ML, Lane RG, Rosen, Tissue heterogeneity effects in treatment plan optimization. *Int J Radiat Biol Phys.* 1994; **30**(3):699-706. [PMID: 7928503]
7. Asnaashari K, Nodehi MR, Mahdavi SR, Gholami S, Khosravi HR, Dosimetric comparison of different inhomogeneity correction algorithms for external photon beam dose calculations, *J Med Phys.* 2013; **38**(2):74-8 [PMID: 23776310]; [DOI: 10.4103/0971-6203.111310]
8. Nikos Papanikolaou, Eric E. Klein, and William R. Hendee, Heterogeneity corrections should be used in treatment planning for lung cancer. *Med. Phys* 2000; **27**(8)

**Peer reviewer:** Kenshiro Shiraishi