Photodynamic therapy using Sulfonated Aluminium Phthalocyanine mix for the eradication of cervical cancer: an *in vitro* study

E P Chizenga[1] **and H Abrahamse**[1,2]

[1]Laser Research Centre, Faculty of Health Sciences, University of Johannesburg, Doornfontein, 2028, Johannesburg, South Africa.
[2] NRF SARChI: Laser Applications in Health, South Africa

Email: habrahamse@uj.ac.za

Abstract. The use of phthalocyanines in Photodynamic Therapy (PDT) has greatly influenced the approach towards the treatment of cancer. PDT is very efficient in eradicating cancer cells but its efficacy depends on the correct choice of Photosensitizer (PS) used. This study, therefore, investigated the effectiveness of Sulfonated Aluminium Phthalocyanine mix ($AlPcS_{mix}$) in PDT of cervical cancer, which, in developing countries, including South Africa, is a common type of cancer. A working solution of $AlPcS_{mix}$ was prepared in phosphate buffered saline, PBS. Cervical cancer HeLa cells (ATCC® CCL2™) were cultured in Dulbecco's Modified Eagle's Medium supplemented with 10% Foetal Bovine Serum and incubated at 37 °C, 5% CO_2 and 85% humidity. The cells were treated with varying concentrations of $AlPcS_{mix}$ and irradiated using 673 nm diode laser at fluences of 5, 10 and 20 J/cm^2. Cellular responses were evaluated 24h post-irradiation to assess changes in cell structre, number and ability to survive after treatment. Results indicated that $AlPcS_{mix}$ localized in cytoplasm, mitochondria and lysosomes, and cellular responses showed dose-dependent structural changes, with decreased cell numbers and impaired ability to grow. The study presented $AlPcS_{mix}$ as an excellent choice of PS for use in PDT and the eradication of cervical cancer cells *in vitro*.

1. Introduction

Cervical cancer is a very common gynecologic malignancy in many parts of the world including South Africa. The burden of cervical cancer is due to lack of effective therapies which result in frequent cancer recurrences and migration to other organs (metastasis). Currently, surgery, chemotherapy and radiation are used for treatment. These therapies are associated with frequent recurrent rates and reduced quality of life for instance surgery, results in loss of fertility [1].

Modern advances in the field of applied physics in medicine, biomedical physics, has significantly modified methods of diagnosis and treatment of human diseases. Since antiquity, the use of light to treat skin diseases and other medical conditions has been in practice but only recently significant modern advances have been introduced to actively target specific diseases like cancer [2]. Photodynamic Therapy (PDT) is a treatment modality that uses light to activate a dye, referred to as Photosensitizer (PS) which reacts with molecular oxygen in its excited triplet state to produce singlet oxygen and other reactive oxygen species that cause damage to cancer cells [3]. This PS is administered into the body and actively localizes in the cancer tissue which upon light exposure, the cancer is eradicated. PDT has therefore gained much attention because of its specificity, noninvasiveness, minimal side effects and

Acknowledgements
This work is based on the research supported by the South African Research Chairs Initiative of the Department of Science and Technology and National Research Foundation of South Africa (Grant No 98337). The authors sincerely thank the University of Johannesburg, the National Research Foundation for their financial grant support, and the National Laser Centre for providing use of their lasers

References

[1] Calixto G M, Bernegossi J, de Freitas L M, Fontana C R and Chorilli M. 2016 *Molecul*, **21** 3
[2] Jadon G and Joshi K S 2012 Cervical Cancer a Review Article*JBPR*, **1** 1
[3] Ackroyd R, Kelty C, Brown N and Reed M 2001 *Photochem. and Photobio*. **74** 5
[4] Boyle R W and Dolphin D 1996 *Photochem. Photobiol*. **64** 469
[5] Abrahamse H and Hamblin M R 2016 *Biochem. J*. **473** 4
[6] Sibata C H, Colussi V C, Oleinick N L and Kinsella T J 2000 *Braz J Med Biol Res*. **33** 8
[7] Zharkova N N, Kozlov D N , Smirnov V V, Sokolov V V, Chissov V I, Filonenko E V, Sukhin G M, Galpern M G and Vorozhtsov G N 1995 Photodynamic Therapy of Cancer II International Symposium on Biomedical Optics Europe '94 Proc. SPIE ed D Brault, G Jori, J Moan, B Ehrenberg (Lille France 12 January 1995) SPIE Digital Library vol 2325 pp 367-374
[8] Kresfelder T L, Cronje M J and Abrahamse H 2009 *Photomed Laser Surg.*. **27** 4