Chapter 67
Towards an Effective Imaging-Based Decision Support System for Skin Cancer

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ABSTRACT

The usage of expert systems to aid in medical decisions has been employed since 1980s in distinct applications. With the high demands of medical care and limited human resources, these technologies are required more than ever. Skin cancer has been one of the pathologies with higher growth, which suffers from lack of dermatology experts in most of the affected geographical areas. A permanent record of examination that can be further analyzed are medical imaging modalities. Most of these modalities were also assessed along with machine learning classification methods. It is the aim of this research to provide background information about skin cancer types, medical imaging modalities, data mining and machine learning methods, and their application on skin cancer imaging, as well as the disclosure of a proposal of a multi-imaging modality decision support system for skin cancer diagnosis and treatment assessment based in the most recent available technology. This is expected to be a reference for further implementation of imaging-based clinical support systems.

INTRODUCTION

Skin cancer is a fast-growing health concern and threat for humans. Its diagnosis is still a challenge, and when made early, eases the consequences with appropriate treatment. Since 1980's technology has incrementally been adopted in daily medical practices to help in the management of health professionals, promotion of better care and aid in diagnostic procedures. Since skin cancer is thriving and the number

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of specialists is limited, the demand for an effective decision support system (DSS) to ease the burden of the existing experts is high.

This chapter is organized by presenting the problem of skin cancer, its types, the traditional diagnosis and treatment options, the promising imaging technologies that can facilitate a differential diagnosis, the existing freely available datasets that can be used for research, a review on the application of decision support systems in the skin cancer diagnosis, the proposal for an implementation of a generic effective DSS for skin conditions and remarks with a critical discussion and conclusion.

This research aims to present the current diagnosis and treatment options for skin cancer, the existing promising imaging technologies to improve it, disclose the existing free datasets for research, review the application of DSS in skin cancer and propose a generic technologically advanced effective DSS for skin conditions management.

BACKGROUND

Like any other cell in the human body, skin cells are subjected to different types of mechanisms that regulate their development and replacement, if considered needed.

Typically, physiological pathways are triggered to induce apoptosis of malfunctioning cells and destroy it before causing harm. If these defense mechanisms fail, the defective cell can grow out of control and generate a skin neoplasm. (Hunter et al., 2002a)

An abnormal cell grow is not inevitably indicative of the appearance of a cancerous tissue. Benign or malignant tumors can arise, and its differentiation should be clarified. Malignant masses are generally referred to as cancers and are histologically characterized by cells considerably dissimilar from the ones of its mother-tissue. There is a clear tendency to grow and multiply at an excessive rate, as well as to eventually infiltrate neighbor tissues and close-by vascular and lymphatic structures. This feature, i.e., metastization, allows it to spread to different organs and originate a new tumor focus, complicating its treatment and increasing the associated life-risk. Contrarily, benign neoplastic cells tend to be somewhat like its tissue of origin, presenting decent cell differentiation. Their growth rate is considered slower when compared to malignant ones, and the ability to metastasize is absent. In fact, these tumor types have a tendency towards local expansion, pushing adjacent structures. Thus, normally, it does not represent a threat for its host. (Crowley, 2013; L Kemp et al., 2015)

Anatomical changes are guaranteed to happen with the emergence of a tumorous mass. Still, the occurrence of physiological shifts is far more relevant, especially if in the presence of a cancerous lesions. (Baba & Catoi, 2007a) Contrarily to what most could hypothesize, the neoplastic mechanisms are not uniquely controlled by genes that underwent mutations. Genes that retained its "normal" structure can have a detrimental influence, as the promotion of the expression of proteins, normally included in regular cellular processes, but at inappropriate occasions and with the inappropriate extent. Thus, enhancing carcinogenesis. (Moasser, 2014)

At the beginning of neoplasm development, the tumor possesses low metabolic requirements than what could be expected. Still, to guarantee a continuous and interrupted growth, its constituent cells disseminate angiogenic growth factors (e.g., vascular endothelial growth factors (VEGF)) to avoid vasoconstriction and subsequent cancellation of blood supply. (Baba & Catoi, 2007b; Moasser, 2014) As cells multiply, eventually oxygen and nutrient deplete and neovascularization takes place, originating new blood vessels within the tumor. Blood perfusion is also triggered, by the neuronal messenger nitric