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Original Research Article

Predicting the success of wart treatment methods using decision tree based fuzzy informative images

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ABSTRACT

Warts are small, rough, benign tumours caused by human papillomavirus (HPV). A challenge is predicting the success of wart treatment methods because success may vary depending on the patient and the features of disease. Recently, a machine learning based expert prediction system and related prediction rules were proposed. However, the success of this system is not satisfactory and should be improved. Furthermore, medical experts find it difficult to interpret the suggested rules of this system. The decision tree-based method was accordingly used in this study to determine the rules of predicting the success of wart treatment methods. According to findings, the success rate varied from 90 to 95% according to the treatment method; these rates are higher than previously reported. Furthermore, the decision tree rules that were determined can be transformed into images to visually interpret the success rates of treatment methods as a function of patient age and the time elapsed since disease appearance. This study provides a method for simple and more accurate interpretation of rules for medical experts. The success of treatment methods is now predictable as a percentage.

1. Introduction

Warts are benign tumours caused by infection with human papillomavirus (HPV) and can be categorized into 3 main types: Cutaneous, Epidermodysplasia Verruciformis (EV) and Mucosal. Although the warts are usually spread by direct contact with the person, they can also be spread via common areas. Wart types are also classified according to the risk level or clinical appearance. Immunocompromised patients are particularly prone to wart infections. Most of the time, warts are small, rough and harmless skins growths that are typically painless. The clinical appearances of warts (types of warts) are the common, plantar, filiform, periungual and genital etc [1]. Common warts usually grow on fingers and toes; sometimes, they can also appear elsewhere. They are greyer than the surrounding skin. They may have rough, rounded top and a grainy appearance. Another wart type is plantar, which grows into the soles of the feet and can make walking uncomfortable. Warts may disappear spontaneously (without treatment) in months or years, but medical treatment is requested by the patients since they visually unappealing;

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patients request the removal of painful warts more urgently than painless ones [2–4].

However, the warts may respond positively or negatively to a variety of treatment measures such as salicylic acid preparation, immunotherapy with candida antigen (immunotherapy), and cryotherapy with liquid nitrogen (cryotherapy). Failed treatment has several drawbacks such as side effects, pain and wasted time. Commonly used methods are cryotherapy and immunotherapy. Cryotherapy method is freezing warts with extreme cold. Immunotherapy is increasing the immune system of the body with foreign molecules that lead to antibody production [5,6]. For example, the time is wasted if the medical experts (Dermatologist or general surgeon) initially preferred immunotherapy and failed. Thus, the next method (cryotherapy) may also be failed since the success of methods may depend on the time elapsed before treatment [7]. Even, side effects of first method may cause the failure of second method. For these reasons, prediction of the appropriate method by utilizing the patient and disease characteristics is very important for the medical experts [8].

Medical experts often choose the treatment method with the help of their personal experience and medical knowledge, but this sense-based prediction may not be successful [9]. Also, success rate of sense-based method has not recorded statistically, and it is not easy for medical experts to make decision. Therefore, computer-assisted automated prediction methods (data mining and machine learning methods) already used for other skin diseases have also been suggested in a recent research to predict the success of wart treatment methods [10–12]. A significant success rate was achieved in this recent research using a real dataset and the rules for prediction of treatment success were suggested. However, the success rate of previously suggested rules-based fuzzy expert system can be increased as the researchers have pointed out in their research [12]. Moreover, the previously suggested prediction rules can be made more interpretable for medical experts. Therefore, an easy interpretable and more successful new method is needed to predict the success of wart treatment methods depending on the attributes of the patients and disease.

Decision trees method determines the attribute ranges that must be selected to reach the desired result values or class labels. So, the decision trees method can determine appropriate treatment method according to the patient and disease attributes and it can be more successful than previously suggested rules-based method. Also, the decision tree rules can be transformed into fuzzy informative images. Thus, the success percentage of treatment methods can be predicted easily and visually.

For this purpose, the rules to be used to predict the success rate of treatment methods were primarily determined by decision trees, in this study. Then, the images representing the decision tree rules were created to provide the visual, easy and rapid interpretation for medical experts. Finally, the images were enhanced by image processing methods to predict the treatment method success as percentage. As a result, the visual and easy interpretable fuzzy informative images were suggested to assist the medical experts while predicting the treatment method success.

2. Materials

Since the aim of this study is to improve the expert system previously proposed in the literature, two data sets used in this study are same with the data sets used in the previous study. These data sets were collected along 2 years in the dermatology clinic of Ghaem Hospital in Mashhad [12–14]. Also, the data sets are available in the web site of UCI Machine Learning

Table 1 – Structure of data sets utilized in this study

Immunotherapy-related data set			Cryotherapy-related data set		
Attributes	Contents	Mean ± SD	Attributes	Contents	Mean ± SD
Gender (41 man, 49 woman)	"1" and "0" corresponding to man and woman		Gender (47 man 43 woman)	"1" and "0" corresponding to man and woman	
Age (year)	Numerical values between 15 and 56	31.04 ± 12.23	Age (Year)	Numerical values between 15 and 67	28.6 ± 13.36
Time elapsed before treatment (month)	Numerical values between 0 and 12	7.23 ± 3.10	Time elapsed before treatment (month)	Numerical values between 0 and 12	7.66 ± 3.4
The number of warts	Numerical values between 1 and 19	6.14 ± 4.2	The number of warts	Numerical values between 1 and 19	5.51 ± 3.57
Types of wart (count)	1", "2" and "3" corresponding to "common", "Plantar" and "both" respectively.		Types of wart (count)	"1", "2" and "3" corresponding to "common", "Plantar" and "both" respectively.	
Surface area of the warts (mm^2)	Numerical values between 6 and 900	95.7 ± 136.61	Surface area of the warts (mm^2)	Numerical values between 4 and 750	85.83 ± 131.73
Induration diameter of initial test (mm)	Numerical values between 5 and 70	14.33 ± 17.22			
Result	Contents		Result	Contents	
Response to treatment	"1" and "0" corresponding to yes and no	19 of them are "0" and 71 of them are "1"	Response to treatment	"1" and "0" corresponding to yes and no	42 of them are "0" and 48 of them are "1"

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