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Review Article

# Role Of Artificial Intelligence in Clinical Diagnosis of Oral Potentially Malignant Disorders: A Scoping Review

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ABSTRACT

Oral potentially malignant disorders encompass a spectrum of lesions that present an increased risk of progressing to oral cancer. Timely and accurate diagnosis, as well as effective risk prediction, are crucial for early intervention and improved patient outcomes. In recent years, the integration of artificial intelligence has emerged as a transformative approach in the realm of medical diagnostics, offering innovative tools to enhance the precision and efficiency of disease identification and risk assessment. Notably, artificial intelligence driven image analysis techniques have demonstrated remarkable potential in interpreting oral lesion images, aiding in the accurate identification of morphological characteristics associated with these oral lesions. This review explores the evolving role of AI in the clinical diagnosis and risk prediction of these disorders.



## Introduction

According to WHO 2022 classification, oral potentially malignant disorders (OPMDs) represent the heterogenous group of clinically-defined conditions associated with a variable risk of progression to oral squamous cell carcinoma. OPMDs are precursor lesions that could become malignant and develop into oral cancer. The 2020 cancer statistics report from India estimated that 66.6% of patients suffering from head and neck cancer were diagnosed at the locally advanced stage [1]. Patients' survival rates and prognosis are seriously impacted when oral cancer patients are identified at later stages, therefore improving early detection should result in a considerable improvement in survival outcomes [2-5]. Early illness detection results in a better prognosis for patients, with a 5-year survival rate of 75% for stage I and a significantly lower rate of 30% for stage IV [6].

OPMDs have a 1% chance of becoming malignant, which may seem like a minimal probability, but developing a malignant lesion increases morbidity and mortality and necessitates more intrusive therapy for the patient [7]. Additionally, the expense of managing oral cancer is three to seven times greater than that of OPMDs, which is noticeably different. Therefore, early diagnosis of these premalignant lesions is crucial because it not only improves survival rates but also lowers treatment costs [8].

It is challenging to accurately diagnose OPMDs due to their clinical manifestations. Their characteristics, which typically manifest as white/red lesions, match those of inflammatory lesions [9-11]. Even skilled professionals can miss these lesions in the oral cavity, which can result in late identification and the progression of premalignant lesions into cancer [12]. Biopsy is the gold standard for verifying the diagnosis of OPMDs. Therefore, it is still important to develop new techniques and technologies to enhance the diagnosis of OPMDs.

The development of machine learning (ML) algorithms in response to the emergence of new AI technical techniques has greatly enhanced the clinical evaluation of OPMDs [13, 14]. The aim of this review is to see the implementation of AI techniques in early clinical diagnosis of OPMDs based on the clinical photographs and moreover predicting the risk of their malignancy transformation by different convolutional neural

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network (CNN) based models. It is anticipated that using these models it would help clinicians to find these lesions, in combined with clinical patient data, to assist in treatment planning, decision-making, and to enhance the referral system.

## Methods

### I Literature Search

Data search was done in two online free databases, namely PubMed and Google Scholar. The MeSH term used were "artificial intelligence and (machine learning) and oral precancerous disease and early diagnosis". Based on the reference lists of the chosen papers and applicable reviews, more search was done to gather information about early detection and screening for AI in OPMDs in the various electronic databases manually/individually. The articles that satisfied the criteria for prediction and detection are used for this review.

### II Inclusion Criteria

Articles which includes the AI based clinical diagnosis of OPMDs and risk prediction, original research articles and articles written in english.

### III Exclusion Criteria

Articles which include histopathology or any surgical method for diagnosis of OPMDs, animal studies and articles written in some different language other than english.

### Review of Literature

OPMDs are frequently disregarded by physicians and patients as well. The likelihood of OPMDs being malignant may not be great. However, rapid diagnosis and treatment will boost the patient's chance of survival [15]. Deep learning (DL), commonly referred to as deep neural networks, has distinguished and categorised anomalies in medical photographs with unmatched accuracy [16]. CNN is the most effective deep learning algorithm in the medical industry because of its accuracy in information analysis and object recognition. Different authors used different CNN based models for clinically detecting the OPMDs and some models also predicts the risk of development of cancer in these cases as mentioned in (Table 1).

**Table 1:** Methods and main findings of AI based models in clinical diagnosis used by various authors.

| AUTHOR | AIMS | SAMPLE | METHODS | MAIN FINDINGS |
|---|---|---|---|---|
| Warin *et al.* [8], (2022) | Evaluated CNN algorithms, classify and detect OPMDs in oral photographs | 600 oral photographs images (300 images of OPMDs and 300 images of normal oral mucosa) | Assessed the most suitable CNN-based classification and detection algorithm models for OPMD detection. | • DenseNet-121 and ResNet-50 are excellent for categorising OPMDs.<br>• YOLOv4 and Faster RCNN performed better in detecting lesions on oral photographic images. |
| Chen W *et al.* [18], (2022) | Estimated cancer risk from oral precancerous lesions using ANN-assisted cancer risk prediction approach. | 230 sample size used in ratio of 7:3 for training & testing sets | BP algorithm was used for predicting the risk of oral cancer in OPMDs cases. | • Accuracy rate of ANN based model algorithm is more than 90%. |
| Phosri K *et al.* [19], (2022) | Developed classification system from 10 comparable pre trained transfer models on oral cavity photographs of white lesions, ulcer and normal mucosa. | 200 images of each oral white lesions, ulcer and normal anatomy | Ten pre-trained transfer learning models were implemented and assessed DenseNet121, DenseNet169, DenseNet201, Xception, ResNet50, InceptionResNetV2, InceptionV3, VGG16, VGG19, and EfficientNetB7. | • Recall of 0.8833 and was performed by the trained models of DenseNet169, DenseNet201, and Xception.<br>• The DenseNet169 performed better than other models in terms of precision, F51score, and specificity, scoring 0.9034, 0.884, and 0.9417, respectively. |
| Lin H *et al.* [17], (2021) | To overcome the difficulties of automatic detection of oral disorders and provide an efficient smartphone-based image diagnosis technique powered by a DL algorithm. | 455 cases(228 normal, 76 apthous ulcer,69 low risk OPMDs,52 high risk OPMDs and 30 oral cancers) | • Retrospective study<br>• Oral cavity images were collected by centered rule image capturing approach<br>• DL network (HRNet) was introduced to evaluate the performance for oral cancer detection. | • Performance attained a sensitivity of 83.0%, specificity of 96.6%, accuracy of 84.3%, and F1 of 83.6%.<br>• "Centre positioning" method performed about 8% better than a simulated "random positioning" method, the resampling method performed 6% better.<br>• HRNet performed marginally better than VGG16, ResNet50, and DenseNet169 in terms of sensitivity, specificity, precision, and F1 score. |

| | | | | |
|---|---|---|---|---|
| Jucryszyn *et al.* [20], (2020) | A useful texture analysis algorithm for diagnosing oral leukoplakia | 35 sample size of leukoplakia patient | Run length matrix and co-occurrence matrix, two textural properties were examined by using ANN, factors were analysed and classes determined. | • Leukoplakia and normal mucosa may be easily distinguished with sensitivity 100% and specificity 97% |

**Discussion**

Precancerous lesions called OPMDs are frequently disregarded by physicians. The likelihood of OPMDs being malignant may not be great. However, rapid diagnosis and treatment will boost the patient's chance of survival [21]. Different scientists use various CNN based models for detection of OPMDs from clinical pictures which are comparable on the basis of sensitivity , accuracy, specificity, AUROC (Area Under the Curve" of the "Receiver Operating Characteristic" curve) and F1 score etc.

Warin *et al.* (2022) concluded that CNN based models DenseNet121 and ResNet-50 are best for categorizing OPMDs with the sensitivity and specificity of 100, 98.39 and 90, 91.67 respectively, while Lin H (2021) preferred HRNet over Resnet-50 and DenseNet 169 and VGG16 [8, 9]. The sensitivity and specificity for HRNet is 83%, 96.6%. Other scientist such as Phosri K (2022) concluded that DenseNet201 and DenseNet169 showed highest testing accuracy of more than 90% and specificity of 0.9417 [17].

Other people used ANN based algorithms like Chen *et al.* (2022) used it for risk prediction in OPMDs and concluded that ANN based algorithms has higher accuracy than traditional methods with accuracy output more than 90% [18], while Jurczyszyn K (2020) used PNN (a type of ANN) for texture analysis of clinical image for diagnosing leukoplakia and got sensitivity and specificity of 100% and 90% respectively [20].

In the current review it is found that the application of AI in clinical diagnosis of OPMDs is at very nascent stage. AI technologies, such as machine learning and deep learning assist clinicians in accurately diagnosing OPMDs and predicting the risk of malignant transformation. The integration of AI into oral pathology and oncology has several notable benefits.

**AI Workflow**

The clinical image of the lesion is taken from smartphone or camera and further processing done. ANN or CNN based models are compared on the basis of there sensitivity, specificity, accuracy, F1 score and AUROC as mentioned in (Figure 1) [22].

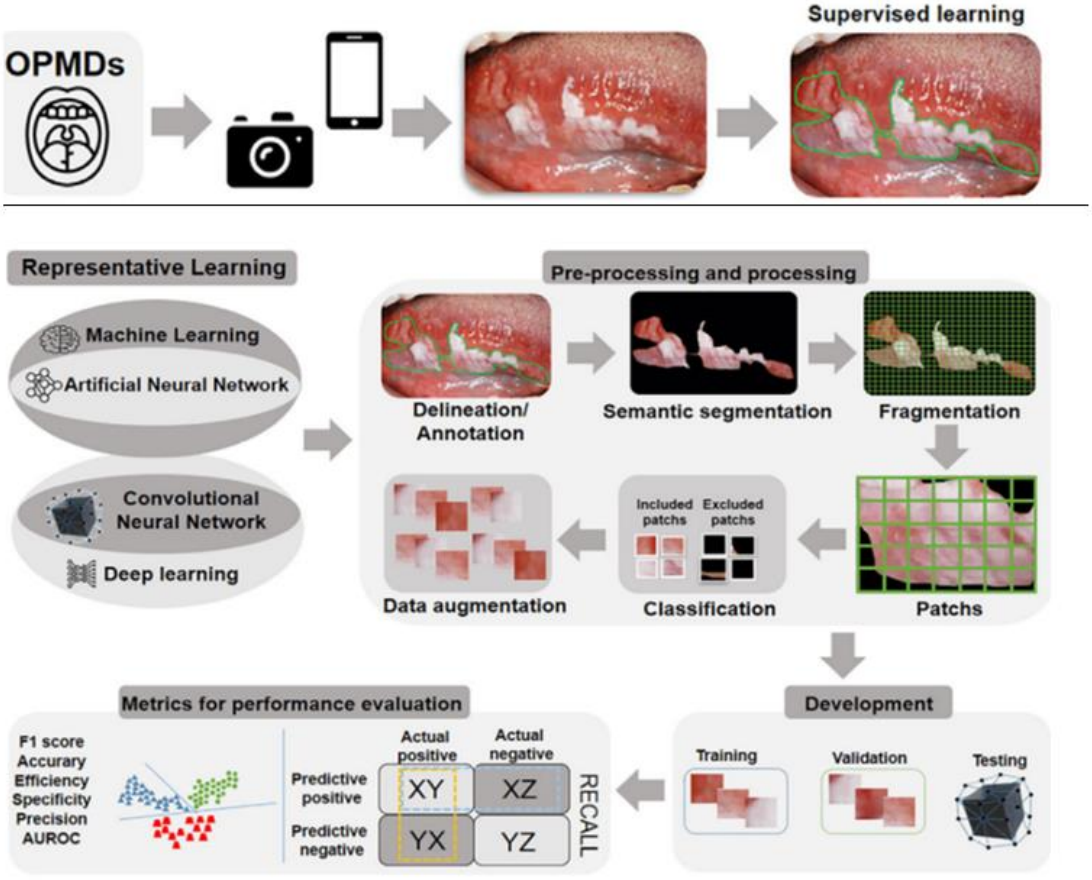


**Figure 1:** AI Workflow chart [22] (Reproduce with License no. 5650591138482 from John Wiley and Sons).

### Advantages of AI in Diagnosing Opmds

Firstly, AI can enhance the efficiency of diagnosing OPMDs by rapidly processing and analysing large amounts of clinical and histopathological data, leading to quicker and more accurate assessments. Additionally, AI systems can help reduce inter-observer variability among clinicians, ensuring consistent and standardized diagnostic results. Furthermore, AI has the potential to identify subtle features and patterns that might be missed by human observers, contributing to early detection of malignancy and improved patient outcomes. By incorporating diverse sources of information, such as medical images, patient history, and genomic data, AI algorithms can provide a comprehensive assessment of the risk associated with OPMDs and offer personalized treatment recommendations. Also patients may get benefits in remote areas where limited doctors /specialist are available.

### Challenges of AI in Clinical Practice

Validating AI algorithms using large and diverse datasets, ensuring interpretability and transparency of AI-generated insights, addressing ethical concerns related to patient privacy and bias, and integrating AI seamlessly into existing healthcare workflows are critical aspects that need careful consideration. In future to robust AI, it should also focus on histopathology, epithelial connective tissue characters, inflammatory cells such as mast cells that show changes during progression of OPMDs [23].

### Conclusion

In conclusion, the application of AI in clinically diagnosing and predicting the risk of OPMDs shows great potential to revolutionize oral healthcare. While there are challenges to overcome, continued research, collaboration between AI experts and healthcare professionals, and the development of robust, validated AI systems can lead to improved diagnostic accuracy, early intervention, and ultimately better patient outcomes in the realm of oral health.

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