

PERFORMANCE OF AUTOMATED CLASSIFICATION OF DIAGNOSTIC ENTITIES IN DERMATOPATHOLOGY

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ABSTRACT

Introduction

- More people are diagnosed with skin cancer each year in the U.S. than all other cancers combined.
- Misdiagnosis and late diagnosis are the repercussions of high workloads and differentiation difficulty resulting in frequent disagreement among pathologists.
- Mechanomind developed a software based on deep-learning algorithm to classify 40 skin tumor types to address the error rate associated with human medical image interpretation and to capture efficiency gains in terms of turnaround times and labor cost.

Hypothesis

- Convolutional Neural Network multi-class classification of tumor types can reach clinical grade accuracy in real world pathology environment.

Methods

- Retrospective study to compare previously diagnosed H&E glass slides by two senior board certified pathologists not involved in algorithm creation with an algorithm answer.
- 300 glass slides (1 slide per patient case) from 4 hospitals in the US and Africa.
- The study was designed to emulate real world pathology examination situations including the most common inferiorities in tissue preparation, staining, and scanning of glass slides.

Results

- The performance of the image recognition algorithm is detailed in Results section.

Conclusion

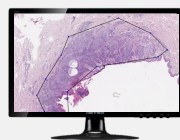
- High specificity and sensitivity algorithms appear to be ready for use in screening, quality assurance, and workload distribution.

BACKGROUND

Algorithm development

- The system receives as an input a WSI and produces probability scores for each of 40 classes.
- Two-staged analysis – local and global with multiple-magnification approach.
- Factor in color and cell size variations.

Resulting software system

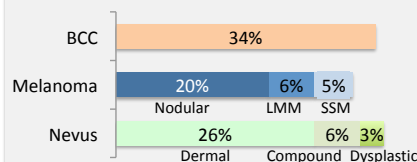


- WSI of H&E slides
- Detection and classification of skin tumor types
- 10-20 sec per image

- No patient or clinical data required.
- Image quality agnostic (presence of artifacts, variability in staining and scanning quality)
- Scanner and file format agnostic.

METHODS

- 300 punch, shave, and excisional biopsy cases of face, neck, back, and arms.
- 87% of the cases were acquired from Midwest United States pathologists in the Chicago area, from Caucasian population.
- 9% of the cases were acquired from Tanzania, and 4% of the cases were from Rwanda, from African population.
- The slides had notable variability in quality of staining, histology and contained artifacts such as folds and ink markings, and represented real world pathology lab conditions.
- Reference diagnoses:



RESULTS

	Melanoma	Nevus	BCC
Sensitivity	97.8%	100.0%	99.0%
Specificity	97.5%	97.8%	100%
PPV	94.7%	96.4%	100%
NPV	99.0%	100.0%	99.5%
# cases	91	107	102

- One of the cases initially misdiagnosed by primary pathologist as melanoma was correctly recognized by Mechanomind algorithm as nevus.

- Diagnoses were initially diagnosed by light microscopy and confirmed by board-certified pathologists using digital pathology.
- No patient identification, history, and no clinical or macro examination information was available in the process.
- Glass slides were scanned using Motic Digital Pathology EasyScan Pro6 and Ventana iScan Coreo, both set at "40X" magnification.
- The scanned whole slide images were then independently interpreted by the Mechanomind image recognition algorithm at the University of Chicago, Ingalls Memorial Hospital medical campus and classified into one of 3 diagnostic classes: BCC, Melanoma or Nevus.
- Each whole slide image took 10 to 20 seconds to analyze
- Two senior board-certified pathologists served as the primary evaluators

DISCUSSION AND CONCLUSIONS

- While additional studies with more lesion types, more cases, and more pathologists are needed, high specificity and sensitivity algorithms appear to be ready for use in primary diagnostics as support tools:
 - Caseload triage in accordance with diagnostic difficulty and optimal distribution of pathologists' workloads which can reduce examination turnaround times and labor costs associated with the diagnostic process, enable remote work and outsourcing, unburden senior specialists from reviewing simple cases
 - 100% quality control, selection of 2-5% of discordant cases for quality assurance
- Deep learning techniques applied to diagnostic entities can -
 - Solve the shortage of pathologists worldwide
 - Improve diagnostic accuracy and turnaround times
 - Raise the standards of care
 - Reduce healthcare costs
 - Scale diagnostic expertise to underserved locations
 - Improve access to quality care

