Mechanised Triage: A Pilot Study Investigating the Role of Machine Learning to Triage Penile Lesions

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INTRODUCTION

enile squamous cell carcinoma (PSCC) is a rare disease with devastating psychosocial consequences. Early recognition and treatment are paramount to preserving function and long-term survival. However, many men present with advanced disease due to a lack of awareness, social stigma, and limited access to culturally appropriate care. There is an urgent need to reduce barriers to subspecialist penile cancer care, especially for men from low socioeconomic backgrounds. Machine learning combined with smartphone photography has demonstrated growing utility by outperforming clinicians in diagnosing skin cancer. This project aims to evaluate the accuracy of an artificial intelligence algorithm for stratifying penile lesions.

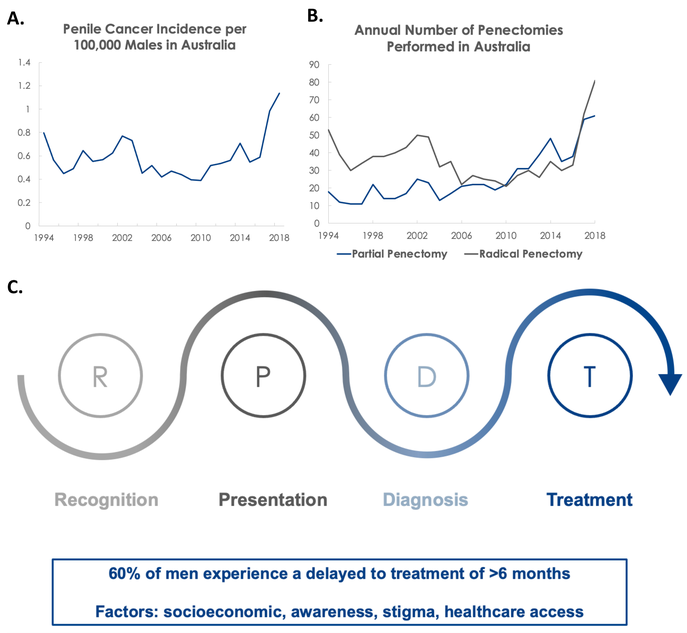

Figure 1: Project Background
Penile cancer incidence in Australia from 1994 to 2018 based on Cancer council data. B. number of penectomies in Australia from 1994-2018 highlighting the increasing operative incidence of PSCC. C. Patient barriers to accessing sub-specialist PSCC care

METHODS

A Google image search was performed for high-quality colour images of penile lesions in peer-reviewed English language articles with a formal diagnosis discussed within the article. The search terms used were "penile cancer", "penile squamous cell carcinoma (SCC)", "penile lesion", "benign penile lesion", "penile carcinoma in situ (CIS)", "penile neoplasm in situ (PeIN)". Images that fit inclusion criteria were downloaded as JPEG files and categorized as benign, pre-malignant, and penile SCC. Two penile cancer subspecialist urologists independently reviewed all images to confirm categorization. A deep learning algorithm was created to extract and automatically segment images into pixels. Contours of pixel edges were used to generate a "mask" representation of the lesion from normal skin. Features such as lesion elevation, erythema, ulceration, redness, and irregularity were extracted and compared. A hold-out validation methodology was performed for training and internally assessing accuracy.

ALGORITHM DESIGN & VALIDATION

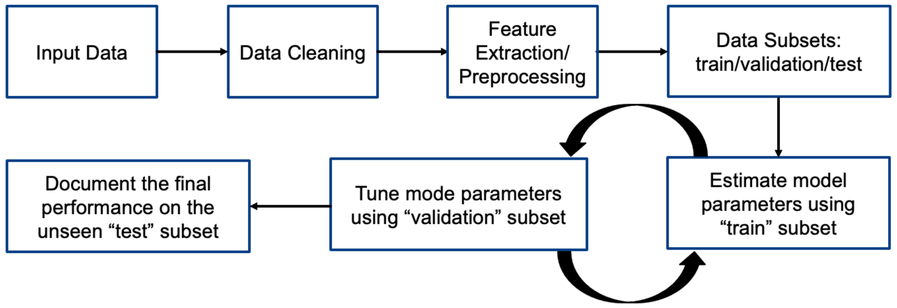

Figure 2: Machine learning workflow
Raw photos are digitally broken down into pixels or groups of pixels and given a weighted average of what output they belong in. As the algorithm sees more photos during "training" these weights change and the accuracy for which box the image belongs gradually improves.
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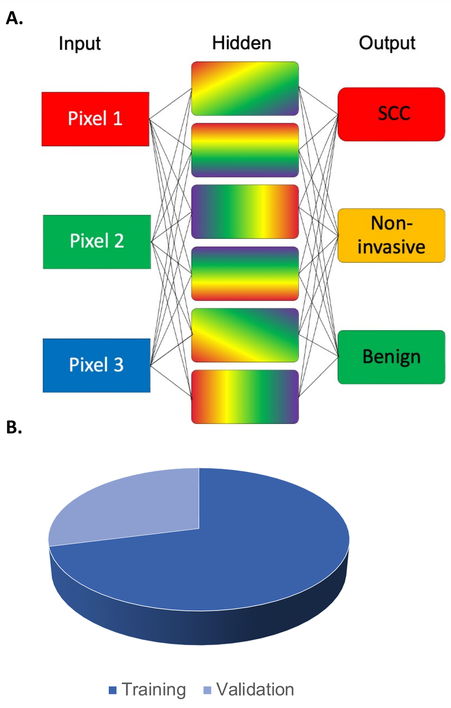
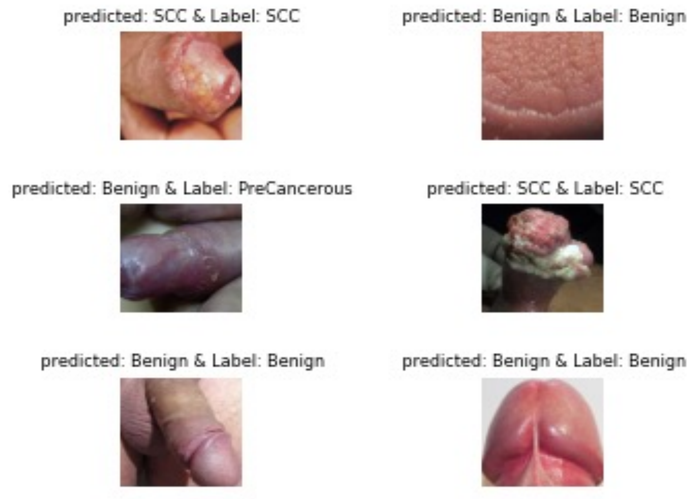


Mature technology where data learns from itself

Total Images 138
Training Subset: 98 images
Validation Subset: 40 images

Figure 3: Analysis of Presentations by Type and Presenter
A. A model of the PSCC AI neural network where input layers (pixel or groups of pixels) are given a weighted probability of correctly aligning with the defined output. Overall, this is a mature technology with a novel application for PSCC risk stratification.
B. The proportion of training and validation subsets of images.

RESULTS



Validation accuracy: 87.5%

Figure 4: AI prediction vs Correct Label
Overall accuracy was found to be close to 88% - which we think may be on par with clinicians. Algorithm accuracy was highest for for benign and overt SCC.However, where the algorithm struggles is with precancerous/superficially invasive lesions

CONCLUSION

- The first study in English literature to identify the role of artificial intelligence in accurately categorizing penile lesions.
- Penile lesions beneath non-retractile foreskin were identified as a limitation for image-based PSCC detection.
- Further image incorporation and validation with clinical images from electronic medical records are underway.
- An opportunity exists to refine artificial intelligence as an education, triage, and referral optimization tool via a smartphone application.
- In the future, artificial intelligence may help to lower barriers to accessing sub-specialist penile cancer care globally.

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