Abstract

Image Quality Assessment Using a Convolutional Neural Network for Clinical Skin Images

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Abstract

Background: The quality of the images received for teledermatology evaluation is often suboptimal, with up to 50% of patients providing images that are poorly lit, off-center, or blurry. To ensure a similar level of care to in-person consultations, high-quality images are essential.

Objective: The aim of this study is to develop an image quality analysis tool to assess patient- and primary care physician (PCP)–derived images using a deep learning model leveraging multiple instance learning and ordinal regression for model predictions.

Methods: The data set used for this study was acquired from patient-derived images submitted to the Department of Dermatology, Duke University, between August 21, 2018, and December 31, 2019, and PCP-derived images between March 1, 2021, and June 30, 2022. Seven dermatology faculty members with a designation of professor, associate professor, and assistant professor evaluated 400 images each, and 2 dermatology residents evaluated 400 images, assuring that each image had 4 different quality labels. We used a pretrained model VGG16 architecture, further fine-tuned by updating weights based on the input data. The images were taken with cell phones (patients) or cameras (PCPs) in RGB scale, with the resolution being 76 pixels per inch for both height and width, and the average pixel size of the image being 2840×2793 (SD 986×983; 1471 inch^2, SD 707 inch^2). The optimal threshold was determined using the Youden index, which represents the best trade-off between sensitivity and specificity and balance the number of true positives and true negatives in the classification results. Once the model predicts the rank, the ordinal labels are transformed to binary labels by using a majority vote as the goal is to distinguish between 2 distinct categories (good vs bad quality) and not predict quality as a continuous variable.

Results: Based on the Youden index, we achieved a positive predicted value of 0.906, implying that the model will predict 90% of the good-quality images as such, while 10% of the poor-quality images are predicted as being of good quality to enhance clinical utility, with an area under the receiver operating characteristic curve (AUC) for the test set at 0.885 (95% CI 0.838-0.933) and sensitivity, specificity, and negative predictive value (NPV) of 0.829, 0.784, and 0.645, respectively. Further evaluation on independent validation consisting of 300 images from patients and 150 images from PCPs revealed AUCs of 0.864 (95% CI 0.818-0.909) and 0.902 (95% CI 0.85-0.95), respectively. The sensitivity, specificity, positive predicted value, and NPV for the 300 images were 0.827, 0.800, 0.959, and 0.450, respectively.

Conclusions: This study shows a practical approach to improve image quality for clinical decision-making. While patients and PCPs may have to capture additional images (due to lower NPV), this is offset by the reduced workload and improved efficiency of clinical teams due to the receipt of higher-quality images. Additional images can also be useful if all images (good or poor) are transmitted to medical records. Future studies need to focus on real-time clinical validation of our results.

Conflicts of Interest: None declared.

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KEYWORDS

teledermatology; image quality assessment; deep learning; convolutional neural network; artificial intelligence; AI

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Multimedia Appendix 1

Overview of the Image Quality Assessment (IQA) network architecture. The input images are partitioned into smaller region and are processed through the neural network architecture. The resulting outputs are aggregated, and a threshold criterion is applied to determine whether the image is accepted (good quality) or rejected (bad quality).
[PNG File , 200 KB-Multimedia Appendix 1]

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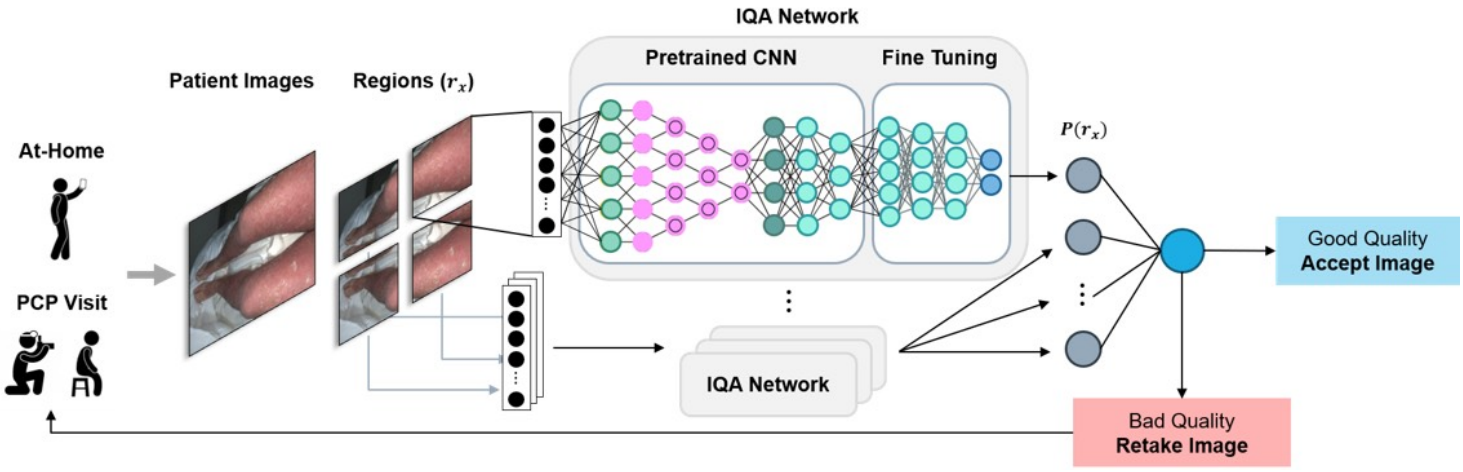

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Hormonal profile of androgenetic alopecia in adolescents and its association with metabolic dysfunction: single center retrospective study

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Androgenetic alopecia (AGA) has not been commonly reported in adolescents compared to adults. As puberty has shifted toward younger ages, early recognition of AGA and changes in androgen or metabolic function are paid more attention. So we investigated the clinical features and hormonal profile of AGA in adolescents. Based on the clinical and trichoscopic findings, 21 subjects (8 boys and 13 girls) were enrolled. Mean age was 16.1 years and family history of AGA in first- or second-degree relatives was observed in 61.9%. Diffuse thinning at crown with frontal hairline preservation was most common (61.9%), followed by vertex and bitemporal thinning (28.6%) and 'Christmas tree' pattern (9.5%). Acne was accompanied in 10 (4 boys and 6 girls) with mean severity score of 1.8 and 1.1 respectively. Total/free testosterone (T) and dehydroepiandrosterone sulfate (DHEA-S) were normal in boys. However, 2 girls showed elevated total T and DHEA-S, while 5 girls only in DHEA-S. Nine subjects (3 boys and 6 girls) showed elevated random insulin or concurrent type 2 diabetes mellitus (DM). Five girls satisfied the Rotterdam criteria of PCOS, while 4 girls, who showed abnormal androgen profile and metabolic dysfunction (increased random insulin or concurrent DM), did not. Adolescents with AGA showed different androgen profile between boys and girls, while concurrent metabolic dysfunction was observed similarly in both sexes. It is suggestive that AGA in adolescents should be dealed differently by their sex and distinguished from adult. Especially in girls, the features of hyperandrogenism and metabolic dysfunction should be carefully investigated.

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Identification of Demographic and Clinical Features Associated with Multi-Biologic Failure in the CorEvitas Psoriasis Registry

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Clinical providers often face difficult-to-treat psoriasis patients who have failed multiple biologic agents and classes. Our objective was to identify patients with multiple biologic failure (MBF) and risk factors for MBF in the CorEvitas Psoriasis Registry. We included plaque psoriasis patients who initiated their first biologic therapy during registry enrollment and had ≥2 years of follow-up (2015-2022). We defined MBF as medically failing ≥2 biologic classes (TNFi, IL12/23i, IL17i, IL23i) with ≥90 days of treatment, and good response (GR) as ≥24 months of continued use of first biologic. Socio-demographics, lifestyle characteristics including comorbidities, psoriasis disease and treatment characteristics, and patient reported outcomes were assessed at first biologic initiation. To identify independent risk factors for MBF vs GR, a multivariable logistic regression model was constructed. The final model included a priori selected variables (age, sex, race, ethnicity, BMI) and others retaining statistical significance of P<0.10. Among the 1,039 biologic-naïve initiators, 65 (6%) were MBF and 490 (47%) were GR, mean age was 49 years, 44% were women and 78% were white. Variables independently associated with MBF included female sex (OR=2.29; 95% CI: 1.11, 4.72), hyperlipidemia (OR=3.14; 95% CI 1.35, 7.30), Medicaid insurance (OR=4.53; 95% CI 1.40, 14.63), and prior non-biologics use (OR=2.47; 95% CI: 1.16, 5.25). Year of first biologic and shorter psoriasis duration were independently associated with MBF, likely reflecting secular trends in biologics availability. These findings identify a subset of psoriasis patients who are more likely to experience MBF and who may warrant more intensive follow-up with their providers.

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https://www.youtube.com/watch?v=bMz1RLn4lHE

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ICI Therapy Toxicities in Psoriasis

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Background: Immune checkpoint inhibitors (ICIs) are immune-modulating therapies used to treat a broad spectrum of malignancies. ICIs confer unique toxicity profiles which can lead to immune intolerance and immune-related adverse event (irAEs) in multiple organ systems. While effective, ICI therapy can impose adverse side effects in patients with immune-mediated disease. Therefore, our aim is to better understand the toxicity profile of ICI therapy in patients with psoriasis. Design TriNetX, a national multi- centered database composed of medical records from over 100 million patients across 69 healthcare organizations, was utilized in this retrospective cohort study. Two cohorts of patients were identified from the database: A cohort of patients who are receiving ICI therapy with a and without history of psoriasis. Then, 1:1 propensity score matching (PSM) analysis was utilized to balance each cohort by age, sex, race, and BMI. After matching, 1-year outcomes for cardio-, nephro-, gastrointestinal, endocrine, respiratory, ocular, hematological, hepato-, musculoskeletal, and neurological toxicity were assessed using adjusted hazard ratios (aHR) with 95% confidence intervals (CI).

Summary: There were a total of 58,099 patients who received ICI therapy on TriNetX, of which 1,151 had a history of psoriasis. After PSM, two balanced cohorts of 1,151 patients were compared in this study. Patients treated with ICI therapy with a history of psoriasis had greater odds for gastrointestinal toxicity (aHR[95%CI]=1.5 [1.19,2.06]) and endocrine toxicity (1.33[1.05,1.69]) within one year of initiation of ICI therapy.

Conclusion: Patients on ICI therapy with history of psoriasis have higher odds of developing gastrointestinal and endocrine toxicities.

Commercial Support: NA.

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Image Quality Assessment using Convolutional Neural Network in Clinical Skin Images

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Introduction: Convolutional neural networks (CNNs) can detect image characteristics such as blurriness, contrast, and exposure in clinical images and can be utilized for real time image quality feedback to streamline clinical workflows via an Image Quality Analysis (IQA) model.

Methods: CNN was trained for ordinal classification (quality rating from 4 reviewers) on 900 images and with 120 and 180 images used for validation and testing, respectively. The images were tested by the IQA model as whole image first. If it failed, it was tested for region of interest (ROI) analysis. We performed statistical analysis to achieve positive predictive value (PPV) of 0.9. Thus, the threshold for the model was selected based on this criterion in order to reduce the number of bad clinical images to 1 in every 10.

Results: At PPV of 0.9, the sensitivity, specificity, and NPV were 0.71, 0.84, and 0.52 respectively, with an AUC of 0.86 for the test set. With ROI analysis on the images that failed whole image test, the sensitivity and NPV increased to 0.82 and 0.64 respectively, while the specificity dropped to 0.78.

Conclusions: Our IQA model was able to assess patient derived images as useful or bad quality. Further validation studies will be required to determine whether the model can be generalizable real-world images taken in both primary care and at-home settings.

Commercial Support: NA.