doi:10.36849/JDD.8213e

The Future of Machine Learning Enabled Technologies for Hair Loss Treatment

Hafsah Sheikh HBSc,[a] Eric McMullen MD,[b] Kyle Storm BSc,[c] Jeff Donovan MD PhD[d,e]

[a]School of Medicine, Queen's University, Kingston, ON, Canada
[b]Michael G. DeGroote School of Medicine, McMaster University, Hamilton, ON, Canada
[c]School of Health, University of Waterloo, Waterloo, ON, Canada
[d]Department of Dermatology, University of British Columbia, Vancouver, BC, Canada
[e]Donovan Hair Clinic, Whistler, BC, Canada

INTRODUCTION

To develop reliable diagnostic methods and more effective hair loss treatments, researchers are exploring technologies like machine learning (ML), a subset of artificial intelligence (AI). ML analyzes data and makes decisions using preprogrammed algorithms. While still in its infancy, ML may help clinicians curate unique, personalized treatment approaches. Current research indicates promise of ML in diagnosing specific types of hair loss, personalizing therapeutic interventions, and objectively evaluating treatment response.

For example, the ARTAS Robotic System, an FDA-approved AI technology to surgically treat hair uses ML. First approved in 2011, ARTAS identifies and excises ideal donor hair follicles for hair transplantation with minimal scarring.[1] ARTAS also predicts ideal recipient sites for these extracted follicular units (FUs) by combining data from various angles, assessing densities and FU locations, and compensating for skin movement. When configured by the physician, this technology can harvest upwards of 500 to 1000 grafts per hour and create 1500 to 2000 recipient sites per hour.[1] The multicenter, prospective, and blinded trials that led to FDA clearance of ARTAS showed transection rates (damage when extracting follicles) with ARTAS average around 6.6%, which is comparable to an experienced hair transplant surgeon and considerably lower than a novice practitioner. Therefore, ML could address the steep learning curve in the field of hair transplantation.

A recent study successfully utilised ML to create superoxide dismutase (SOD) nanozyme mimics to treat androgenetic alopecia in a mouse model.[2] These mimics removed reactive oxygen species-induced oxidative stress that damages hair follicles and leads to hair loss. ML models tested 91 combinations of transition-metal thiophosphate compounds to synthesise nanosheets, and predicted optimal SOD-like function of $MnPS_3$.[2] When applied to mice, the treatment showed 1.92 times greater hair coverage on day 12, and significant regrowth of thicker hair on day 13 versus mice treated with minoxidil.[2] The results suggested potential for ML in designing nanozymes to treat hair loss.

Deep learning (DL), a form of ML, has shown promise in evaluating treatment responses.[3] A DL image-based model was trained to non-invasively quantify hair and follicle counts on patients with differing hair types. The authors' model reported good accuracy in assessing hair counts compared to human evaluators, with differences of +1.6% in hair counts, and –8.7% in follicular counts.[3] Another study employed an image-based ML model using trichoscopic images to predict treatment response in patients with alopecia areata (AA).[4] 80% of patients predicted to be AA non-responders showed no significant treatment response, and 81% of patients predicted to be responders showed a positive treatment response.[4]

Finally, ML algorithms were implemented in multiple studies to identify gene biomarkers in patients. The algorithms were accurate in predicting which AA patients will progress to severe disease, with values ranging from 0.76 to 0.87.[5] In hair loss treatment, ML influences therapeutic development, disease assessment, and treatment response.

Despite their perceived potential to evaluate treatment response at levels matching human evaluators, these ML applications are very specific. To date, there are no available technologies that can replace an experienced clinician.

DISCLOSURES

The authors have no conflict of interest to disclose.

REFERENCES

1. Anastassakis K. Future Trends in HRS. In: Anastassakis K, ed. *Androgenetic Alopecia From A to Z: Vol.3 Hair Restoration Surgery, Alternative Treatments, and Hair Care.* Springer International Publishing; 2023:577-591. doi:10.1007/978-3-031-10613-2_37
2. Zhang C, Yu Y, Shi S, et al. Machine learning guided discovery of superoxide dismutase nanozymes for androgenetic alopecia. *Nano Lett.* 2022;22(21):8592-8600. doi:10.1021/acs.nanolett.2c03119
3. Urban G, Feil N, Csuka E, et al. Combining deep learning with optical coherence tomography imaging to determine scalp hair and follicle counts. *Lasers Surg Med.* 2021;53(1):171-178. doi:10.1002/lsm.23324
4. Alarcón-Soldevilla F, Hernández-Gómez FJ, García-Carmona JA, et al. Use of artificial intelligence as a predictor of the response to treatment in alopecia areata. *Iproceedings.* 2021;7(1):e35433. doi:10.2196/35433
5. Xiong J, Chen G, Liu Z, et al. Construction of regulatory network for alopecia areata progression and identification of immune monitoring genes based on multiple machine-learning algorithms. *Precis Clin Med.* 2023;6(2):pbad009. doi:10.1093/pcmedi/pbad009

AUTHOR CORRESPONDENCE

Jeff Donovan MD PhD
E-mail:.................……......................... office@donovanmedical.com