# Artificial intelligence in trichology - usage and prospects

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## Abstract

**Introduction:** This article presents possible applications of AI in trichology services, depicting opportunities and challenges for practitioners.

**Material and methods:** The authors have made an inquiry into existing literature regarding how AI is used in hair loss consultancy and treatment with particular focus on trichology. The authors have used a descriptive method of analysis.

**Results:** The results show that the AI can be used for diagnostics, treatment supervision, customer contact, marketing automation in trichology services, but legal aspects should be particularly looked into.

**Summary and conclusions:** AI is a novel and promising technology in chosen areas of trichology services, according to literature, yet, with little evidence in the Polish market.

**Keywords:** artificial intelligence, trichology, hair loss diagnostics

## Introduction

The topic of artificial intelligence (AI) has been known – at least in technical means – since 1950s (Nillson, 2009). As a philosophical concept artificial intelligence takes us back to 17th century when Descartes predicted the problem faced nowadays, coined the term of 'actor', an artificial object that could to some extent mimic human intelligence. Since then, AI has been developed into variety of forms, where a basic division between narrow and broad (general) AI stipulates how this technology can be applied. On one hand, general AI is to imitate and overreach human skills and capabilities, yet, it still is a technology to see in future. On the other hand, narrow AI, which is destined for basic (narrow pur-

poses) may slowly cease to satisfy users, as they seek quicker and more reliable performance (Duin & Pedersen, 2023).

Such a shift in demand for AI is also observed in medicine. The very issue of AI uses in medicine dates back to late 1990s (Altman, 1999). Generally, AI is expected to support diagnostic procedures, analyse data. Furthermore, AI is sought for in the back-office operations: help with communication with patients and make auxiliary operations in the area of marketing and sales (particularly in the private medical sectors). In contrast with these expectations and unraveled potential of AI, this topic also raises questions regarding how to solve various regulatory problems, and how not to use AI, if this was ever to generate any legal breaches (Kaźmierczyk et al., 2022).

In global scale, the AI market has been estimated to be worth 456 billion USD in 2022, with expectation to increase five-fold till 2023 (2,5 trillion USD) (Precedence Research, 2023). Such future-oriented assessments may leave no other possibility for the healthcare sector and its subsectors, but to adopt and use the AI. Still, however, it is an open-ended question on how such a process could be carried out.

For example, Stiglitz and Korinek (2019) explain that for the economy it may be better to adjust (slow down) the pace of AI development and application, since it needs multidimensional adjustments from consumers/citizens, businesses and the public sector. Also, there are risks of increased in unemployment. Nevertheless, this requires us to see the issue from the other way around: how AI can help in high-skills deficit trades, such as in the field of medicine.

From this point of view, AI may be a promising agent in trichology, which could help trichologists, when working with their customers-patients. It is, therefore, reasonable to discuss how AI could be employed by trichologists. The aim of this article is to show the possibilities for the use of AI in trichology services alongside key opportunities and challenges.

## Main body

### AI in medicine

When the healthcare sector is assessed as a market for AI solutions, OECD (2024) estimates that it has been worth 11 billion USD on a global scale in 2021, with the projections for 2023 with 188 billion USD. This may suggest that healthcare sectors around the world, including Poland, are expected to harness the power of AI. In the field of medicine, International Telecommunication Union (2018) sees that AI investment may deliver two possible results: substitution of workforce by AI-related capital investment, and/or increased effectiveness of key medical professionals who – owing to AI - may be able to focus on their core tasks, and leave time-consuming, yet, burdensome tasks to the algorithm. From the patient perspective, a more effective communication and care may be expected.

It may be taken in similarly, that Buch et al. (2018) claim that AI is unlikely to replace physicians, but possibly it will do so with less trained occupations used in the healthcare sector. These authors also state that AI may excel at some

tasks in healthcare sector, but these tasks need to be precisely defined and a high degree of training provided and there must be data in order to achieve such results.

Trichology as a field of application of AI

The authors of the article postulate that trichology is an area of AI applications in the following areas:

- Personalised treatment plans,
- Diagnosis and detection,
- Hair transplantation and regrowth,
- Treatment supervision and monitoring,
- Customer contact,
- Marketing automation.

## Trichology diagnostics and detection

Prospects for the applicability of AI in trichology diagnostics stem from the previous experience in the field seen in dermatology (Shpudeiko et al. 2022). By the focus and scope of tasks, trichology is associated with dermatology (Siemiątkowska, 2020), therefore what has been achieved in either of them, may be checked for reproduction in the other one.

In relation to dermatology, there have been a series of successful application of AI: when AI was based on the neural network, it was taught to recognise 26 common skin disorders, or oncologists with AI algorithm have been able to classify malignant skin tumors more accurately than humans alone (Shpudeiko et al. 2022).

Jain et al. (2024) discuss broadly how AI could be employed in trichology diagnostics, specifically in trichoscopy and trichograms with some additional support from deep learning models. These authors state opinion on the positive outcomes of such an applications, however, they point out that this field still needs to be carefully looked into, as AI-based image processing models are not so efficient that there is full reliability of such solution. Computer vision, image analysis and AI could also be applied to a separate hair, scalp or hair + scalp diagnosis and assessment. The previous research on these diagnostic configurations have been proven to be efficient and effective. The efficiency describes how the application of AI combined with computer vision or image analysis can work fast with the uploaded data. Effectiveness of AI in these diagnostic settings may be measured as successful accomplishment of the ordered diagnostic procedure, as well as completeness and accuracy of the conducted diagnostics (Tiwari et al., 2023).

A confronting view comes from Gao et al. (2022) who have developed and studied an AI-propelled algorithm to analyse trichoscopic image analysis and quantitative model to assess and measure hair loss in male androgenetic alopecia patients. This team has confirmed predictability and quantifiability of results using this solution. The same can be said about a previous study (Bernardis and

Castelo-Saccio, 2018), where an AI programme has been developed in order to measure hair loss and adjust it to SALT hair loss severity score. This means that the AI usability in trichology services does not only cover diagnosis, but also detection and assessment of various pathological conditions.

To back this up, Alarcon-Soldevilla et al. (2021) have studied a predictive AI which was used to assess possible outcomes of treatment in alopecia arreata. This study has shown that trichoscopic images may serve as a predictor of how alopecia arreata may develop, or how effective the targeted treatment may be. Despite satisfactory results (90% conformance), authors have underlined that this solution still needs development: data from larger population samples should be collected for the purpose of algorithm training. Katoulis (2024) provides evidence that AI in trichology may not only be applied in diagnosis and assessment of macroscopic object (hair + scalp in overall, in other words: larger area of the head), but also microscopic objects, where the observed indicators are different and require more potent optical devices, and these indicators are i.e. hair density and hair diameter. In addition, Sultanpure et al. (2024) prove that this would be possible, when AI could stretch is operability between macroscopic and microscopic objects in head scalp hair+skin diagnostics by using various methods of deep learning, such as convolutional neural networks.

In a wider perspective, Gupta et al. (2021) present various AI applications in dermatology and trichology. This is rather user- than diagnostics-, or treatment-based approach, in which AI is used for hair and head skin diagnostics, and restoration (trichologist as a user) and for self-diagnosis (patient as a user).

In the market, such solutions have started to appear and are now available for trichology service providers. The example of such product is Haircosys, an AI-propelled system for trichology hair and scalp diagnostics and detection that provides: hair evaluation, skin evaluation, and quantitative analysis of the skin/hair health status. This programme also provides data analysis and reports, as well as suggestions for treatments. The commercial side of Haircosys are marketing and sales modules (customer relations management, membership and reward systems, communications and customer service functions, as well as ecommerce functions) (Haircosys, 2025).

### Personalised treatment plans

Personalisation has become a very influential and prospective paradigm in all health- related areas, specifically in medical treatment. The potential of personalisation can be harnessed mainly due to the development, proliferation and magnified analytical power of ICT. Addition of AI to this setup, may only magnify possibilities to deal with clients and patients in an increasingly personalised manner (Prainsack, 2017).

Dermatology as the field of medical sciences, that holds the closest affinity to trichology services has already used and benefited from various personalisation solutions in AI in patient test and pilot studies. Dermatology sees potential in the use of AI as a blended technological means that is to analyse data from

documentation, data from diagnostic devices, mobile apps, images and other sources in order to formulate recommendations for treatment plans. It should be emphasised that AI in dermatology may help analyse clinical data (clinimetrics) and data from questionnaires and various scales for psychometric profiling and assessment (psychometrics) which may altogether create pre-treatment planning synergies (Wongvibulsin et al., 2022).

Personalisation has been proposed as one of the key directions for the development and growth of trichology services, long before AI could be considered in the same field. The reasons why personalised treatment has always been desired and sought for, could be associated with often great complexity of skin and hair disorders, and many variables having an impact on disorder progression, salvaging treatment, monitoring of the healing process (Iman, 2024). The need for personalised treatment in trichology does not only stem from the quest for optimisation and better results. Markiewicz and Idowu (2018) claim that due to migration, the genotypical landscape of potential patients may be as blended as never before. Due to this screening of such patients should be more complex, and treatment plans should also acknowledge ethnic (genotypical) variety.

The most popular approach to personalisation in trichology services could be the digital twins approach. This approach is concentrated on generating with the use of AI and other technological means, a digital 'impersonation' of skin and hair of a patient that can be easily and thoroughly analysed towards assessment of condition, and possible treatment directions. In the setting of trichology services this could possibly mean that the patients could be consulted and treated by the trichologists alone, or there could be a field for the needed interdisciplinary approaches due to needed antibiotics therapy, hormonal therapy, or even genetic screening, which in such case would require involvement of medical doctors (Haykal, 2025).

## Hair transplantation and regrowth

Hair transplantation and regrowth may be considered as one of the critical areas of responsibility in trichology services, taking into account the importance of success, and elevated risks on the side of the patient. Regenerative trichology is also one of the very important service segments, likely more than preventive and protective trichology services, which are concentrated on hair and skin enhancement. The key variables in hair transplantation and regrowth is the assessment of the hair on the head, regrowth rate, condition of transplanted hair (Arora & Mysore, 2025).

It should be noted that in the legal framework for trichology services, hair transplantation cannot be administered and performed by trichologists, but only by the hair transplant surgeons. Trichologists can be allowed to perform trichoscopy and other diagnostic procedures prior to the final surgical treatment. But in business practice, both surgeons, dermatologists and trichologists often work in the same facility, composing interdisciplinary teams which could benefit from AI. In this case, an AI engine could play an auxiliary role in the process, by stock-

ing, transforming and analysing all the data, from diagnostics, treatment and monitoring phases, in order to help alleviate side effects, and extent the life of transplanted and regrown hair (Gupta et al., 2021).

### Treatment supervision and monitoring in trichology

AI in the service steps dedicated to treatment supervision and monitoring offers a wide range of data-based solutions which could help supervise how fast and seamless patients regenerate during or after the conducted treatment. Mobile apps and various devices may monitor various metrics which do not only measure hair and skin conditions. Potentially, this may include dietary habits, lifestyle, environment, work organisation, genetics and epigenetics. In such a holistic approach combined with dynamic growth of AI applications, the success rate on the side of trichologists and their clients may at least steadily, but noticeably grow during the years and decades to come. In such a case allorhythmia approach to design of AI solutions in supervision and treatment may be implemented to see correlations between dietary intakes and hair condition, etc. (Kololgi & Lahari, 2024).

Treatment supervision is a multi-faceted concept, since it may involve supervision of a lower-grade specialist by a more experienced or higher-rank colleague, or between physicians and other medical staff (nurses, physiotherapists, diagnostic technicians, etc.). Further, treatment supervision may describe relation between a person from a medical personnel and patient (Owen & Shohet, 2012).

From this point of view, it may be discussed how AI could be given a task to supervise treatment by overseeing performance of trichologists, or compliance of patients, who have been prescribed various therapeutic means (hygiene tasks, usage of specific active substances, at a pre-determined time of the day, frequency, etc.) (Matysek-Nawrocka et al. 2018).

Treatment supervision by AI could have some supportive effect for trichologists, since AI programmed to see into patients' prescribed activities and tasks could take communicative and coordinating action. This could be done with messages sent to patients (reminders, notices) or to trichologists responsible for treatment (i. e. confirmations that patients follow treatment procedure accordingly). This may suggest that AI could be integrated with web-based or mobile apps, where patients could educate themselves on key areas (hygiene, diet, lifestyles for healthy head scalp skin, etc.) or they could report that a specific procedure is followed (use of specific shampoo, or pills with active substances, etc.) (Bhogireddy, 2023).

In interdisciplinary teams, trichologists and dermatologists could use AI in prediction of potential effects of the prescribed drugs. Kim et al. (2024) have used AI in treating patients with various skin and hair disorders, where data from various sources, including devices, documents and images were employed in order to see how these data can be related to the prescribed and used drugs. The application of AI has delivered positive results in better drug adjustment, which resulted in better treatment outcome and lesser risk of side effects.

## Customer contact

Customer contact in trichology clinics and offices may be a replication of solutions that have been seen in other markets and industries. Various companies use AI for a series of purposes where they get in touch with customers: potential or actual. Examples of solutions that could be reviewed, show considerable variety. For example, AI voiceover may be providing customer service for incoming calls. In the opposite direction, AI could automatically call customers to remind them about their appointments. The same operation can be executed regarding various matters: prepayment reminders, or preparation for diagnostics (both: incoming and outgoing contacts). AI could also initiate remote consultations (video consultations initiated by AI and taken over by a proper trichology practitioner).

An open question in this field of AI applications is whether customers may find such a form of contact acceptable or even advantageous for them. Wielgosik (2017) states the importance of customer contact, from which, implicitly, may be derived that a genuine personal setting is most welcome. Thus, automated customer service if not performed by software, but when a human consultation is replaced with AI, may be seen as a gap in quality of service. Li et al. (2020) explain that many customers use i. e. chatterbots, which are best embedded into practice, conversative algorithms having been used for customer service purposes for years. But, what may happen to these customers is that they may perceive AI in customer service as a fallacy, while they have expected a real medical staff member.

## Marketing automation

Marketing automation is a concept which describes various marketing activities, which are performed without or with minimum attendance from human personnel (LeSueur, 2017). Marketing automation in businesses is always based on available data, and exploits various digital channels, such as websites or online shops, newsletters, automated SMS engines. Non-AI marketing automation works in such a way, that it only executes simple orders, such as release of emails at a specific date and time. In comparison, marketing automation with the application of AI, can perform similar tasks, but AI may analyse data, make suggestions for possible action, or undertake action on its own when some baseline criteria are met (Corrigan, 2023).

Trichology as a field of medical practice and business operations may show some degree of viability for marketing automation. While some trichological clinics and offices still refrain from using websites and online stores to implement mature digital strategies, others actually use these tools to reach customers, identify their needs or implement activities supporting health education. In such a setting, AI-propelled marketing automation may be used in the following areas (Guercini, 2023):

Assessment of seasonality of customer calls and incoming emails, and based on this: increased frequency of newsletter or promotional material which is fitted

to when customers are most engaged into looking for trichological treatment,

Autonomous management of A/B tests of website or online shop, which checks which web settings are responsible for better performance and traffic monetization,

They analyse website traffic data and propose pricing tactics.

## AI IN TRICHOLOGY – CONCEPT LIMITATION

Williams et al. (2024) warn that the basic limitations for AI in medicine is when its application make it an effective solution, which is at least positive to patients, in terms of health status and outcomes. The second instance, according to the same authors (Williams et al. 2024) is that the clinicians need to be able to verify AI's performance. The same perception could be attributed to possible applications of AI in trichology.

Apart from the core practice of trichologists, AI may pose some legal issues, which should be, too, taken into consideration. AI is a technology, which use is not restricted in neither regulated nor non-regulated medical trades. But, in spite of that, the problems that may be arising could be identified in the following fields, mainly on the basis of civil law (Król-Całkowska and Walczak, 2021):

- Consumer rights' protection law,
- Data protection law,
- Issues with patient's or customer's informed consent,
- Personal and organisational liability for damages caused to patients,
- Implications of AI for civil liability (and consequences for liability insurance used by some trichologists),
- The issue of legally protected secrets (lacking in trichologists' practice, but obvious in regulated medical trades).

The use of AI would at any time make liable: a user (individual employee, be it administrative, or from core practice), or a business (legal entity that runs trichology clinic or office). The trade of trichologist is unregulated since it lacks a specific systemic law, and it has no recognised professional self-government (not like in medical practice of physicians, nurses, or stomatologists). As this sets no boundaries on the use of AI in marketing activities for trichologists, expect those from civil law (regarding consumer protection, as well as offer and contract clauses). The described state of matters brings both opportunities and risks. Opportunities may come from the above mentioned areas of AI applicability, while risks may be associated with abusive practices of some trichology practitioners, confident that there would be no disciplinary measures for them. The system of recommendation and certification held by PST (2024) is only a small first step to regulate the sector. In addition, the use of specific technologies should be taken into account in this process.

## Summary

In summary, for this article, it may be assumed that AI can be well applied by trichologists in Poland.

Because the provision of these health services is not subject to specific regulations and is dominated by private companies, there are no associated regulatory restrictions on the use of artificial intelligence un this moment, however, AI could be exploited with significant attention to such legal issues as: personal data protection, and preventive measures to avoid any patient data or patient consent breaches. What is more, the article presents a wide landscape for the usage of AI in diagnostics and detection, treatment supervision and monitoring, hair transplant and restoration, customer contact, marketing automation. While marketing automation could be done without any professional involvement of trichologist, the other domains are a promising field for the development and efficiency in their core practice. Furthermore, the complexity of client needs and hair and skin disorders on head scalp calls for design of AI so that it could support interdisciplinary teams in solving interdisciplinary problems. Thus, AI offers a transformation of trichology services into a strongly data-driven discipline and line of business.

Simultaneously the article emphasises a large disproportion within an ongoing discussion in the literature dedicated to AI in trichology. The authors have explored the field of diagnostics is an area of lively debate, nonetheless other fields analysed still need more attention. The article also treats the discussion on the topic from the point of view of dermatology, which is very popularly presented as a field to apply AI, which may be acknowledged as field of inspiration for trichology services.

Further, authors have signalled that the discussion on the AI in trichology which recognises both applications and limitations, may be understood as a reliable base for discovering how AI can relate to a digitalised concept of health services (e-health) and how this could be translated into specific meaning and significance for trichology (postulated term of 'e-trichology' as a multidimensional concept for the use of digital technologies and solutions in trichology), however, data-driven trichology may be also and even more appropriate, considering the fact the 'e-' concepts originate from late 1990s and 2000s since when progress in data technologies has brought trichology services towards mobile apps, more powerful data storage, and most importantly, AI.

The topic is new, and a more intense debate still remains to be seen, the article can be treated as a good basis for more in-depth studies regarding the discussed points, which may include identification of other digital technologies, except AI, that might be applied by trichologists. What is more, while AI may be seen as an additional building block to e-health concept (in the healthcare sector, in general), a similar assumption made for trichology may require to see answers on whether there is a gap in the form of missing 'e- trichology' concept. In addition, another publication might deal with legal issues that the use of AI would involve if used in various contexts specific for the practice of trichologists.

Yet, there is little evidence that AI is used in trichology services on a significant scale, so that a discussion could be started on how it has so far affected business models in this line of business. Probably, first steps with AI may have been made in some trichology services venues, but this topic could still be a phenomenon at a very early phase of development. Hence, the state of the art of AI in trichology in Poland remains to be seen.

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