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REVIEW PAPER

Occupational hazards related to chemical factors in the work environment of a cosmetologist*

Piotr Sit[1], Dariusz Bartyzel[2], Olga Krawczyk[3], Maciej Żerdziński[4], Piotr Szenk[5], Małgorzata Czarny-Działak[6]

[1] College of Engineering and Health, Warsaw, Poland
[2] District Hospital, Health Care Complex, Sochaczew, Poland
[3] Fortis Mentis Psychotherapy Clinic, Warsaw, Poland
[4] Faculty of Medical Sciences, Silesian University, Katowice, Poland
[5] Faculty of Medicine, Lazarski University, Warsaw, Poland
[6] Medical College, Jan Kochanowski University, Kielce, Poland

Abstract

Cosmetology clinic employees are exposed to a multitude of chemical substances, which constitutes a significant health risk for them, even though the profession of a cosmetologist is often regarded as low risk. Research shows that long-term exposure to chemicals may lead to occupational diseases such as contact dermatitis, occupational asthma, and chronic respiratory diseases. The primary aim of the study was to identify and analyze the substances most commonly found in a cosmetologist's work environment which may constitute a real toxicological threat. A comprehensive review of available scientific information was conducted by searching electronic databases, focusing on research in the areas of occupational medicine, toxicology, occupational dermatology, epidemiology, and legal regulations concerning occupational health and safety in cosmetology clinics. Nearly 10,000 different substances with potential toxic effects are currently used in the cosmetic sector. The lack of full validation of the health safety of people exposed to chronic occupational contact constitutes a significant issue. The paper discusses chemical agents most commonly encountered in a cosmetologist's work environment and presents possible health effects of exposure to them. It emphasizes the importance of comprehensive prevention and regular prophylactic examinations of employees. Furthermore, it points out that compliance with hygiene standards does not guarantee complete safety for employees, as mixtures of substances can cause toxic synergistic effects. This would suggest a need for further research into chemical interactions to assess risk levels more effectively and to develop methods to reduce them.

Keywords: occupational hazards, toxic substances, cosmetology

Piotr Sit, MSc in Environmental Biology, College of Engineering and Health, ul. Bitwy Warszawskiej 1920 nr 18, 02-366 Warsaw, Poland, e-mail: p.sit@interia.pl
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INTRODUCTION

Cosmetology clinic employees, who constitute a numerous occupational group in Poland, estimated to include over 100,000 people, are exposed to a multitude of factors during their professional activities, the impact of which on their health is not always fully understood. The cosmetics services sector has experienced dynamic growth in recent years; however, it is difficult to determine the exact number of people employed in this industry due to the ambiguity of the classification codes used by the Central Register and Information on Economic Activity (Centralna Ewidencja i Informacja o Działalności Gospodarczej – CEIDG. Until 2024, the Polish Classification of Activity (PKD) code 96.02.Z was defined as "hairdressing and other cosmetic treatments." Since 2025, new subclasses have appeared, including the separation of PKD for hairdressing activities (96.21.Z) and the creation of new codes for cosmetic activities (96.22.Z). According to CEIDG data, over 45,000 entities have been registered under this "new" code (data from November 2025) – CEIDG (2025). It ought to be noted that the register also includes inactive entities and, on the other hand, entities employing even some several dozen people. Although these data are certainly incomplete, the cosmetics industry has been undergoing a growth trend for over a decade. Poland is no exception to this rule; a similar situation can also be observed across Europe and in the United States (Turcu et al. 2025).

A characteristic feature of Polish beauty salons is their size – they are mostly micro-enterprises, run by one or several people in small rooms, often without adequate ventilation and air conditioning. Such use of space increases employee exposure to harmful chemicals. What is more, many clinics operate in shared premises with hairdressing services, which results in cumulative exposure to a variety of agents.

The modern cosmetics industry makes use of around 10,000 different substances (European Commission 2025). A significant problem is that not all of them have been tested for worker safety in terms of their exposure to such chemicals on a long-term, occupational basis. The issue of health risks in the cosmetologist's work environment includes not only chemical substances, but also biological, physical, acoustic, biomechanical hazards, as well as hazards related to stress and burnout.

In accordance with present legal standards, in particular Directive 98/24/EC and Regulation of the Minister of Health (Council Directive 1998, Regulation … 2005), employers are required to determine which chemical agents and other employee hazards are present in the work environment, as well as carry out and document an assessment of occupational risk (Chmielewski et al. 2020*a*). However, in practice, many smaller clinics do not fully comply with these legal requirements. Employee education in hazard recognition, risk assessment, and implementation of appropriate protective measures remains insufficient. As a result of inspections carried out in 2018 by the

National Sanitary Inspection, 4,529 violations were found in the investigated workplaces related to not meeting hygiene standards for harmful agents (PIP 2019). Cosmetology clinic employees are often unaware that chronic exposure to chemicals from cosmetics can lead to serious health effects, ranging from skin diseases to respiratory diseases and reproductive disorders (Chmielewski et al. 2019, 2020*b*).

The present paper aims to introduce the occupational hazards in cosmetology clinics, which are the result of exposure to harmful chemical substances. The discussion will cover the characteristics of the most important chemical compounds that clinic employees encounter during their professional work, highlighting any toxic properties and potential health effects. The publication is based on available scientific research, existing hygiene norms, legal regulations, and the practical experiences reported by cosmetology clinics.

MATERIALS AND METHODS

In order to achieve the aims of the study, scientific literature published in both Polish and English between 2000 and 2024 was analyzed. The PubMed, Google Scholar, and Scopus databases were used. The literature included medical, epidemiological, legal, and ergonomic works on occupational hazards in a cosmetologist's work environment. Articles on the prevalence of medical and health hazards among cosmetologists, as well as the extent of their exposure to occupational risk factors, were identified. After compiling a list of potentially relevant articles, a comprehensive selection of appropriate papers was prepared on the topic of occupational hazard characteristics, occupational risk factors in cosmetology, health effects of exposure to chemicals, occupational allergies, and the effectiveness of preventive measures and health protection for cosmetic workers. Papers on the impact of occupational hazards on the professional functioning and quality of life of cosmetologists, as well as research on the implementation of safety procedures in cosmetology clinics, were of particular importance.

RESULTS AND DISCUSSION

Chemical hazards

Exposure to chemical substances and mixtures is the predominant and most complex hazard in a cosmetologist's daily work. Beauty industry workers are exposed to a wide range of chemical compounds through three main absorption routes: inhalation (inhaling vapors, gases, dusts, and aerosols), dermal contact (direct contact with the skin and mucous membranes), and,

to a much lesser extent, ingestion (accidental ingestion) – Chmielewski et al. (2020*a*). The dermal route is of particular importance given the nature of the job, which is an example of so-called "wet work." This refers to the kind of occupation where an employee is required to spend more than two hours a day with their hands in a wet environment, wear tight protective gloves, or wash their hands frequently. Such exposure leads to damage to the epidermal barrier, degreasing, and an increase of skin pH, which facilitates the penetration of irritants and allergens.

Employees' risk exposure to chemicals in the form of gases, vapors, aerosols, and dusts originates from a wide range of cosmetic products, as well as liquids, pastes, creams, gels, nail modeling bases, and other solid substances. These substances can cause both immediate and long-term effects, e.g., carcinogenic, mutagenic, teratogenic (Chmielewski et al. 2022*c*).

According to present regulations, a chemical agent is defined as an element or chemical compound in its pure form or in a mixture, in the state in which it occurs in nature or in which it is manufactured, used, or released in the work environment (Council Directive 1998, Regulation ... 2004). The effect of a chemical on an employee's body depends on its concentration in the work environment, the route of its absorption, the length of exposure, and the individual characteristics of the employee (their age, gender, health status, genetic susceptibility) – EU-OSHA (2025).

Inorganic substances

Inorganic compounds most commonly found in cosmetology clinics include hydroxides, hydrogen peroxide, and heavy metals (Table 1).

Inorganic compounds constitute a basic hazard in a cosmetologist's daily work. However, it is organic substances that constitute the core of chemical hazards, including a wide variety of compound classes with varying toxicity.

Organic compounds

Organic solvents used in nail polish, nail polish removers, etc., are primarily aromatic hydrocarbons. They are among the most commonly used substances in cosmetology clinics and are one of the main sources of chemical hazards for employees. The most important solvents include toluene, xylene, ethylbenzene, and benzene (Table 2).

Ketones

Used in cosmetic preparations mainly have an irritating effect and can cause headaches and neurological disorders. Their volatile vapors can become a significant issue in poorly ventilated rooms (Table 3).

Tabela 1

Characteristics of selected inorganic chemical compounds

Chemical compounds	Characteristics	Source
Hydroxides	Potassium hydroxide and sodium hydroxide are compounds used in hair removal and skin softening products. Permissible concentrations are at levels below 5%. They may cause irritation and, in higher concentrations, be highly corrosive.	(Tsai et al. 2021)
Hydrogen peroxide	Commonly used in hair lightening products and perm neutralizers. In higher concentrations (acceptable levels of up to 12% in hair cosmetics and up to 4% in skin cosmetics), it has a strong corrosive effect on the skin, and its alkaline solutions damage the hair texture. It is also dangerous for the eyes.	(He et al. 2022)
Heavy metals	They are under strict restrictions but may still be present in products as trace impurities. There are several heavy metal compounds that are permitted for cosmetic use, such as: dichromium trioxides, pigments CI 77288 and CI 77289 – both ingredients are permitted provided they do not contain free chromium ions, thiomersal, a preservative in concentrations of up to 0.007% in terms of mercury, may only be used in makeup and makeup removal products. Thiomersal is an organic compound (!).	(Arshad et al. 2020, Podgórska et al. 2021)

Tabela 2

Characteristics of selected aromatic compounds

Chemical compound	Characteristics	Source
Toluene (Methylbenzene)	Aromatic hydrocarbon traditionally used in nail polish and products containing methacrylates. It has an irritating effect on the eyes and the skin. Its main effect is neurotoxic (headaches, sight disturbance, insomnia). In Poland, toluene is banned in many cosmetic products due to its harmful effects on reproduction.	(Alnuqaydan et al. 2024)
Xylene (Dimethylbenzene)	Aromatic hydrocarbon, which is irritating to the eyes, skin, and respiratory tract. Prolonged exposure may cause headaches, dizziness, and neurological disorders.	(Eom et al. 2025, Thetkathuek et al. 2015)
Ethylbenzene	Aromatic hydrocarbon, most commonly used in solvent mixtures, is irritating to mucous membranes.	(Davidson et al. 2021)
Benzene	Substance banned in the cosmetics industry due to its proven carcinogenicity (Carc. 1A), but still detected in small amounts, mainly in ethanol-based disinfectants and sun protection products.	(Alnuqaydan et al. 2024)

Table 3

Characteristics of selected ketone solvents

Chemical compound	Characteristics	Source
Acetone	One of the most commonly used solvents, it is the main ingredient of nail polish removers. It has a characteristic odor and has an irritating and allergenic effect. It can cause headaches, dizziness, and irritation of the eyes and respiratory tract.	(Cole de Paula et al. 2025)
Methyl ethyl ketone (MEK)	Solvent, fragrant substance with an irritating effect on the eyes, skin, and respiratory tract, may cause headaches.	(Forouzan et al. 2020)

Alcohols and phenols

Although seemingly alike, these two classes of compounds differ significantly in their properties. In alcohols, the hydroxyl group (–OH) is attached to an aliphatic carbon atom (sp3), while in phenols it is attached to an aromatic carbon atom (sp2). Therefore, phenols have much stronger acidic properties than alcohols and react with iron chloride (III). The characteristics of the alcohols and phenols most commonly encountered in cosmetology are outlined in Table 4.

Aldehydes

A separate group of chemical compounds that, according to contemporary scientific research, constitute a real health hazard are aldehydes, especially formaldehyde. Although this compound has formally been banned in cosmetic products (since May 2019) (Regulation EC ... 2019), it is still possible to use selected compounds that function as so-called aldehyde donors, i.e., substances that release small amounts of formaldehyde in the final product. The characteristics of formaldehyde and glutaraldehyde are outlined in Table 5. Another toxic agent people working in cosmetology clinics are exposed to is glutaraldehyde, the use of which is strictly prohibited in cosmetic products, but remains a popular sterilizing agent, nonetheless.

Amines and their derivatives

In terms of chemical structure, amines are derivatives of ammonia whose hydrogen atoms are replaced by hydrocarbon groups. The characteristics of selected amines that constitute a risk in the field of cosmetology are presented in Table 6.

Carboxylic acids and hydroxycarboxylic acids

Carboxylic acids are generally monofunctional because they contain only a carboxyl group (–COOH). Hydroxycarboxylic acids, on the other hand, are

Table 4

Selected alcohols and phenols

Chemical compound	Characteristics	Title 3
Ethanol	Primary ingredient of antiseptic products. Although it is widely used, it can cause skin irritation (it strongly degreases the epidermis, leading to dryness and cracking) and irritates the eyes and respiratory tract. Prolonged exposure to ethanol vapors can lead to adverse neurological effects.	(MacLean et al. 2017)
Isopropanol	Second most important alcohol used in disinfection. It has properties similar to ethanol – it irritates the eyes, skin, and respiratory tract.	(Tasar et al. 2020)
1-Propanol	Used in cosmetics as a solvent and antiseptic, as well as an ingredient in cosmetic products to reduce viscosity and foaming. Like the aforementioned alcohols, it has an irritating effect.	(Angelova-Fischer et al. 2020)
Phenol	A derivative of aromatic hydrocarbons with the general formula Ar-OH, has antiseptic properties. Some have an odor. Phenol is toxic and corrosive. It is also classified as a substance with possible mutagenic effects.	(He et al. 2023)
Resorcinol	Component of oxidative paints. It is highly irritating to the eyes and skin.	(Tasar et al. 2020)
Hydroquinone	Primarily used in skin lightening products. It is irritating and is also classified as a substance with limited evidence of carcinogenicity (Carc. 2).	(Boo et al. 2021)

Table 5

Characteristics of selected aldehydes

Chemical compound	Characteristics	Source
Formaldehyde	Classified as a carcinogen and skin allergen (contact allergen), it may irritate the eyes, skin, and respiratory tract. It also shows genotoxic effects and may affect reproductive functions through disrupting the endocrine system. In its pure form, the substance is banned in cosmetics. Substances that are formaldehyde donors can still be used. The most common examples of formaldehydes in cosmetic products include: DMDM Hydantoin, Imidazolidinyl Urea, 2-Bromo-2-nitropropane-1,3-diol, Diazolidinyl Urea.	(Balwierz et al. 2023)
Glutaraldehyde	Aldehyde used as the primary ingredient in products used for disinfecting and sterilizing tools. It is an irritant and has an allergenic effect – it can cause sensitization both through inhalation and skin contact. It can cause occupational asthma and allergic dermatitis.	(Pandey et al. 2024)

Table 6

Characteristics of selected amines

Chemical compound	Characteristics	Source
Phenylenediamines (diaminobenzenes)	Aromatic compounds containing an amino group, used in permanent hair dyes, are toxic substances with an effect on the respiratory tract, skin, and digestive system. They can cause allergic reactions upon contact with the skin, and they irritate the eyes. Substance hazardous to the environment.	(He et al. 2022)
Aminophenol	Phenol derivative with an amino group, also used in hair dyes, may cause adverse health effects, harmful if swallowed or in contact with the skin, has mutagenic effects, used at a maximum concentration of 0.9%.	(He et al. 2022, Gallo et al. 2025)
Triethanolamine (TEA)	pH regulator, emulsifier and stabilizer in cosmetic products	(Roman et al. 2025)
Diethanolamine (DEA)	Gives cosmetic products their desired consistency, acting as a thickener but also an emulsifier, used in cleansing products as a foaming agent.	(Niculescu et al. 2007)
Monoethanolamine (MEA)	Like DEA and TEA, a product pH regulator, emulsifier, foaming agent, and stabilizer.	(Garlapati et al. 2021)
MEA, DEA and TEA	Use is regulated in annex of the III Regulation No 1223/2009 and they may be used in cosmetics within the recommended concentration ranges. In high concentrations, they irritate the mucous membranes and respiratory tract.	(Regulation EC … 2009)

compounds that additionally have a hydroxyl group (–OH) in their molecule. Therefore, hydroxycarboxylic acids are multifunctional compounds that combine the characteristics of acids and alcohols. Both carboxylic acids and hydroxycarboxylic acids are widely used in cosmetology due to their significant effects on skin care (Table 7). The best-known examples of such compounds are glycolic, citric, lactic, and salicylic acids. In cosmetics, they are valued for their exfoliation and regeneration effects.

The chemical compounds discussed in the present paper were chosen due to their widespread use and potential negative effects on the human body.

SUMMARY

Chemical agents are among the key occupational hazards in a cosmetologist's working environment. This profession, often perceived as low risk,

Table 7

Characteristics of acids used in cosmetology

Chemical compound	Title 2	Title 3
Glycolic acid	It has a strong irritating effect on the skin and mucous membranes. When coming into contact with the skin at high concentrations, it causes irritation, redness, and possible burns. Inhaling glycolic acid vapors causes irritation of the upper and lower respiratory tract.	(Narda et al. 2021)
Thioglycolic acid	Although it contains sulfur instead of carbon in a carboxyl group, it functions similarly to carboxylic acids. It is a component of perm neutralizing cosmetics, as well as eyelash and eyebrow lamination products. When in contact with the skin at higher concentrations, it can cause irritation, redness, and even burns.	(Ghanem et al. 2024)
Citric acid	It is registered as a food additive (E330) and no acceptable daily intake (ADI) has been established, indicating safety in case of long-term exposure. It also has no allergenic effect. However, it should be noted that at high concentrations, it exhibits corrosive effects of a typical acid.	(Sweis et al. 2018)
Lactic acid	In high concentrations, it can cause skin irritation and redness, and during prolonged contact, it has the potential to cause burns with the possibility of blisters. When coming in contact with the eyes, it can cause serious damage, pain, tearing up, and redness.	(Kim et al. 2025, Bizrah et al. 2019)
Salicylic acid	At concentrations of 30% and above, it has a corrosive effect on tissues. It can cause chemical burns, in particular when applied to large areas of the skin or during prolonged contact. In high concentrations, it is capable of chemically penetrating the epidermis. At therapeutic concentrations (up to 20%), the corrosive effect is limited, and the compound has mainly keratolytic effects.	(Wang et al. 2025)
Mandelic acid	At concentrations up to 20%, it has a moderate irritating effect; higher concentrations are recommended for professional use. It can cause burning, redness, and flaking of the skin. Contact with eyes causes irritation and tearing up. It is considered to be one of the milder AHA acids due to its relatively large molecule size. It is not allergenic.	(Malviya et al. 2025, Almeman et al. 2024)
Azelaic acid	It has an irritating effect on the skin and eyes, but this effect is moderate and usually short-term. It may cause stinging, itching, and flaking of the skin, especially at the start of usage. At higher concentrations (20% and above), the irritation may be more intense. It has no allergenic effect on the respiratory tract or skin.	(Mariano--Rodriguez et al. 2025)

cont. Table 7

Chemical compound	Title 2	Title 3
Pyruvic acid	It has a corrosive effect on the skin and mucous membranes. At high concentrations (20% and above) or due to prolonged contact, it can cause chemical burns and epidermolysis. Pyruvic acid exfoliation must be performed by specialists due to the risk of complications. It is not allergenic.	(Goyal et al. 2025)
Lactobionic acid	A naturally occurring compound, a derivative of lactose, is well tolerated by the body. It is non-allergenic and has virtually no corrosive effect. In cosmetic concentrations (up to 10%), it does not cause chemical burns. It has an exfoliating and calming effect without causing tissue damage	(Warowna et al. 2025)

is in fact associated with long-term repeated exposure to a wide variety of chemicals present in nail polishes, degreasers, cleaning agents, disinfectants, and skin and nail care products, which may be irritating, allergenic, neurotoxic, and even potentially carcinogenic.

Although environmental measurements carried out in many countries have not confirmed that the present maximum acceptable toxicant concentrations (MATC) for specific substances have been exceeded, cosmetology clinic employees often report adverse symptoms such as mucous membrane irritation, coughing, headaches, fatigue, and allergic skin reactions. This phenomenon can be explained by the so-called mixed exposure, i.e., simultaneous exposure to tens or hundreds of chemicals that, when in reaction with each other, can increase their toxic effects even at concentrations that are seemingly safe. According to data from the French Agency ANSES, in the nail cosmetology clinics and in the products they used, over 690 potentially hazardous substances have been identified, of which more than 150 have been classified as compounds with a high toxicological risk (ANSES 2017).

Long-term exposure to these agents may lead to the development of occupational diseases such as contact dermatitis, occupational asthma, or chronic respiratory diseases. This issue requires the implementation of comprehensive preventive measures at both the organizational and individual levels. Some are particularly important such as: the use of personal protection equipment (gloves, masks, safety glasses), ensuring adequate general and local ventilation, compliance with occupational hygiene rules, regular cleaning and disinfection of workstations, and health and safety education. Moreover, preventive examinations and monitoring of the health of personnel are of utmost importance, allowing for an early detection of adverse health effects.

The profession of a cosmetologist also exposes employees to other types of hazards – biological, physical, ergonomic, and psychosocial. The rapid pace

of work, contact with customers, and repetitive tasks can lead to chronic stress and occupational burnout. For this reason, occupational risk assessment should cover all aspects of the work environment, not just chemical exposure.

CONCLUSIONS

Chemical exposure in cosmetology clinics is a significant health problem, in particular due to the simultaneous activity of many chemicals in low concentrations.

The fact that PEL values are not exceeded does not mean that exposure is safe – interactions between chemical compounds can cause toxic effects in mixed exposure.

Prevention and control of exposure require a systematic approach, addressing both personal protective equipment and appropriate technological solutions (ventilation, ergonomics, hygiene).

Continuous health surveillance of employees, training in work safety, and awareness of hazards are key to limiting occupational diseases.

Future research should focus on analyzing synergistic effects between different chemical compounds, which will enable a more accurate assessment of risks and the development of more effective prevention methods.

In summary, although the profession of a cosmetologist is generally considered to be safe, it involves real health risks resulting from contact with chemical substances. Only comprehensive identification, assessment, and control of these hazards can ensure safe and hygienic working conditions in the cosmetic industry.

Author contributions

Conceptualization, methodology – PS, validation, investigation, data handling – PS, DB, MŻ, MCz, writing original draft – PS, DB, editing – OK, visualization – PS, OK, result interpretation – PS, DB, MŻ, PSz, writing the final version – PSz, approval of the final version – MCz, project administration – MCz.

All authors have read and agreed to the published version of the manuscript.

Conflicts of interest

The authors ensure that they have neither professional nor financial connections related to the manuscript sent to the Editorial Board.

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