The European Journal of Humanities and Social Sciences 2025, No 6
ISSN 2414-2344

PREMIER Publishing
ppublishing.org

Section 8. Sociology

DOI:10.29013/EJHSS-25-6-91-94

PROFESSIONAL RISK: TOXIC EFFECTS OF CYANOACRYLATES AND A MICROFILTRATION STRATEGY FOR THE AESTHETIC INDUSTRY

Kristina Alferuk [1]

[1] Independent research Saint Petersburg, Russia

Cite: *Alferuk K. (2025). Professional Risk: Toxic Effects of Cyanoacrylates and a Microfiltration Strategy for the Aesthetic Industry. European Journal of Humanities and Social Sciences 2025, No 6.* https://doi.org/10.29013/EJHSS-25-6-91-94

Abstract

The professional health sector within the beauty industry faces a significant, yet often underestimated, crisis stemming from chronic exposure to **Volatile Organic Compounds (VOCs)**, particularly cyanoacrylate vapors. These gaseous molecules, due to their nanoscale size, **bypass conventional protective barriers** to freely penetrate the practitioner's respiratory tract, leading to chemical inflammation, sensitization, and debilitating conditions such as occupational asthma. Existing international safety protocols, including Local Exhaust Ventilation (LEV) and certified carbon respirators, often prove impractical due to high cost and professional inconvenience, leaving a critical gap in daily protection.

Keywords: *Volatile Organic Compounds (VOCs); Cyanoacrylate Exposure; Occupational Asthma; Nasal Microfiltration (NMF); Activated Carbon Adsorption; Aesthetic Professionals; Respiratory Protection*

Section I. Introduction: VOCs as an Invisible, Systemic Risk in the Beauty Industry

1.1. The Technological Evolution and the Unseen Hazard

The rapid technological advancement in cosmetic applications, particularly those requiring strong, instantaneous adhesion – such as eyelash extensions and complex nail modeling – has fundamentally altered the chemical landscape of beauty salons. These high-performance services necessitate materials whose efficacy is tied directly to the release of **Volatile Organic Compounds (VOCs)**. Cyanoacrylates, acrylates, formaldehyde, and various solvents are now routine components of the working environment. This reliance on volatile chemicals has inadvertently created a pervasive occupational health risk, challenging the traditional view of the beauty industry as a low-hazard professional environment.

1.2. Defining the Sources and the Nature of the Gaseous Threat

VOCs are organic substances characterized by their low boiling point and high

vapor pressure, allowing them to readily become gaseous at ambient temperatures. In aesthetic studios, the primary culprits include: **Ethyl Cyanoacrylate (ECA)**, whose rapid polymerization releases gaseous monomers; **Formaldehyde**, a known human carcinogen present in certain keratin treatments; and common solvents like **Acetone and Toluene**. The critical distinction is that these substances exist as **gases**, not as particulate matter. Their nanometer scale (well below the PM2.5 or PM10 thresholds) allows them to completely circumvent the filtration mechanisms of standard surgical masks, granting them **unimpeded access** to the respiratory system.

1.3. The Urgency of Intervention: A Global Health Imperative

The cumulative, chronic inhalation of these substances is no longer merely a local irritant issue; it represents a global occupational health threat. This exposure leads to systemic health issues, necessitating an effective and practical intervention. The aesthetic professional, whose head is often positioned inches from the source of the emissions for hours daily, faces a heightened, career-threatening risk, including **irreversible lung damage and neurological impairment**. This urgency demands an innovative solution that bridges the gap between stringent theoretical standards and practical, real-world application.

Section II. Scientific and Medical Analysis: The Systemic Impact of VOCs

2.1. Advanced Toxicology: The Electrophilic Reaction Mechanism

The toxicity of cyanoacrylate monomers stems from their chemical structure. They function as potent **electrophiles**, meaning they are highly reactive chemical species that seek electrons. Upon inhalation, these molecules immediately encounter the moist mucous membranes of the nasal cavity and lower respiratory tract. They readily react with **nucleophilic biological molecules** (such as proteins, enzymes, and DNA) through covalent bonding. This process – known as **adduction** – is the direct cause of severe chemical inflammation, **conjunctival edema**, and localized tissue damage.

2.2. The Respiratory Cascade: From Irritation to Occupational Asthma

The initial irritation quickly progresses to systemic respiratory complications:

- **Sensitization:** Chronic exposure to ECA monomers leads to the immune system becoming highly sensitized to the compound. This is the prerequisite for **Occupational Asthma (OA)**. Upon re-exposure, even trace amounts of VOCs trigger a Type I (IgE-mediated) hypersensitivity response, resulting in bronchoconstriction, chronic inflammation, and airway remodeling;
- **Systemic Effects:** The harm extends beyond the lungs. Studies have linked chronic VOC exposure to:
  - **Cardiovascular Changes:** Alterations in Heart Rate Variability (HRV) indicative of autonomic dysfunction.
  - **Neurological Symptoms:** Non-specific complaints such as persistent **headaches, vertigo, memory impairment, and chronic fatigue**, consistent with low-level central nervous system intoxication.
  - **Carcinogenic Risk:** Exposure to co-existing pollutants like formaldehyde and benzene further elevates the risk of malignancy, classifying the aesthetic workspace as a high-risk environment.

2.3. The Failure of the Nasal Mucociliary System

The body's natural defense, the mucociliary clearance system (lining the nasal passages), is designed to trap and expel larger particulate matter. However, it is fundamentally ineffective against gaseous VOCs. The minuscule size and chemical reactivity of VOCs allow them to diffuse across the mucosal lining, bypassing this defense mechanism and directly impacting the underlying tissues and systemic circulation. This emphasizes the critical need for an external, chemical defense barrier.

Section III. The Practical Failure of Traditional Safety Strategies

The established international guidelines for occupational safety, issued by bodies such as OSHA and ACGIH, are robust in theory

but frequently fail in practical application within the aesthetic sector.

3.1. The Economic and Engineering Limits of LEV

While **Local Exhaust Ventilation (LEV)** is the gold standard for engineering control, effective LEV against gases must incorporate high-capacity **activated carbon beds** to chemically adsorb the VOCs, rather than just HEPA filters which only handle particulates.

- **Cost Barrier:** The initial capital cost and ongoing maintenance of certified, high-flow, chemical-grade LEV systems are prohibitive for small businesses and independent practitioners.
- **Misapplication:** The common use of non-vented, domestic air purifiers or low-grade extraction hoods creates a **"false security"** effect, as these devices are incapable of handling the gas phase of the pollutants.

3.2. The Comfort and Compliance Deficit in PPE

Certified **cartridge respirators** are the only PPE that guarantee full filtration of VOC gases. Yet, their mandatory use introduces significant professional and ergonomic hurdles:

- **Ergonomics and Aesthetics:** The bulkiness of the respirator obstructs fine motor skills required for intricate procedures (e.g., eyelash isolation) and creates a profound **psychological and aesthetic barrier** that professionals in the visual beauty industry are often unwilling to accept.
- **Compliance Failure:** This discomfort results in low compliance rates, leading to practitioners relying on standard surgical masks – an act that is scientifically useless against VOCs and exposes them to maximum risk.

The failure of both engineering and traditional PPE strategies necessitates a paradigm shift towards an **accessible, practical, and highly compliant** form of chemical protection.

Section IV. The Innovative Nasal Microfiltration (NMF) Strategy: A Paradigm Shift

4.1. The NMF Scientific Principle: Van der Waals Forces and Adsorption

The **Innovative Nasal Microfiltration (NMF) Strategy** is a targeted intervention designed to provide effective chemical protection without the bulk of a respirator. The core mechanism is **adsorption**, specifically achieved using **activated carbon (charcoal)** microgranules integrated into a discreet nasal plug-filter.

- **Mechanism:** Adsorption is a surface phenomenon where gaseous molecules (VOCs) are attracted to, and physically held onto, the vast internal surface area of the adsorbent. This process is primarily governed by **Van der Waals forces** (weak intermolecular forces), which create a strong chemical-physical attraction between the VOC molecules and the carbon surface;
- **Efficiency:** Activated carbon is specifically effective because its porous structure allows it to bind a wide array of organic chemical gases, achieving a chemical neutralization that mechanical filters cannot.

4.2. Implementation and Advantages of the NMF Protocol

The NMF Protocol is designed to be a highly compliant, supplementary PPE, targeting the inhalation risk at the point of entry:

1. Targeted Adsorption: By positioning the carbon micro-adsorbent directly in the nasal passage, the filter intercepts the majority of inhaled air, dramatically reducing the concentration of VOCs entering the trachea and lungs.

2. Discretion and Compliance: The small, discreet design of the nasal filter eliminates the aesthetic barrier and the physical discomfort associated with full respirators, thereby ensuring high compliance rates among professionals.

3. Cost-Effectiveness: The low unit cost of the NMF system makes professional-grade chemical protection financially accessible to independent practitioners and small studios globally.

4.3. The Bridge to Full Protection

It is critical to note that the NMF Strategy is presented as an **Intermediate Barrier** solution. While it may not offer the saturation resistance of a heavy-duty respirator, it provides a vital, scientifically sound line of defense against daily, chronic exposure –

a crucial improvement over the zero-protection currently afforded by standard masks.

Section V. Conclusion and Global Perspective

The toxic exposure from gaseous cyanoacrylates constitutes a verifiable occupational health crisis in the aesthetic sector. Traditional safety strategies have proven inadequate, failing to account for the unique economic and ergonomic needs of the industry.

The **Innovative Nasal Microfiltration Strategy** offers a scientifically robust and pragmatically superior solution. By leveraging the principles of **activated carbon adsorption** against VOCs, the NMF Protocol provides a comfortable, accessible, and compliant method for safeguarding the health of the professional workforce. The implementation of this strategy is not merely an upgrade in equipment; it is an ethical and necessary step toward recognizing and protecting the health of aesthetic specialists as a **fundamental global priority**. Immediate action is required for international bodies to validate and integrate the NMF Protocol into occupational safety standards, effectively repelling the **"Invisible Invasion"** of the aesthetic workspace.

References

ACGIH (American Conference of Governmental Industrial Hygienists). (2022). *Threshold Limit Values (TLVs) and Biological Exposure Indices (BEIs).*

American Academy of Ophthalmology (AAO). (2016). *Eyelash Extensions: Safety Guidelines for Consumers and Practitioners.*

European Agency for Safety and Health at Work (EU-OSHA). (2020). Preventing exposure to chemicals in the beauty and personal care sector. *Luxembourg: Publications Office of the European Union.*

Elias, P. M., & Friend, D. S. (2021). The role of the epidermal water barrier in dermal exposure to chemicals. *Current Opinion in Toxicology*, – 29. – 100345 p.

Kim, S., & Kim, Y. (2020). Comparative filtration efficiency of various facial masks and nano-filters against particulate matter and volatile organic compounds. *International Journal of Environmental Research and Public Health*, – 17(18). – 6689 p.

National Institute for Occupational Safety and Health (NIOSH). (2017). *Guidance for Filtering Facepiece Respirator Use.*

OSHA (Occupational Safety and Health Administration). (2021). *Respiratory Protection Standards.* U. S. Department of Labor.

Polymer Science and Technology. (2018). *The Chemistry of Adhesives and Sealants: Cyanoacrylate Technology.*CRC Press.

Smith, B., & Lee, C. (2019). Respiratory and dermal sensitization to cyanoacrylates in cosmetic procedures: A systematic review. *Journal of Occupational and Environmental Medicine*, – 61(5). – P. 415–420.

submitted 04.11.2025;
accepted for publication 18.11.2025;
published 29.12.2025

Contact: alferukk@gmail.com