Nail Cosmetics
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Nail cosmetics are used worldwide by millions of women who desire attractive, adorned nails. Smooth, shiny fingernails and toenails are highly desirable and an entire industry is devoted to achieving that end for the consumer. The grooming and decoration of nails is a well-ingrained cultural ritual in many countries of the world. In the United States alone, $6.4 billion was spent on nail salon services in the year 2004.

Benefits of nail cosmetics

Nail cosmetics hide a multitude of unsightly nail problems. Pitting, discoloration, ridging, onycholysis, and other unattractive nail features can be disguised by a simple coat of nail lacquer. Weak, brittle, and dystrophic nails are fortified by several nail enhancement coatings. Decorative finishes are painted or airbrushed onto the nail to provide color and decoration and hide ugly or diseased nails. A coating of nail product can fortify thin, weak nails and make brittle nails appear stronger. These temporary cosmetic fixes for diseased nails do not provide a cure for the problem, but they do cover and conceal the undesirable features of diseased or aging nails. Nail cosmetics can give the illusion of healthy nails in the face of nail disease and provide a youthful appearance for aging nails.

Harmful features of nail cosmetics

Nail cosmetics are not inherently dangerous, but there are some significant medical problems that can occur with the use or application of nail cosmetics. These problems are divided into two categories: those associated with the nail cosmetic materials used to adorn nails, and those associated with the procedures and processes used to groom and beautify natural nails (Box 1). A description of the chemistry of nail cosmetic materials is useful in evaluating and understanding the problems associated with nail cosmetics.

Principles and chemistry of nail cosmetic materials

An understanding of the properties and chemistry of nail cosmetic materials is based on three chemical and physical principles of adhesion, polymerization, and evaporation as described by Schoon [1] in his book titled Nail Structure and Product Chemistry.

Adhesion

The concept of which nail extension is based emphasizes the importance of adhesion of a product to the natural nail plate. The natural nail plate should be free of oil and dirt that would weaken the attachment of the product to the plate. The base coat or primer is material that sticks to the nail plate and the overlay material. Primers for nail extensions are corrosive acids and can burn the nail bed and nail folds if too much is used, or if it is splashed onto skin. The practice of roughing up the surface of the nail plate by filing is highly discouraged because it thins and damages the nail plate.

Polymerization

Nail enhancement requires the application of a liquid monomer consisting of single molecules. In the presence of an initiator and an energy source (heat or UV light) these molecules join together to form strong bonds through a chain.
reaction that results in the cross-linking of the molecules into chains and webs. These bonds are tight and require a strong solvent to break them. This chemical reaction requires heat or light, plus an initiator and a catalyst to make the reaction happen quickly. The energy source can be UV or visible light, depending on the material being polymerized, or heat from the body. Polymerization causes shrinkage of the material of up to 20% and sometimes causes heat release (exothermic reaction). There are three categories of enhancement materials: cyanoacrylate in wraps and no-light gels, methacrylates in two parts (powder polymer and liquid monomer) in sculpted nails, and acrylates in UV light gels.

**Evaporation**

Evaporation of solvent is the method of hardening of various coatings, such as nail base coat, topcoat, and nail polish. Various polymers are dissolved in a volatile solvent (often toluene) and as the solvent evaporates, the material hardens. These coatings do not contain monomers (hence no polymerization); however, they do contain dissolved mature polymers.

The materials used in nail cosmetics can cause allergic reactions and irritant reactions around the nail unit or at distant sites, such as the face and neck, and changes in the nail plate itself. Some of the more commonly found allergens are toluene sulphonamide formaldehyde resins (TSFR), the thermoplastic resin in nail polish, nickel in metal mixing beads in nail polish, and formaldehyde in nail hardeners (Fig. 1). TSFR-free polishes are now available that contain other resins, including epoxy or phthalic-polyester based products. Although less sensitizing, these alternative products provide a less durable finish.

**Nail cosmetology**

Most of the potential complications of the procedures involved in manicure, pedicure, and
application of nail enhancements are related to trauma and infection when the tissue around the nail is manipulated and injured allowing access of pathogenic organisms (Fig. 2).

A manicure or pedicure begins with soaking the nails in soapy water to soften the cuticles, which are then pushed back, usually with a metal implement. Cuticle remover is sometimes used, and often the cuticles are clipped or trimmed with nippers or small scissors. The nails are shaped by filing and then are painted or buffed to obtain a highly desirable shiny and smooth finish (Figs. 3–9).

Problems associated with nail cosmetics can affect the nail plate, the periungual tissue, and distant ectopic sites, such as the face and neck (Fig. 10). The nail plate is adversely affected by nail enamel that stains the nail plate yellow because of the yellow dye in the product. The yellow color is more intense distally than proximally and can be scraped away with a blade (Fig. 11); it dissipates slowly over time if polish is avoided.

The nail plate can become crumbly and friable on the surface because of nail products, described by Buran [2] as keratin granulations (Fig. 12). This white crumpling of the nail plate surface looks similar to white superficial onychomycosis, which is differentiated by a positive potassium hydroxide preparation for fungal elements. It is not clear if the granulations predispose the nail to the occurrence of subsequent fungal infection. Keratin granulation is more common in pedicures in which a base coat is used and the polish remains undisturbed on the nail for several months. It also is seen when the polish is reapplied without removing the first layers. The mechanism of this superficial granulation of keratin is not known, but it tends to be more common following salon pedicures during which a primer base coat is used to enhance adherence of the subsequent nail enamel.

Artificial nail wear causes thinning of the nail plate when the nail is filed before application, a practice that is used widely but highly
discouraged because of the deleterious effect on the nail plate. If acrylic nail enhancements are not properly maintained small areas of loosening occur causing moisture to collect and providing a hospitable niche for microorganisms; *Pseudomonas* species are common (Fig. 13). Artificial nail enhancements that are too long initiate a lever effect and result in onycholysis, which may become secondarily infected with yeast and bacteria. Some of the materials used in nail enhancements, especially primers, can irritate proximal and lateral nail folds and result in chronic paronychia.

The periungual tissue is affected by materials that cause allergic reactions and irritant reactions, exacerbating preexisting conditions, such as onycholysis and paronychia [3]. Nail cuticle remover contains keratolytic materials that are irritating to the nail fold and can initiate paronychia. The primer used to enhance adhesion of the acrylic material to the nail plate usually is methacrylate acid, a strong irritant that results in irritation and even chemical burns of the paronychial tissue if accidentally spilled or splashed onto skin. Allergic reactions cause itching and burning sensations after the product is applied. This phenomenon is common particularly in photobonded gel nails whereby the liquid gel material is hardened (polymerized) by several minutes of UV light exposure. Several articles suggest screening for acrylate allergy by patch testing to ethyl methacrylate [4].

**Nail cosmetic controversies**

**Infections in nail salons**

There is no data on the prevalence of infections transmitted through nail salons. Theoretically, bacterial, viral, and fungal infections are spread by poor sanitation and inadequate precautions with nail salon procedures. This problem is intensified if there are breaks in the integrity of the paronychial skin. Cutting the cuticle or probing
under the nails open portals for infection from improperly cleaned implements. Although many salons safely follow the guidelines for sanitation, many other salons do not properly sanitize the implements used on multiple clients. It is recommended, therefore, that women bring their own files and implements to the salon for their own use. The most risky implements are files that cannot be sterilized that carry fungal spores, viral particles, and even bacteria from client to client. The insufficient number of state inspectors for the 250,000 salons in the United States makes enforcing rules nearly impossible. There are several measures that the consumer can use to avoid nail salon infections (Box 2).

A recent concern is that of pedicure spas spreading *Mycobacterium* infections. Many women in a salon in California were infected by *Mycobacterium fortuitum* when the pedicure tubs were not properly cleaned and the *Mycobacterium* organisms were sequestered in the debris in the filter of the circulating whirlpool footbaths. Women who had shaven their legs recently before the pedicure developed furuncles on their legs (Fig. 14) \[5,6\]. Similar cases have been seen in Texas, Oregon, and Florida.

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**Box 2. Patient information on safe use of nail products and salons**

- Use a licensed nail technician and licensed salon.
- Wash hands before any nail salon services.
- Look for cleanliness in the salon.
- Ask about sanitization and sterilization in the salon.
- Bring your own instruments, particularly files that cannot be sterilized.
- If you experience any itching or burning after a service, it could signal a reaction.
- Allergy to nail polish can show up on the face, eyelids, and neck.
- Keep nail extensions short.
- Do not allow the technician to file the surface of the nail plate in preparation for extensions.
- Do not overbuff the nails, which weaken them.
- Wear gloves for all wet work chores to protect the manicure and help prevent infections associated with artificial enhancements.
- If you experience a nick or cut during a salon procedure, seek medical attention to avoid infections.

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Fig. 11. Yellow staining of nail plate from dye in nail polish (enameled).

Fig. 12. Keratin granulations of nail plate from prolonged polish exposure.

Fig. 13. Pseudomonas bacteria in an onycholytic nail.
should nail cosmetics be allowed in operating rooms?

Numerous case reports support the potential hazards of artificial nails in the health care setting [11]. Artificial nails have been implicated in some cases of medical complications of infections, which has led the Association of Operating Room Nurses to advise against wearing artificial nails in the operating room setting [12,13,14].

References

[8] National Institute of Occupational Safety and Health (NIOSH). Controlling chemical hazards in one small study of six salons [8]. Contact sensitization occurred in nail technicians who were exposed to the chemicals and filings of nail acrylic enhancement materials. A total of 20 nail technicians and 20 controls in the salons were questioned about their individual symptoms, and the only statistically significant health effect noted was throat irritation. Also noted, but not statistically significant, were symptoms of dizziness, drowsiness, skin irritation, and trembling of hands [9]. A recent report about dibutyl phthalate in nail polish has shown it to be teratogenic at high doses in rats [10].

Furuncle lesions are firm, nontender nodules that on tissue culture grow the Mycobacterium organism (Fig. 15).

The safety of the nail salon as workplace

Many nail technicians spend long hours applying materials to clients' nails and in the process breathe in fumes and dust particles that are released by filing the artificial nails. Salons follow the Occupational Safety and Health Administration rules and have material data safety sheets; however, not all salons are well ventilated [7]. Particles in the air range up to 15.6 ppm, as reported

Fig. 14. Furuncle on leg from Mycobacterium in pedicure spa.

Fig. 15. Pedicure spa. Note the filters or screens that collect debris and microorganisms.


