

MEDICAL AND SOCIETAL IMPLICATIONS OF TATTOOS: FROM ANCIENT TRADITIONS TO MODERN RISKS AND REMOVAL CHALLENGES

¹Hilary M. Holets & ²John V. Flores

^{1&2}Orange Partners Surgicenter, USA.

Abstract

Tattoos, an ancient form of body art with roots dating back 5000 years, have evolved from cultural markers to mainstream symbols of self-expression. While historically significant figures like Amunet and Captain James Cook contributed to tattoo lore, modern celebrities like David Beckham and Kat Von D have propelled tattoos into popular culture. However, alongside their rise in popularity, tattoos also bring health risks. Research indicates that up to 67% of individuals with tattoos experience complications, with infections, allergic reactions, and scarring being common concerns. Moreover, tattoos can exacerbate existing medical conditions, particularly in individuals with diabetes, heart conditions, or immunosuppressive disorders. Individuals who are pregnant or breastfeeding face additional risks due to physiological changes affecting wound healing and immune response. The chemical composition of tattoo ink, especially in complex styles like tridimensional matryoshka tattoos, poses further health concerns, including heavy metal toxicity and infection risks. Adequate safety measures, including choosing reputable artists, proper aftercare, and thorough pre-tattoo screening, can mitigate these risks. Prompt medical intervention is crucial in severe complications, emphasizing the importance of awareness and precaution in tattooing. Additionally, tattoo removal methods come with their own set of risks and considerations, with laser therapy being the primary choice but not assuring complete removal.

Keywords: *Black Ink Reactions, Body Art Training, DIY Tattooing, Q-Switched Lasers, Self-Tattooing, Tattoo Removal, Tattoo Risks, Tridimensional Matryoshka Tattoos.*

I. Introduction

Tattoos have a rich and varied history, with the earliest recorded examples dating back 5000 years in Egypt and the Pacific Islands (Clark & Langley, 2019; Friedman et al., 2018). In ancient Greece and Rome, tattoos were used to mark enslaved people and criminals, while in Japan; tattoos known as "irezumi" were associated with criminal gangs. However, tattoos were also used for decoration and cultural identification across many cultures, such as the Maori of New Zealand and the Picts of Scotland (Lippert, 1980; Velsor, 2016).

Notable people throughout history have also been known for their tattoos, including the ancient Egyptian priestess Amunet, who had tattoos of sacred symbols, and the Polynesian navigator and explorer Kupe, who had tattoos that represented his travels and conquests (Sanborn, 2011; Velsor, 2016). The explorer Captain James Cook introduced the word "tattoo" to the English language and was known for his extensive tattoo-renderings collection (Young, 2021).

In modern times, tattoos have become increasingly popular in mainstream culture. Tattoo artists such as Ed Hardy and Kat Von D have gained celebrity status, and notable figures such as David Beckham and Angelina Jolie are known for their extravagant body art (Barron, 2020).

Despite their long history and popularity, tattoos can have health consequences. Tattoos have been associated with the transmission of infectious diseases, including hepatitis B and C and human immunodeficiency virus (HIV). Adverse reactions to tattoo inks, such as tattoo-associated dermatoses, allergic contact dermatitis, and granulomatous reactions, have been reported. Tattoos can interfere with medical imaging and the detection of skin cancers

and dermatological conditions (Bălăceanu-Gurău et al., 2024).

II. Discussion

A tattoo involves injecting ink into the dermis layer of the skin through punctures made by a needle. As the ink disperses within the dermis, it forms a permanent design or image.

Epidemiology

Incidence and Prevalence

Tattoos, a prevalent form of body art, have risen in popularity. Despite their widespread acceptance, they are associated with various complications of varying severity. Research by Korn, Bonny-Noach, Koren, and Nissanholtz-Gannot (2021) indicates that approximately 18% of individuals with tattoos encounter medical complications. Chalarca-Cañas, Caviedes-Cleves, Londoño, Ospina-Gómez, and Velásquez-Lopera (2024) reported a higher prevalence, with up to 67% of tattooed individuals experiencing complications.

Mortality Rate

While it is uncommon for tattoos to lead to fatalities directly, there have been cases where tattoo-related complications have resulted in death. Dieckmann et al. (2016) reported 3 cases of tattoo-related fatalities.

Gender, Race, and Culture

Tattoos serve as a means of self-expression and are influenced by demographic factors such as gender, race, and culture. A survey by the Pew Research Center observed a higher prevalence of tattoos among women (38%) compared to men (27%) in the United States (Schaeffer & Dinesh, 2023). Furthermore, the survey identified a greater occurrence of tattoos among individuals of Black or Hispanic ethnicity.

Age Group and Socioeconomic Status

Tattoos are commonly linked with younger demographics, leading to a higher incidence and prevalence of complications among this age group. Laumann and Derick (2006) indicated that individuals aged 18-29 exhibited the highest incidence of tattoo-related complications. They revealed a correlation between lower socioeconomic status and the occurrence of tattoos.

All-Cause Mortality

Tattoos have been linked to additional health risks that can affect overall mortality rates. Carson (2014) observed a correlation between tattoos and engagement in high-risk behaviors, including smoking and drug use. Their findings indicated that individuals with tattoos exhibited a higher overall mortality rate compared to those without tattoos.

Considerations and Complications

Tattoos can induce various adverse effects, such as infections, allergic reactions, and scarring (Table 1).

Infection Risk

A primary concern linked to tattooing is infection. The tattooing process entails effecting small puncture wounds in the skin, heightening susceptibility to bacterial, viral, and fungal pathogens. Tattoo-related infections typically stem from the tattoo artist, equipment, or tattoo ink (Bălăceanu-Gurău et al., 2024). Notably, tattoo inks lack regulation, allowing for various contaminants that raise the infection risk (Fels, Lachenmeier, Hindelang, Walch, & Gutsche, 2023). Tampa et al. (2022) found that bacterial infections were the most common complication of tattoos and were often associated with exposure to contaminated ink.

Allergic Reactions

Another potential complication associated with tattooing is allergic contact dermatitis induced by components within the tattoo ink. These substances may include

metals, solvents, and preservatives capable of eliciting an allergic response. Allergic reactions to tattoo ink were more common in individuals with pre-existing allergies, indicating a possible genetic component to the etiology of this adverse effect (Shao, Casterline, & Martin, 2024).

Scarring

Tattooing can precipitate scar formation, especially when proper post-procedural care is lacking. Scarring may result from inadequate tattoo placement, inappropriate needle depth, or suboptimal aftercare practices (Petrochko et al., 2019). According to Temiz and Özlü (2021), scarring is a common complication of tattoos.

Table 1. Considerations and Complications of Tattoos

Adverse Effect	Mechanism	Research Evidence
Infection	Small puncture wounds in the skin increase risk of bacterial, viral, and fungal infections	Bacterial infections most common; contaminated ink a risk factor
Allergic Reactions	Tattoo ink contains substances triggering allergic response, including metals, solvents, and preservatives	Higher incidence in individuals with pre-existing allergies
Scarring	Improper tattoo placement, needle depth, or aftercare	Scarring common

Tattoos can lead to complications such as infections, allergic reactions, and scarring. These complications arise from various physiological responses to tattooing, including inflammation, foreign body reactions, and wound healing. The application of tattoos involves puncture wounds in the skin, leading to inflammation ranging from mild to systemic, increasing the risk of infection if the immune response is compromised. Using tattoo ink, a foreign substance, can elicit a hypersensitivity response in the immune system, leading to allergic contact dermatitis, granulomatous reactions, and lichenoid reactions (Bălăceanu-Gurău et al., 2024). The wound-healing process in maintaining homeostasis can be disrupted by infections or allergic reactions due to various cells, growth factors, and cytokines involved in the healing process, which is crucial for tissue repair (Guo & DiPietro, 2010). Such disruptions may result in abnormal healing, delayed wound healing, or skin scarring.

Timing of Complication Onset

Tattoo complications can manifest soon after the tattoo application or as late-onset issues. Common acute complications include pain, blistering, and systemic symptoms like fever and malaise. Delayed complications may include pigmentary changes, hypopigmentation, vitiligo, and scarring. Infectious diseases, particularly hepatitis C virus (HCV) and bacterial infections, are significant concerns in this population (Khunger, Molpariya, & Khunger, 2015).

Immediate or Delayed Hypersensitivity Reactions

Allergic reactions in tattooed skin are increasingly common and can be categorized as immediate or delayed hypersensitivity reactions. Symptoms range from itching and burning to eczematous rashes. Other delayed reactions include bacterial and viral infections, granulomatous and lichenoid reactions, and scarring (Shashikumar et al., 2017).

Contributing Endogenous and Exogenous Risk Factors

Tattooing has endogenous and exogenous factors contributing to complications associated with tattooing. Endogenous infections are caused by microorganisms that are part of the normal flora and can infect the skin, leading to complications such as cellulitis and abscesses (Wong, Wong, & Yuen, 2012). Exogenous infections result from contamination during the tattooing process, such as the use of unsterilized needles, which have been

reported to cause drug-resistant staphylococcal infections (Cohen, 2021).

Concerns in Various Health Conditions

Tattooing can be associated with a range of complications, which may result in severe morbidity and mortality. The risk of these complications is higher in people with pre-existing medical conditions, such as diabetes, heart conditions, infective endocarditis (IE), immunosuppressive conditions, inherited and acquired blood disorders, nevus, other pigmented lesions, pyoderma gangrenosum (PG), and systemic diseases.

Diabetes

People with diabetes have an increased risk of developing infections as the body's immune system is weakened. Nerve damage and poor circulation, often present in people with diabetes, can lead to delayed healing of wounds, increasing the risk of infection (Burgess, Wyant, Abujamra, Kirsner, & Jozic, 2021). Additionally, people with diabetes are at a higher risk of developing conditions such as diabetic neuropathies, which can cause complications during the tattooing process and also affect the tattoo-healing process (Mieczkowski, Mrozikiewicz-Rakowska, Kowara, Kleibert, & Czupryniak, 2022). Thus, individuals with diabetes should receive adequate counseling to understand the risks associated with obtaining a tattoo and be advised on the best approach to minimize complications.

Heart Conditions and Infective Endocarditis (IE)

Individuals with heart conditions such as congenital heart disease, valvular heart disease, or a history of endocarditis are at a higher risk of consequences associated with tattooing. This higher risk is due to infection at the site of a tattoo, which can spread to the heart, resulting in infective endocarditis, a rare but life-threatening complication (Müller, Breuer, Adler, & Freudenthal, 2021). For such individuals, the American Heart Association (n.d.) recommends using appropriate prophylaxis measures to reduce the risk of IE. The use of prophylaxis is determined individually following consultation with the treating physician.

Immunosuppressive Conditions

Individuals with immunosuppressive conditions such as human immunodeficiency virus (HIV) or acquired immunodeficiency syndrome (AIDS) or who are on immunosuppressive therapies post-organ transplant may have a weakened immune system, thereby increasing the risk of infections (Bulbuloglu & Kapikiran, 2021; Dropulic & Lederman, 2016).

Moreover, individuals who are on immunosuppressive medications such as azathioprine or cyclosporine are at an increased risk of developing opportunistic infections. These medications can result in greater susceptibility to skin infections, leading to delayed wound healing and increased risks of infections when getting a tattoo (Hussain & Khan, 2022). Thus, it is critical that individuals with immunosuppressive conditions and those being treated with immunosuppressive therapies be made aware of the increased risk of infection and receives proper aftercare instructions.

Inherited and Acquired Blood Disorders

Individuals with blood-borne conditions such as hemophilia, von Willebrand disease, and sickle cell disease face heightened risks when getting tattoos. These conditions impact the clotting pathway and immune response, increasing susceptibility to severe and prolonged bleeding, infections from tattooing, and delayed wound healing (Arruda, Lillicrap, & Herzog, 2022; Ochocinski et al., 2020). Awareness of these risks is essential for individuals with such conditions considering tattooing.

Nevus and Other Pigmented Lesions

Tattooing over a nevus, particularly a dysplastic or atypical nevus, might make it more challenging to monitor for skin cancer risks. There are some anecdotal reports of melanomas arising within tattoos, and the pigments within a tattoo, mainly when the tattoo

ink is a darker color or composed of heavy metals, might interfere with monitoring for the early signs of skin cancer (Leijs et al., 2021). Thus, individuals with pre-existing nevus and pigmented lesions should be advised to have these analyzed before getting a tattoo.

Tattoos are associated with an increased risk of nonmelanoma skin cancers, including basal cell carcinoma and squamous cell carcinoma, especially in individuals with previous skin damage and sun exposure (Cohen, Erickson, Uebelhoer, & Calame, 2020). Certain studies have also found that tattoos can interfere with the detection of skin cancers and dermatological conditions. Metal components in inks can cause artifacts on imaging, obscuring malignant lesions ((Anthony, Lun, Godbolt, & McMeniman, 2014).

Pyoderma Gangrenosum (PG)

PG is a rare autoimmune dermatosis characterized by rapidly evolving, necrotic, and painful ulcers. Various triggers, including trauma, surgical procedures, or psoriasis, have been associated with PG onset, with documented occurrences following tattooing (Litvinov & Sasseville, 2014; Schlott, Karrer, Terhorst- Molawi, & Dissemond, 2020). Given the substantial risk of precipitating these cutaneous lesions, it is imperative to counsel individuals with PG against undergoing tattoo procedures.

Systemic Diseases

Various systemic diseases predispose individuals to heightened risks of complications and adverse reactions following tattooing. Those with connective tissue disorders, such as lupus erythematosus, rheumatoid arthritis, and scleroderma, face an elevated likelihood of experiencing delayed healing, infections, and allergic reactions (Khunger et al., 2015). Also, individuals with sarcoidosis and other granulomatous diseases may manifest granulomatous reactions to tattoos (Bose, Sibley, & Fahim, 2020; Kluger, 2020).

Table 2 summarizes the medical conditions, associated risks with tattooing, and recommendations to mitigate risks and further complications.

Table 2. Medical Conditions, Associated Risks with Tattooing, and Risk Mitigation Recommendations

Medical Condition	Risk Factors	Recommendations
Diabetes	Weakened immune system, nerve damage, poor circulation, delayed wound healing	Adequate counseling to understand risks, advised on minimizing complications
Heart Conditions & Infective Endocarditis (IE)	Increased risk of infective endocarditis, spread of infection to the heart	Use appropriate prophylaxis as recommended by the American Heart Association, consultation with treating physician
Immunosuppressive Conditions	Weakened immune system, increased risk of infections	Awareness of increased infection risk, proper aftercare instructions
Inherited & Acquired Blood Disorders	Severe bleeding due to impact on clotting pathway, excessive risk of infections	Understand associated risks, potential for delayed wound healing and prolonged bleeding
Nevus & Pigmented Lesions	Difficulty monitoring for skin cancer risks, anecdotal reports of melanomas arising within tattoos	Analyze pre-existing lesions before tattooing, consider potential interference with monitoring for early signs of skin cancer
Pyoderma Gangrenosum (PG)	Triggering of skin lesions, rapid progression of ulcers	Caution against tattooing, awareness of high risk of triggering skin lesions

Systemic Diseases	Increased risk of adverse reactions including delayed healing, infection, and allergic reactions, granulomatous reactions	Thorough medical evaluation, closely monitor health conditions, minimize risks through proper aftercare
-------------------	---	---

Individuals with pre-existing medical conditions or using immunosuppressive therapies are at a higher risk of developing adverse effects such as infection, delayed healing, and risks of systemic diseases.

Possible Risks in Pregnancy and Breastfeeding

Tattooing poses potential health risks for individuals who are pregnant and breastfeeding due to concerns regarding the effects of tattoo ink and the process itself. Limited existing data suggests that pregnant women are advised to avoid tattoos due to possible transmission of infectious diseases, such as Hepatitis B and C, HIV, and other infections from contaminated tattoo equipment (Cohen, 2021). Additionally, physiological changes during pregnancy, including alterations in immune function and skin pigmentation, may heighten the risk of complications such as infection and adverse reactions to the ink and affect wound healing (Motosko, Bieber, Pomeranz, Stein, & Martires, 2017).

Concerning breastfeeding, although data regarding the transmission risk of harmful pathogens through breast milk due to tattooing is sparse, the potential remains for such transmission (Blackshaw et al., 2020; Roche-Paull, 2015). The impact of tattooing on the immune response and wound healing of the body during breastfeeding presents additional risks for both the mother and the infant.

Chemical Composition of Tattoo Ink

The chemical composition of tattoo ink, encompassing pigments, carriers, and preservatives, is implicated in developing tattoo-related adverse effects. Research by Laumann et al. (2006) identified elevated polycyclic aromatic hydrocarbons (PAHs), potential carcinogens, in black tattoo ink (Lehner et al., 2014). Additionally, many tattoo inks contain hazardous substances like lead, cadmium, and arsenic, posing risks of acute and chronic toxicity (Abed, Moosa, & Alzuhairi, 2024). Fels et al. (2023) reported heightened concentrations of these unsafe substances across a substantial proportion of tested tattoo inks.

Special Considerations and Possible Adverse Effects of Tridimensional Matryoshka Tattoos

A tridimensional matryoshka tattoo features multiple layers of artwork arranged to produce a three-dimensional illusion. However, the heightened complexity of this tattoo style raises concerns regarding potential medical toxicities and infection risks associated with the increased use of tattoo ink and related equipment.

Adverse Reactions

The presence of heavy metals, including copper and mercury, in tattoo ink utilized in tridimensional matryoshka tattoos poses risks for adverse reactions. These tattoos, characterized by multiple layers of artwork, extend the duration of exposure to ink containing diverse chemical compounds, thereby increasing the likelihood of allergic reactions, granulomatous or lichenoid reactions, and inflammation, resulting in systemic and local toxicities (Tammaro et al., 2019).

Distribution of Nickel and Chromium-Containing Particles

The presence of nickel and chromium particles in tattoo ink and equipment frequently utilized in tridimensional matryoshka tattoos is widespread. These particles have been associated with specific dermatological reactions in susceptible individuals and may potentially induce systemic toxicity over prolonged periods (Schreiber et al., 2019; Tammaro et al., 2019).

In a study utilizing laser-induced breakdown spectroscopy (LIBS), researchers assessed the distribution of tattoo ink (e.g., nickel and chromium particles) across various tissue layers and lymph nodes (Manrique, Garrido, & Velasco, 2024). The findings demonstrated the migration of ink particles into deeper subcutaneous tissue and axillary lymph nodes. These observations underscore the significance of selecting ink types judiciously—particularly in tridimensional matryoshka tattoos—to mitigate the risk of particle dissemination and subsequent immediate or delayed adverse effects.

Tattoo Inks and Specific Microorganisms

Tattoo image can be compromised, or the process can be complicated by infectious diseases caused by diverse microorganisms from contaminated ink and equipment and inadequate post-tattoo care practices (Table 3).

Bacteria

Bacterial infections are a prevalent complication associated with tattooing. Streptococcus and Staphylococcus species are frequently implicated in tattoo-related infections, with Staphylococcus aureus being the predominant bacterium linked to post-tattoo infections. Rare cases of Staphylococcus aureus infections present life-threatening risks (Dieckmann et al., 2016; Khunger et al., 2015).

Fungi

Complications related to fungal pathogens stem from tainted tattoo ink and equipment. Diverse fungi, including Candida species and Aspergillus spp., have been implicated in tattoo-associated infections, manifesting with a spectrum of symptoms and severity. Candida albicans, a yeast species, typically induces localized infections, while Aspergillus fumigatus, a fungal pathogen, can trigger invasive infections, particularly in immunocompromised individuals (Ho et al., 2020; Pfaller, Pappas, & Wingard, 2006).

Viruses

HCV and HIV have rarely been associated with tattooing-related infections. The primary transmission route of HCV and HIV is through exposure to contaminated blood and needles, mostly in intravenous drug users. However, some cases have been reported to be linked to tattooing-related practices (Bălăceanu-Gurău et al., 2024; Tohme & Holmberg, 2012).

Table 3. Specific Microorganisms and Their Adverse Effects

Microorganism Category	Specific Microorganism	Adverse Effects
Bacteria	Streptococcus	Commonly detected in infections after tattoos
	Staphylococcus	
	Staphylococcus aureus	Most common bacterium associated with post-tattoo infection; can be life-threatening in rare situations
Fungi	Candida	Various symptoms and severity including localized infections
	Aspergillus spp.	
	Candida albicans	Type of yeast causing localized infections
	Aspergillus fumigatus	Fungus causing invasive infections in individuals with immunosuppression
Viruses	Hepatitis C virus (HCV)	Rarely associated with tattooing-related infections; transmission through exposure to contaminated blood and needles
	Human immunodeficiency virus (HIV)	

In addition to the above concerns of contaminated ink and equipment, the health status of the tattoo artist, any assistants, and the overall tattooing environment should also be considered as possible contamination vectors.

Managing and Treating Tattoo Complications

Previously, acute side effects of tattoos included immediate pain, bleeding, swelling, and infection. In contrast, delayed complications include allergic dermatitis, photosensitivity, and the development of infections caused by various microorganisms (Khunger et al., 2015). These complications can be treated using various measures, including topical and systemic antibiotics, systemic steroids, anti-inflammatory agents, and laser therapy.

Laser therapy using quality-switched (Q-switched) lasers is an effective option for treating medical issues resulting from tattoos. It can treat acute irritations, allergic reactions from tattoo ink, and other dermatological complications (Williams, 2014). Laser-induced photoacoustic removal of tattoo ink uses high-intensity laser pulses to fragment ink molecules selectively. This process may result in some discomfort and minor long-term scarring, but it is generally less painful and more effective than surgical excision (Tjipta, Ramadhan, & Lubis, 2023).

Surgical interventions such as excision or reconstruction may be warranted in rare cases of severe tattoo complications. Complete excision may be indicated for severe allergic reactions, chronic inflammatory reactions associated with black ink, or papulonodular reactions resistant to alternative treatments. Reconstruction techniques such as skin grafting may also be necessary to address areas of necrosis resulting from allergic reactions or trauma (Othman et al., 2022).

Tattoo Safety and the Prevention of Possible Tattoo Complications

Ensuring tattoo safety and preventing tattoo-related complications are fundamental, and various strategies to mitigate adverse reactions should be implemented (Paola, Sazan, Laura, & Bianchi, 2016).

It is recommended that individuals choose a reputable and skilled artist who follows proper infection control procedures and utilizes sterile equipment to ensure safe tattooing.

Topical antibiotics or antiseptics may be applied to the tattoo site to prevent infection.

It is advised that individuals undergo thorough screening before tattooing to identify ink allergies or skin sensitivities that can cause adverse reactions.

Individuals with known or suspected immunocompromised conditions should consult their healthcare provider before getting a tattoo.

It is also important for individuals to adhere to aftercare instructions, which include avoiding swimming and exposure to sunlight and keeping the tattoo clean and moisturized.

Individuals can request a patch test before receiving a complete tattoo to identify and avoid allergic reactions to the tattoo.

Emergency Procedures for Severe Acute Tattoo-Induced Infections

Severe acute tattoo-induced infections are rare but can be life-threatening and require prompt medical attention and emergency or urgent care intervention.

Any signs or symptoms of an infection should immediately be reported to a healthcare provider. The symptoms of a severe acute tattoo-induced infection can include fever, chills, excessive pain, swelling, redness, and drainage from the tattoo site (Khunger et al., 2015).

In acute tattoo-induced infections, treatment strategies may vary depending on the severity of the infection and the causative agent. Broad-spectrum antibiotics, such as clindamycin, and intravenous fluids are often administered to manage the infection. In severe cases, surgical intervention (e.g., the removal of the affected tissue or amputation of the affected limb) may be required (Hui, 2010).

Patients with underlying risk factors, such as immunocompromised conditions or diabetes, may be more susceptible to severe acute tattoo-induced infections and should be

closely monitored.

Tattoo Removal Options

Tattoo removal can be managed through various methods, including laser therapy, surgical excision, dermabrasion, and chemical peels.

Laser therapy is the predominant choice for tattoo removal owing to its effectiveness and favorable safety profile. The laser light targets tattoo ink particles, fragmenting them into smaller components that are subsequently eliminated by the body's immune system via dermal macrophages. Typically, laser treatment necessitates multiple sessions spaced several weeks apart (Tjipta et al., 2023).

Surgical excision involves the complete removal of tattooed skin using a scalpel. It is typically utilized for small tattoos. However, it may not be suitable for larger tattoos due to the risk of substantial scarring (Othman et al., 2022).

Dermabrasion utilizes a high-speed rotary device to abrade the superficial layers of the skin, thereby eliminating the tattoo (Dash et al., 2022).

Chemical peels involve applying a chemical agent that induces blistering and peeling of the skin, ultimately resulting in tattoo removal (Dash et al., 2022).

Surgical excision, dermabrasion, and chemical peels are less commonly used due to the increased risk of scarring and pigmentary changes (Dash et al., 2022).

The selection of a tattoo removal method should involve consultation with a healthcare provider, considering factors such as the tattoo's size, location, pigment depth, and the individual's skin type. Notably, despite effective removal techniques, complete tattoo elimination and restoration of normal skin color and texture are not ensured.

Tattoo Removal Procedure Risks

Tattoo removal procedures carry risks, including pain, scarring, and textural changes in the skin. Laser therapy, the most common method, can cause pigmentary changes and local inflammatory reactions. Other removal techniques, such as dermabrasion and cryotherapy, have associated risks, specifically nerve damage and bacterial infections (Bălăceanu-Gurău et al., 2024).

Deterioration of Tattoo Appearance Overtime

Tattoo degradation and fading can occur over time and are influenced by the ink type and tattoo placement. Exposure to sunlight and UV radiation has been implicated in expediting tattoo ink fading. UV radiation absorption by skin melanin can induce photochemical degradation of tattoo ink, contributing to the probability of fading (Hauri & Hohl, 2015).

Reduced skin elasticity and hydration can also contribute to the degradation of tattoo aesthetics. Aging-induced epidermal thinning and dermal collagen and elastin loss may lead to blurred or distorted tattoo appearances (Imokawa & Ishida, 2015).

Friction, moisture, and certain medications may contribute to the fading and deterioration of tattoos.

Tattoos located on areas of the body that experience considerable friction (e.g., the hands or feet) may experience more rapid fading due to intermittent or persistent skin abrasion. Moisture can also cause the ink to degrade and fade over time. Some medications, such as antibiotics and retinoids, may increase the skin's sensitivity to UV radiation and accelerate the fading process (Hofmann & Weber, 2021).

Individuals are advised to minimize UV radiation exposure, particularly during peak hours, and adhere to a regimen of regular skin moisturization to preserve the tattoo's aesthetic integrity. Also, periodic touch-up sessions may be necessary to sustain the tattoo's vibrancy and clarity over time.

Self-Tattooing Risks

Self-tattooing, also known as DIY (do-it-yourself) tattooing is a common method that involves using non-sterile instruments such as needles, ink, and even pencil lead. Self-

tattooing is often performed in unsterile environments and can lead to infections or other complications, such as blood-borne diseases, scarring, and granulomas (Khunger et al., 2015; Patel & Cobbs, 2015).

While self-tattooing may appeal to some due to its lower cost and convenience, it can come with various risks. Self-tattooing can introduce bacteria and other pathogens into the skin that can cause infection. Moreover, self-tattooing can result in scarring, unevenness, and color fading (Khunger et al., 2015).

Self-tattooing is associated with a higher incidence of complications than professional tattooing (Patel & Cobbs, 2015). This higher incidence is likely due to a lack of training, experience, and proper equipment.

III. Conclusion

Tattoos, while prevalent and often embraced as a form of self-expression, come with inherent risks and complications. From infections to allergic reactions and scarring, the adverse effects can vary in severity and onset. Epidemiological studies have shed light on the prevalence of complications, with research indicating a substantial number of individuals experiencing issues post-tattooing. Factors such as age, socioeconomic status, gender, race, and culture play significant roles in both the likelihood of getting tattoos and the susceptibility to complications.

Individuals with pre-existing medical conditions face heightened risks, including those with diabetes, heart conditions, immunosuppressive conditions, inherited and acquired blood disorders, nevi, and systemic diseases. Pregnancy and breastfeeding also present concerns regarding the safety of tattooing due to physiological changes and potential transmission risks.

The chemical composition of tattoo ink, particularly in complex tattoo styles like tridimensional matryoshka tattoos, poses additional risks, including allergic reactions and systemic toxicity. Microbial contamination of tattoo ink and equipment further contributes to infectious complications, emphasizing the importance of strict infection control measures.

Effective management and treatment of tattoo complications involve various approaches, from topical treatments to laser therapy and surgical interventions. However, tattoo removal procedures also carry risks and may not always result in complete image elimination or restoration of normal skin appearance.

Garnering knowledge, proper screening, adherence to aftercare instructions, and selecting reputable tattoo artists are essential to mitigating risks and preventing adverse outcomes. Self-tattooing, in particular, poses significant dangers and should be avoided due to its association with higher complication rates and lack of sterilization practices.

References

- Abed, M. S., Moosa, A. A., & Alzuhairi, M. (2024). Heavy metals in cosmetics and tattoos: A review of historical background, health impact, and regulatory limits. *Journal of Hazardous Materials Advances*, 13, 100390. <https://doi.org/10.1016/j.hazadv.2023.100390>
- American Heart Association. (n.d.). Infective endocarditis. Retrieved from <https://www.heart.org/en/health-topics/infective-endocarditis>
- Anthony, E., Lun, K., Godbolt, A., & McMenemy, E. (2014). Diagnostic difficulties in skin cancer detection within tattoos. *Australian Family Physician*, 43(10), 714–715.
- Arruda, V. R., Lillcrap, D., & Herzog, R. W. (2022). Immune complications and their management in inherited and acquired bleeding disorders. *Blood*, 140(10), 1075–1085. <https://doi.org/10.1182/blood.2022016530>
- Bălăceanu-Gurău, B., Apostol, E., Caraivan, M., Ion, A., Tătar, R., Mihai, M. M., . . . Orzan, O. A. (2024). Cutaneous adverse reactions associated with tattoos and permanent makeup pigments. *Journal of Clinical Medicine*, 13(2), 503. <https://sgi-journals.com/>

<https://doi.org/10.3390/jcm13020503>

Barron, L. (2020). Tattoos and popular culture: Cultural representations in ink. Emerald Publishing Limited eBooks. Emerald Publishing Limited.
<https://doi.org/10.1108/9781839092152>

Blackshaw, K., Valtchev, P., Koolaji, N., Berry, N. J., Schindeler, A., Dehghani, F., & Bánati, R. B. (2020). The risk of infectious pathogens in breast-feeding, donated human milk and breast milk substitutes. *Public Health Nutrition*, 24(7), 1725–1740.
<https://doi.org/10.1017/s1368980020000555>

Bose, R., Sibley, C. D., & Fahim, S. (2020). Granulomatous and systemic inflammatory reactions from tattoo ink: Case report and concise review. *SAGE Open Medical Case Reports*, 8, 2050313X2093603. <https://doi.org/10.1177/2050313x20936036>

Bulbuloglu, S., & Kapikiran, G. (2021). The effect of immunosuppressive therapy after liver transplantation on activities of daily living and fear of death during the COVID-19 pandemic. *Transplant Immunology*, 69, 101470.
<https://doi.org/10.1016/j.trim.2021.101470>

Burgess, J. L., Wyant, W. A., Abujamra, B. A., Kirsner, R. S., & Jozic, I. (2021). Diabetic wound-healing science. *Medicina*, 57(10), 1072.
<https://doi.org/10.3390/medicina57101072>

Carson, H. J. (2014). The medium, not the message: How tattoos correlate with early mortality. *American Journal of Clinical Pathology*, 142(1), 99–103.
<https://doi.org/10.1309/ajcpdoi32fwqlueo>

Chalarcha-Cañas, D., Caviedes-Cleves, M. A., Londoño, L. a. C., Ospina-Gómez, J. P., & Velásquez- Lopera, M. M. (2024). Tattoos: risks and complications, clinical and histopathological approach. *Anais Brasileiros De Dermatologia*.
<https://doi.org/10.1016/j.abd.2023.07.004>

Clark, G., & Langley, M. C. (2019). Ancient tattooing in Polynesia. *Journal of Island and Coastal Archaeology*, 15(3), 407–420.
<https://doi.org/10.1080/15564894.2018.1561558>

Cohen, P. R. (2021). Tattoo-associated viral infections: A review. *Clinical, Cosmetic and Investigational Dermatology*, Volume 14, 1529–1540.
<https://doi.org/10.2147/ccid.s284796>

Cohen, P. R., Erickson, C. P., Uebelhoer, N. S., & Calame, A. (2020). Tattoo-associated basal cell carcinoma: Coincident or coincidence. *Biomedicine Hub*, 5(2), 1–8.
<https://doi.org/10.1159/000508208>

Dash, G., Patil, A., Kassir, M., Goldman, M. P., Gold, M. H., Adatto, M., . . . Goldust, M. (2022). Non- laser treatment for tattoo removal. *Journal of Cosmetic Dermatology*, 22(1), 74–78. <https://doi.org/10.1111/jocd.14819>

Dieckmann, R., Boone, I., Brockmann, S., Hammerl, J. A., Kolb-Mäurer, A., Goebeler, M., . . . Dahouk, S. A. (2016). The risk of bacterial infection after tattooing. *Deutsches Ärzteblatt International*. <https://doi.org/10.3238/arztebl.2016.0665>

Dropulic, L. K., & Lederman, H. M. (2016). Overview of infections in the immunocompromised host. *Microbiology Spectrum*, 4(4).
<https://doi.org/10.1128/microbiolspec.dmih2-0026-2016>

Fels, P., Lachenmeier, D. W., Hindelang, P., Walch, S. G., & Gutsche, B. (2023). Occurrence and regulatory evaluation of contaminants in tattoo inks. *Cosmetics*, 10(5), 141.

<https://doi.org/10.3390/cosmetics10050141>

- Friedman, R., Antoine, D. J., Talamo, S., Reimer, P., Taylor, J., Wills, B., & Mannino, M. A. (2018). Natural mummies from Predynastic Egypt reveal the world's earliest figural tattoos. *Journal of Archaeological Science*, 92, 116–125. <https://doi.org/10.1016/j.jas.2018.02.002>
- Guo, S., & DiPietro, L. A. (2010). Factors affecting wound healing. *Journal of Dental Research*, 89(3), 219–229. <https://doi.org/10.1177/0022034509359125>
- Hauri, U., & Hohl, C. (2015). Photostability and breakdown products of pigments currently used in tattoo inks. In *Current problems in dermatology* (pp. 164–169). <https://doi.org/10.1159/000369225>
- Ho, J., Camilli, G., Griffiths, J. S., Richardson, J. P., Kichik, N., & Naglik, J. R. (2020). *Candida albicans* and candidalysin in inflammatory disorders and cancer. *Immunology*, 162(1), 11–16. <https://doi.org/10.1111/imm.13255>
- Hofmann, G. G., & Weber, B. (2021). Drug-induced photosensitivity: Culprit drugs, potential mechanisms and clinical consequences. *Journal Der Deutschen Dermatologischen Gesellschaft*, 19(1), 19–29. <https://doi.org/10.1111/ddg.14314>
- Hui, D. (2010). Infectious diseases. In *Approach to Internal Medicine* (pp. 233–272). Springer. https://doi.org/10.1007/978-1-4419-6505-9_8
- Hussain, Y., & Khan, H. (2022). Immunosuppressive drugs. *Encyclopedia of Infection and Immunity*, 726–740. <https://doi.org/10.1016/b978-0-12-818731-9.00068-9>
- Imokawa, G., & Ishida, K. (2015). Biological mechanisms underlying the ultraviolet radiation-induced formation of skin wrinkling and sagging I: Reduced skin elasticity, highly associated with enhanced dermal elastase activity, triggers wrinkling and sagging. *International Journal of Molecular Sciences*, 16(12), 7753–7775. <https://doi.org/10.3390/ijms16047753>
- Khunger, N., Molpariya, A., & Khunger, A. (2015). Complications of tattoos and tattoo removal: Stop and think before you ink. *Journal of Cutaneous and Aesthetic Surgery*, 8(1), 30. <https://doi.org/10.4103/0974-2077.155072>
- Kluger, N. (2020). Systemic diseases and infections, anecdotal complications and oddities associated with tattooing. *Presse Medicale*, 49(4), 104055. <https://doi.org/10.1016/j.lpm.2020.104055>
- Korn, L., Bonny-Noach, H., Koren, G., & Nissanholtz-Gannot, R. (2021). Factors associated with medical complications after body art among Israeli adults: a retrospective study. *Israel Journal of Health Policy Research*, 10(1). <https://doi.org/10.1186/s13584-021-00474-w>
- Laumann, A. E., & Derick, A. (2006). Tattoos and body piercings in the United States: A national data set. *Journal of the American Academy of Dermatology*, 55(3), 413–421. <https://doi.org/10.1016/j.jaad.2006.03.026>
- Lehner, K., Santarelli, F., Vasold, R., Penning, R., Sidoroff, A., König, B., . . . Bäumlner, W. (2014). Black tattoos entail substantial uptake of genotoxic polycyclic aromatic hydrocarbons (PAH) in human skin and regional lymph nodes. *PloS One*, 9(3), e92787. <https://doi.org/10.1371/journal.pone.0092787>
- Leijts, M., Schaefer, H., Rübber, A., Cacchi, C., Rustemeyer, T., & Van Der Bent, S. (2021). Cutaneous malignancies in tattoos, a case series of six patients. *Current Oncology*, 28(6), 4721–4737. <https://doi.org/10.3390/curroncol28060398>

- Lippert, P. (1980). Tattooing: The image becomes the self. *ETC: A Review of General Semantics*, 37(2), 158–171. Retrieved from <https://www.jstor.org/stable/42575469>
- Litvinov, I. V., & Sasseville, D. (2014). Pyoderma gangrenosum triggered by red tattoo dye. *CMAJ. Canadian Medical Association Journal*, 186(12), 935. <https://doi.org/10.1503/cmaj.140122>
- Manrique, J. M., Garrido, P. L., & Velasco, J. (2024). Laser-induced breakdown spectroscopy in biological samples: A review of experiments with soft tissues. *Atoms*, 12(4), 21. <https://doi.org/10.3390/atoms12040021>
- Mieczkowski, M., Mrozikiewicz-Rakowska, B., Kowara, M., Kleibert, M., & Czupryniak, L. (2022). The problem of wound healing in diabetes—from molecular pathways to the design of an animal model. *International Journal of Molecular Sciences*, 23(14), 7930. <https://doi.org/10.3390/ijms23147930>
- Motosko, B. C. C., Bieber, A. K., Pomeranz, M. K., Stein, J., & Martires, K. J. (2017). Physiologic changes of pregnancy: A review of the literature. *International Journal of Women's Dermatology*, 3(4), 219–224. <https://doi.org/10.1016/j.ijwd.2017.09.003>
- Müller, N., Breuer, J., Adler, K., & Freudenthal, N. (2021). “Body modification: piercing and tattooing in congenital heart disease patients”, decoration or disaster?—a narrative review. *Cardiovascular Diagnosis and Therapy*, 11(6), 1395–1402. <https://doi.org/10.21037/cdt-21-458>
- Ochocinski, D., Dalal, M., Black, L. V., Carr, S., Lew, J., Sullivan, K., & Kissoon, N. (2020). Life-Threatening Infectious complications in sickle cell Disease: A concise narrative review. *Frontiers in Pediatrics*, 8. <https://doi.org/10.3389/fped.2020.00038>
- Othman, S., Elfanagely, O., Klifto, K. M., Fowler, C., Pugliese, D. J., & Kovach, S. J. (2022). Surgical excision and reconstruction of tattoo following hypersensitivity. *Eplasty*, 22, e15.
- Paola, P., Sazan, P., Laura, C., & Bianchi, I. (2016). Safety of tattoos and permanent make-up: Adverse health effects and experience with the Council of Europe Resolution (2008)1. Publications Office of the European Union. <https://doi.org/10.2788/177900>
- Patel, M., & Cobbs, C. (2015). Infections from Body Piercing and Tattoos. *Microbiology Spectrum*, 3(6). <https://doi.org/10.1128/microbiolspec.iol5-0016-2015>
- Petrochko, J. M., Krakowski, A. C., Donnelly, C., Wilson, J., Irick, J., & Stawicki, S. P. (2019). Tattoo-associated complications and related topics: A comprehensive review. *International Journal of Academic Medicine*, 5(1), 19. https://doi.org/10.4103/ijam.ijam_13_19
- Pfaller, M. A., Pappas, P. G., & Wingard, J. R. (2006). Invasive fungal pathogens: Current epidemiological trends. *Clinical Infectious Diseases/Clinical Infectious Diseases* (Online. University of Chicago. Press), 43(Supplement_1), S3–S14. <https://doi.org/10.1086/504490>
- Roche-Paull, R. (2015). Body modifications and breastfeeding: What you need to know. *Journal of Human Lactation*, 31(3), 552–553. <https://doi.org/10.1177/0890334415584597>
- Sanborn, G. (2011). Chapter three: Te Pehi Kupe's Moko. In *Whipscars and Tattoos: The Last of the Mohicans, Moby-Dick, and the Maori* (pp. 73–92). Oxford Academic. <https://doi.org/10.1093/acprof:oso/9780199751693.003.0003>

- Schaeffer, K., & Dinesh, S. (2023, August 15). 32% of Americans have a tattoo, including 22% who have more than one. Retrieved from <https://www.pewresearch.org/short-read/2023/08/15/32-of-americans-have-a-tattoo-including-22-who-have-more-than-one/>
- Schlott, S., Karrer, S., Terhorst-Molawi, D., & Dissemmond, J. (2020). Pyoderma gangrenosum as a late complication in tattoos: A case report series. *International Wound Journal*, 17(6), 2031–2032. <https://doi.org/10.1111/iwj.13453>
- Schreiber, I., Hesse, B., Seim, C., Castillo-Michel, H., Anklamm, L., Villanova, J., . . . Luch, A. (2019). Distribution of nickel and chromium containing particles from tattoo needle wear in humans and its possible impact on allergic reactions. *Particle and Fibre Toxicology*, 16(1). <https://doi.org/10.1186/s12989-019-0317-1>
- Shao, C., Casterline, B. W., & Martin, K. (2024). Tattoo-induced allergic contact dermatitis presents diagnostic challenge as a cellulitis mimic. *The American Journal of Emergency Medicine*, 77, 234.e1-234.e3. <https://doi.org/10.1016/j.ajem.2023.12.016>
- Shashikumar, B., Harish, Bondel, S., Manjunath, K., Kalegowda, D., & Phani, H. (2017). Hypersensitive reaction to tattoos: A growing menace in rural India. *PubMed*, 62(3), 291–296. https://doi.org/10.4103/ijid.ijd_210_16
- Tamaro, A., Iacovino, C., Magri, F., Capalbo, A., Giordano, D., R, P. F., . . . De Marco, G. (2019). Tridimensional Matryoshka tattoo: An important. *ADC: Acta Dermatovenerologica Croatica*, 27(3), 198–199.
- Tampa, M., Mitran, M. I., Mitran, C. I., Matei, C., Amuzescu, A., Buzatu, A., & Georgescu, S. R. (2022). Viral infections confined to tattoos—a narrative review. *Medicina*, 58(3), 342. <https://doi.org/10.3390/medicina58030342>
- Temiz, S. A., & Özlü, E. (2021). Medical complications of tattoos. *Journal of the Turkish Academy of Dermatology*, 15(1), 1–7. <https://doi.org/10.4274/jtad.galenos.2021.02486>
- Tjipta, A., Ramadhan, H., & Lubis, R. A. (2023). Immune response in laser tattoo Removal: A systematic review. *Journal of Lasers in Medical Sciences*, 14, e66. <https://doi.org/10.34172/jlms.2023.66>
- Tohme, R. A., & Holmberg, S. D. (2012). Transmission of hepatitis C virus infection through tattooing and piercing: A critical review. *Clinical Infectious Diseases/Clinical Infectious Diseases (Online. University of Chicago. Press)*, 54(8), 1167–1178. <https://doi.org/10.1093/cid/cir991>
- Velsor, A. (2016). Personal agency and the tattooed body: Individual identity communicated through voluntary and involuntary tattoos. *California State University Dominguez Hills*. Retrieved from <http://hdl.handle.net/20.500.12680/1544bp86s>
- Williams, N. (2014). Quality-switched laser tattoo removal. *Journal of the American Academy of Physician Assistants*, 27(6), 53–56. <https://doi.org/10.1097/01.jaa.0000447001.04339.bo>
- Wong, S. S., Wong, S. C., & Yuen, K. (2012). Infections associated with body modification. *Journal of the Formosan Medical Association*, 111(12), 667–681. <https://doi.org/10.1016/j.jfma.2012.10.016>
- Young, R. F. (2021). Invisible ink? The strange case of the vanishing tattoos, or—missionaries, art, and (mis)representation in early “Christian” Hawaii, ca. 1837. *The Journal of Presbyterian History (1997-)*, 99(2), 57–69.