



EUROPEAN COMMISSION
DIRECTORATE GENERAL JRC
JOINT RESEARCH CENTRE
Institute for Health and Consumer Protection
Physical and Chemical Exposure Unit

Risks and Health Effects from Tattoos, Body Piercing and Related Practices

by
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Final Draft

Peer-reviewed by the
“JRC – Regulatory and Scientific/Technical Tattoo/piercing expert network”
“JRC-TattooNet”

Ispra, 05 May 2003

Foreword

The present preliminary version of this working paper is a step in a series of actions of the Institute for Health and Consumer Protection (IHCP)/Physical and Chemical Exposure Unit (PCE) aiming at supporting the work of DG SANCO, European Commission in the field of “Technical/scientific and regulatory issues on the safety of tattoos, body piercing and of related practices”.

A Technical Working Group (TWG) of experts from Member States was established to carry out the action plan of the project. This action plan and the minutes of the meetings of the TWG will be available at the project website currently under construction.

The members of the TWG are currently developing in collaboration with other experts and organisations, the following working papers:

- ◆ **Regulatory Review (JRC)**
- ◆ **Chemicals used in tattoos/piercings** (Norwegian Food Control Authority & CHEMTOX A/S & University Regensburg)
- ◆ **Review of health effects and risks** (JRC & University Regensburg & WHO)
- ◆ **Policy options:**
 - ◆ **Positive & negative list** (Norwegian Food Control Authority)
 - ◆ **Risk Assessment** (Dutch Inspectorate for Health Protection)
 - ◆ **Authorisation & Registration** (Danish EPA & CHEMTOX A/S)
 - ◆ **Education & Skills** (National Consumer Agency, Finland)
 - ◆ **Hygiene Practices** (Dutch Inspectorate for Health Protection & GC&GD Amsterdam)
- ◆ **Status Report on the current situation, nature and size of the problem in the EU** (JRC)

The draft versions of these working papers will be peer-reviewed by the members of the “**JRC – Regulatory and Scientific/Technical Tattoo/Piercing expert network**” and the final texts will be published following their presentation and discussion in a **workshop in 6-7 May 2003 at the premises of the JRC in Ispra, Italy**.

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1. Project Description

Regarding the safety of tattoos and body piercing there are recent concerns expressed by Member States and the European Parliament, in particular because of the health risks involved and the absence of a clear legislative background in the EU and at world scale. In this light, the JRC has been requested by DG SANCO to undertake action with the overall aim to collect and assess all necessary information for establishing a common knowledge basis for the conception of a future legislation at EU level. The main axes are:

- ◆ Take stock of the actual situation in the EU on tattooing and body piercing activities in terms of prevalence
- ◆ Review the regulatory situation on tattooing/body piercing in the EU and elsewhere
- ◆ Review the safety data, epidemiology, of tattooing dyes and pigments, piercing, tattooing/body piercing practices
- ◆ Review the professional aspects (training, requirements, hygiene standards, etc)

The end of the day goal is to assess the need of, and, if appropriate, come up with regulatory proposals to harmonise these activities across the EU. In this undertaking, the JRC and DG SANCO are working together with the Council of Europe, which is preparing a resolution on “permanent make-up and tattooing colours”.

As a first step, a technical working group from experts active in Member States in the above areas was established. The working group is assisting the JRC in the planning of the work, the information exchange/assessment and the review of the deliverables. Two meetings have been held at the JRC, Ispra on December 16th 2002 and in Brussels on January 28th 2003.

In these meetings the members of the TWG reviewed the currently available information and agreed that the currently available policy options are the following:

- provisions on authorisation/registration of the activity
- provisions on skills/education of the practitioners
- provisions on the equipment/space
- provisions on hygienic practices
- provisions on sterility of products/equipment/practices
- request for risk assessment
- introduction of a negative list of substances
- introduction of a positive list of substances

On this basis the JRC is organising a **workshop on “Technical/scientific and regulatory issues on the safety of tattoos, body piercing and of related practices” in Ispra on 6-7 May 2003**. The workshop includes daily sessions:

- technical/scientific issues on health effects and risks
- regulatory issues and roundtable discussion.

2. Scope of the present survey

In line with the above overall project objectives, the focus of the present draft working paper is to review the current knowledge on health effects and risks. To this end, we present in this paper the results of our preliminary survey of the existing publications on this subject. Being aware that our current information basis is very limited, we are kindly inviting the recipients of this survey to

- ◆ **verify that the information concerning their own publications or activities is interpreted and integrated in the text appropriately**
- ◆ **communicate to us detailed scientific information on their current activities**
- ◆ **communicate to us about regulatory information and activities by using the attached questionnaire on the regulatory review**
- ◆ **communicate to us any missing information whose inclusion in this working paper is important**
- ◆ **feel free to comment on any area independent from their own.**

On the basis of this survey, the information collection was completed and JRC is able to distribute the final draft version to all experts participating in the “**JRC-TattooNet**”. Finally, the working paper will be briefly presented in the May workshop and published following the conclusions of this workshop. In the future, the paper will be updated when needed.

3. Review of Health Effects & Risks

3.1 Introduction

Since tattoo compounds in comparison to cosmetics are not officially controlled, the origin and chemical structure of these colouring agents are hardly known, even the tattoo manufacturers do not know which substances are punctured into the skin. There is no disclosure of the ingredients of these colouring agents. A variety of tattoo pigments has been analysed recently^{1,2,3}. The results show that pigments are mainly industrial organic pigments with high microbiological and impurities load.

The resulting health effects are numerous and to some extent documented as single case reports. On the basis of the case reports collected in the literature we organised the present review along the axes:

- ◆ Infectious Risks
- ◆ Non-Infectious Risks

Peer review of the information presented and more systematic networking of the scientific society involved will possibly provide the clues for future ways of effectively monitoring the health effects to adequately support regulatory action.

¹ H.R. Reus; R.D. van Buuren, Inspectorate for Health Protection North, Ministry of Health: Tattoo and Permanent Make-up Colorants. An exploratory examination of: -Chemical and microbiological composition; - Legislation, Report no ND COS 012, November 2001

² Lundsgaard J: Chemtox A/S: Investigation of pigments in tattoo colours, Survey no 2 – 2002, on behalf of the Danish EPA

³ Baeumler W; Eibler ET; Hohenleutner U; Sens B; Saeur J; Landthaler M: Q-switch laser and tattoo pigments: first results of the chemical and photophysical analysis of 41 compounds, Lasers Surg Med. 2000;26(1):13-21

3.2 Infectious Risks

Evidence about TTDs (Transfusion-Transmitted-Diseases) that can be transmitted by tattooing has been recently reviewed systematically⁴. TTDs include viral, infections and diseases, bacterial infections and diseases, fungal infections and diseases, and potentially Chagas disease.

3.2.1 Viral infections

Viral infections and diseases potentially transmitted by tattooing include the following viruses:

- Hepatitis B virus (HBV);
- Hepatitis C virus (HCV);
- Hepatitis D virus (HDV);
- Human immunodeficiency virus (HIV) transmitting acquired immunodeficiency syndrome (AIDS);
- Papillomavirus causing cutaneous infections;
- Vaccinia

Hepatitis is an inflammation of the liver. The most common cause is one of the five hepatitis viruses, but it can also be caused by other viruses, bacteria, parasites, and toxic reactions to drugs, alcohol, and chemicals.

AIDS is a disease of the human immune system that is caused by infection with the retrovirus HIV; that is characterized cytologically by esp. by reduction in the number of T helper cells; that is commonly transmitted in blood and bodily secretions, and that renders the subject highly vulnerable to life/threatening conditions (pneumonia, Karposi sarcoma).

Cutaneous infections caused by papillomavirus include common warts, plantar warts, and juvenile or flat warts.

Vaccinia is a virus infection of cow's udders, transmitted to man by direct contact, causing very mild symptoms similar to smallpox.

According to some studies, there is strong evidence for the transmission of hepatitis B virus (HBV) infection and hepatitis C virus (HCV) infection by tattooing. Tattooing may also transmit the human immunodeficiency virus (HIV). Epidemiological studies to date

⁴ Nishioka S de A; Gyorkos TW: Tattoos as risk factors for transfusion-transmitted diseases, *Int J Infect Dis* 2001;5(1):27-34

have shown a large variation in odds ratio estimates of the association between tattooing and HBV, HCV, and HIV infections^{5,6,7,8,9}.

Clinically apparent HCV infection developed in a prison inmate after two tattooing episodes within the recognised incubation period for HCV infection. Seroconversion and HCV viraemia with subsequent resolution of hepatitis and loss of plasma viraemia were also documented¹⁰. Self-made tattoo instruments in prison may be important in transmitting viral infections.

A report about the situation in the city of Frankfurt am Main, Germany is covering the period 1995-1999¹¹. Studios for tattoos or piercing were informed about hygiene rules and annually controlled from 1995-1999, using a special checklist on cleanliness in the studios, disinfection and sterilisation procedures etc. For permission of tattoo and piercing exhibitions special hygiene orders were made mandatory. During 1995-1997 the absolute number of complaints decreased from 20 to 9, in spite of the increasing number of tattoo studios in Frankfurt am Main (from 6 to 10). This was true also of the tattoo and piercing exhibitions. After 1 year without control visits however, an increase of complaints to 22 was to be seen in 1999. A report on the prevention of infectious diseases by the Public Health office of the city of Bremen¹² has also been published.

Viral transmission (hepatitis B, hepatitis C, hepatitis delta, HIV) is another risk considered by the French study group, which reports that a few cases of fatal fulminant hepatitis have been described immediately after piercing.

Another study tried to define risk factors associated with HCV transmission in patients without a previous history of injection drug use or blood transfusion before 1990. In this case-controlled study, three independent risk factors of "sporadic" HCV were identified. These included a history of sexually transmitted disease, heavy alcohol intake, and presence of a tattoo(s). In addition, a larger number of cases had a history of needle-stick

⁵ Nishioka S de A; Gyorkos TW; Joseph L; Collet JP; Maclean JD: Tattooing and risk for transfusion-transmitted diseases: the role of the type, number and design of the tattoos, and the conditions in which they were performed, *Epidemiol Infect* 2002 Feb;128(1):63-71

⁶ Franz R: Tattooing a major route of hepatitis C infection, *Dermatol Nurs* 2001 Aug;13(4):307-8

⁷ Nishioka S de A, Gyorkos TW, MacLean JD Tattoos and transfusion-transmitted disease risk: implications for the screening of blood donors in Brazil. *Braz J Infect Dis* 2002 Aug;6(4):172-80

⁸ Nishioka S de A, Gyorkos TW, Joseph L, Collet J-P, MacLean JD. Tattooing and transfusion-transmitted diseases in Brazil: A hospital-based cross-sectional matched study. *Eur J Epidemiol* (in press)

⁹ Nishioka S de A, Gyorkos TW, Collet J-P, Joseph L. Selection of subjects for hospital-based studies based on outward manifestations of disease. *Clin Invest Med* 2001; 24:299-303.

¹⁰ Post JJ; Dolan KA; Whybin LR; Carter IW; Haber PS; Lloyd AR: Acute hepatitis C virus infection in an Australian prison inmate: tattooing as a possible transmission route, *Med J Aust* 2001 Feb 19;174(4):183-4

¹¹ Heudorf U; Kutzke G; Seng U: Tattooing and body piercing--experiences from public health infection surveillance by a public health office [Tatowieren und Piercing--Erfahrungen aus der infektionshygienischen Überwachung eines Gesundheitsamtes.] *Gesundheitswesen* 2000 Apr;62(4):219-24

¹² Zolondek U; Stelling R; Hohmann H: Development of public health regulations for tattooing and piercing and their realization][Entwicklung von Hygieneregeln für das Tatowieren und Piercing und ihre Umsetzung.] *Gesundheitswesen* 1998 Mar;60(3):170-2

exposure when compared to controls. Including needle exposure as another independent risk factor, 88% of the "sporadic" cases had an identified risk factor for their HCV infection. Unfortunately, these authors did not assess the role of intranasal cocaine use as a possible risk factor in this study¹³.

In a recent study¹⁴ in the United States risk factors for blood-borne infection were assessed by physician's interview of 626 consecutive patients undergoing medical evaluation for spinal problems in 1991 and 1992 while unaware of their HCV status. Later all were screened for HCV infection with enzyme-linked immunosorbent assay (EIA-1 and EIA-2), and positives were confirmed with second-generation recombinant immunoblot assay (RIBA). Forty-three patients were seropositive for HCV. Logistic regression analysis identified 4 independent risk factors for HCV infection: injection-drug use, ancillary hospital jobs held by men, tattoos from commercial tattoo parlours, and drinking. If causal, these 4 risk factors account for 91% of HCV infections, with tattooing explaining 41%, heavy beer drinking 23%, injection-drug use 17%, and ancillary health care jobs for men 8%. Unlikely to be explained by confounding or incomplete disclosure of other risk factors, tattooing in commercial tattoo parlours may have been responsible for more HCV infections than injection-drug use.

The two latter studies quoted above have been debated controversially regarding the causal association between tattooing and HCV¹⁵. Some other studies do not provide evidence to support the observation that tattoos serve as a risk factor for chronic viral hepatitis¹⁶, and most particularly regarding HCV¹⁷. Moreover, one has to take into consideration that the class of population – involved in tattoos – changed within the last five years. Nowadays, not only people with abuse of drugs and alcohol have tattoos. Obviously, there is a need of new studies regarding the infection with hepatitis, in particular in view of new types of hepatitis.

The relationship of viral hepatitis and body piercing has been reviewed in a study considering twelve research studies published between 1974 and 1997. Eight of them identified¹⁸ percutaneous exposure, including body piercing and ear piercing, as a risk

¹³ Balasekaran R, Bulterys M, Jamal MM, et al. A case-control study of risk factors for sporadic hepatitis C virus infection in the Southwestern United States. *Am J Gastroenterol* 1999;94:1341-6

¹⁴ Haley RW; Fischer RP: Commercial tattooing as a potentially important source of hepatitis C infection. *Clinical epidemiology of 626 consecutive patients unaware of their hepatitis C serologic status*, *Medicine (Baltimore)* 2001;80(2):134-51

¹⁵ Alter MJ *Epidemiological Studies Evaluating Risk of Viral Hepatitis Infection from Tattoos and Body Piercing*. Website: http://www.fda.gov/OHRMS/DOCKETS/ac/02/briefing/3839s1_12_alter/

¹⁶ Silverman AL; Sekhon JS; Saginaw SJ; Wiedbrauk D; Balasubramaniam M; Gordon SC: Tattoo application is not associated with an increased risk for chronic viral Hepatitis, *Am J Gastroenterol* 2000 May;95(5):1312-5

¹⁷ Thompson SC; Goudey RE; Breschkin AM; Carnie J; Catton M: Exposure to hepatitis B and C of tattooists in Victoria in 1984, *J Viral Hepat* 1997 Mar;4(2):135-8

¹⁸ Hayes MO; Harkness GA: Body piercing as a risk factor for viral hepatitis: an integrative research review, *Am J Infect Control* 2001 Aug;29(4):271-4

factor for viral hepatitis. Six studies found that hepatitis seropositivity was significantly associated with ear piercing.

A recent study¹⁹ reported on thirty-one female patients with leprosy lesions starting over tattoo marks observed over a period of 16 years are reported. All the patients belonged to the Chhattisgarh State, which is highly endemic for leprosy. Most of the patients were in the third decade of life. All of them had ornamental tattooing done by roadside tattoo artists, who used unsterile needles for tattooing a large gathering one after another with the same needles. In all of them, the first lesion of leprosy started over a tattoo mark. Twenty-five cases had only single lesion of leprosy exclusively confined to tattoo marks. The duration between tattooing and appearance of first lesion in most of the cases varied from 10 to 20 years. Paucibacillary leprosy was the commonest type observed in 29 cases, while two had multibacillary leprosy. The diagnosis was confirmed by histopathology in all cases. This study supports the hypothesis of transmission of leprosy in these cases through tattooing.

3.2.2 Bacterial infections

Bacterial infections and diseases transmitted by tattooing include the following bacteria²⁰:

- Streptococcus pyogenes, leading to impetigo, erysipelas, and septicemia;
- Staphylococcus aureus transmitting toxic shock syndrome;
- Pseudomonas aeruginosa transmitting septicemia;
- Clostridium tetani transmitting tetanus;
- Haemophilus ducreyi transmitting chancroid;
- Treponema pallidum transmitting syphilis;
- Mycobacterium tuberculosis transmitting tuberculosis;
- Mycobacterium leprae transmitting leprosy.

Impetigo is an inflammatory skin disease marked by isolated pustules, which become crusted and rupture. It usually occurs around the mouth and nostrils. Erysipelas is an acute febrile disease with localized inflammation and redness of the skin and subcutaneous tissue accompanied by systemic signs and symptoms including fever, chills, nausea, vomiting, painful and warm skin, and hot, red lesions on the face and head. Septicemia is the presence of pathogenic microorganisms (bacteria, fungi, parasites, mycobacteria) in the blood.

The toxic shock syndrome is a rare and sometimes fatal disease caused by a toxin or toxins produced by the bacterium staphylococcus aureus.

¹⁹ Ghorpade A: [Inoculation \(tattoo\) leprosy: a report of 31 cases](#), J Eur Acad Dermatol Venereol 2002 Sep 16:494-9

²⁰ Nishioka S de A; Gyorkos TW: Tattoos as risk factors for transfusion-transmitted diseases, Int J Infect Dis 2001;5(1):27-34

Tetanus is an infectious disease of the central nervous system caused by an endotoxin of the tetanus bacillus. The toxin is produced at the site of a wound.

Chancroid is a highly infectious non-syphilitic venereal ulcer caused by the gram-negative Ducrey's bacillus. Syphilis is an infectious, chronic venereal disease marked by lesions that may involve any organ or tissue with usually cutaneous manifestations.

Tuberculosis is characterized pathologically by inflammatory infiltrations, formation of tubercles, caseation, necrosis, abscesses, fibrosis, and calcification. It most commonly affects the respiratory system, but other parts of the body such as the gastrointestinal genitourinary tracts, bones, joints, nervous system, lymph nodes, and skin may also become infected. All three types of the tubercle bacillus may infect humans: human, bovine and avian. Tuberculosis may occur in an acute generalized form or in chronic localized form. The primary infection usually consists of localized lesions of the lung.

Leprosy is a communicable disease, which may occur at any age, and in various clinical forms. The two principal forms are lepromatous (LL) and tuberculoid (TT). The LL form is characterized by skin lesions and symmetrical involvement of peripheral nerves (skin, upper respiratory tract, testes) with anaesthesia, muscle weakness, and paralysis. In TT, which is usually benign, the nerve lesions are asymmetrical and skin anaesthesia is an early occurrence. LL is much more contagious than TT.

In France between 10% and 20% of all piercings are reported to lead to a local infection²¹. This seems to be consistent with results obtained in the USA²². The most commonly found causal agents are Staphylococcus aureus, group A Streptococcus and Pseudomonas spp. These germs may eventually cause severe life-threatening complications even in common localizations (earlobe).

Piercing the upper ear can cause infection. Its devastating chondritis leads to collapse of the ear. Five cases referred for autogenous-tissue ear reconstruction are reported²³. In four of them, the destroyed segments of ear cartilage were replaced with a carved costal-cartilage framework. In another study, a male patient, who underwent chest augmentation and nipple piercing, developed chronic nipple infection, which led to unnecessary invasive diagnostic procedures, serious implant infection, and eventually urgent explantation. The study²⁴ recommends avoiding nipple piercing in men with chest implants. Another study

²¹ Guiard-Schmid JB; Picard H; Slama L; Maslo C; Amiel C; Pialoux G; Lebrette MG; Rozenbaum W: [Piercing and its infectious complications. A public health issue in France] [Le piercing et ses complications infectieuses. Un enjeu de sante publique en France.] Presse Med 2000 Nov 18;29(35):1948-56

²² Braithwaite R.L. et al.: Risks associated with tattooing and body piercing, J. Public Health Policy, 1999; 20: 459-70

²³ Cicchetti S; Skillman J; Gault DT: Piercing the upper ear: a simple infection, a difficult reconstruction, Br J Plast Surg 2002 Apr;55(3):194-7

²⁴ de Kleer N; Cohen M; Semple J; Simor A; Antonyshyn, O: Nipple piercing may be contraindicated in male patients with chest implants, Ann Plast Surg 2001 Aug;47(2):188-90

reported²⁵ three adolescents who developed infections due to anaerobes at pierced body sites: the nipple, the umbilicus and the nasal septum. Anaerobes (*Prevotella intermedia* and *Peptostreptococcus anaerobius*) were recovered from pure culture of specimens obtained from one patient with nipple infection and were mixed with aerobic bacteria in cultures of specimens obtained from two patients (*Streptococcus aureus*, *Peptostreptococcus micros* and *Prevotella melaninogenica* were recovered from a patient with nasal septum infection and *Bacteroides fragilis* and *Enterococcus faecalis* were recovered from a patient with umbilical infection). The infection resolved in all patients after removal of the ornaments and use of antimicrobial drug treatment.

Reported infectious cases related to tattooing are of endocarditis caused by repeated tattooing in an individual with known valvular heart disease²⁶, candida endophthalmitis after tattooing in an asplenic patient²⁷.

Piercing has also been correlated with endocarditis. The case of a 24-year-old man in whom coarctation of the aorta had been corrected 15 years earlier has been reported²⁸. Two months after piercing his left nipple without antibiotic prophylaxis, he developed a local mastitis, followed by bacterial endocarditis that required replacement of the aortic valve. Another case study²⁹ of a 25 years old man with congenital heart disease suggests that *H. aphrophilus* endocarditis was possibly caused by tongue piercing.

The results from a survey carried out in the Netherlands³⁰ on the chemical composition and microbiological contamination of products used for tattoos and PMU give a glimpse of the health risks involved: 63 samples of products used for tattoos and PMU from the Dutch market and taken from opened and sealed containers were analysed for the presence of pathogenic bacteria, yeasts and moulds. Eleven samples (18%) were found to be microbiologically contaminated. Of these eleven samples, eight samples had been taken from opened colorant containers and three from sealed containers. In seven samples, more than 100,000 bacteria/ml were found. Six samples (10%) contained the species *Pseudomonas*. The pathogen *Pseudomonas aeruginosa* was identified in three samples (5%). Intradermal injection of these contaminated dyes products could result in serious infections.

²⁵ Brook I: Recovery of anaerobic bacteria from 3 patients with infection at a pierced body site, *Clin Infect Dis* 2001 Jul 1;33(1):e12-3

²⁶ Satchithananda DK; Walsh J; Schofield PM: Bacterial endocarditis following repeated tattooing, *Heart* 2001 Jan;85(1):11-2

²⁷ Alexandridou A; Reginald AY; Stavrou P; Kirkby GR: Candida endophthalmitis after tattooing in an asplenic patient, *Arch Ophthalmol* 2002 Apr;120(4):518-9

²⁸ Ochsenfahrt C; Friedl R; Hannekum A; Schumacher BA: Endocarditis after nipple piercing in a patient with a bicuspid aortic valve, *Ann Thorac Surg* 2001 Apr;71(4):1365-6

²⁹ Akhondi H; Rahindi AR: Haemophilus aphrophilus Endocarditis after Tongue piercing, *Emerging Infectious Diseases* [serial online] August 2002, www.cdc.gov/ncidod/EID/vol8no8/01-0458.htm

³⁰ H.R. Reus; R.D. van Buuren, Inspectorate for Health Protection North, Ministry of Health: Tattoo and Permanent Make-up Colorants. An exploratory examination of: -Chemical and microbiological composition; - Legislation, Report no ND COS 012, November 2001

3.2.3 Fungal infections

Fungal infections and diseases transmitted by tattooing include the following fungi:

- *Sporotrix schenckii* transmitting sporotrichosis;
- *Saksenaea vasiformis* transmitting zygomycosis.

Sporotrichosis is a chronic granulomatous infection usually of the skin and superficial lymph node, marked by the formation of abscesses, nodules, and ulcers.

Zygomycosis refers to the angiotropic (blood vessel-invading) infection produced by the various Zygomycetes. Mycoses caused by members of the family Mucorales (and sometimes the family Entomophthorales) are generally acute and rapidly developing in debilitated patients. The infection typically involves the rhino-facial-cranial area, lungs, gastrointestinal tract, skin, or less commonly other organ systems. The fungi show a predilection for vessel (arterial) invasion resulting in embolization and necrosis of surrounding tissue. Suppurative pyogenic reactions develop. Infections are typically acute and fulminant. Rhinocerebral disease in acidotic patients usually results in death, often within a few days

3.2.4 Other infectious diseases

Chagas disease is caused by *Trypanosoma cruzi* and is characterized by fever, lymphadenopathy, hepatosplenomegaly, and facial edema. Chronic cases may be mild or asymptomatic, or may be accompanied by myocardioathy, megaesophagus, and megacolon, with fatal outcome. The biting reduviid bug transmits the disease. There is no evidence to date regarding transmission via tattooing.

3.3 Non-Infectious Risks

A recent review³¹ of the English literature provides a quick reference to tattoo reactions. Generally, the pigments used for tattooing seem to be well tolerated by the skin. Nevertheless, adverse reactions have been published in the literature, which might be arranged in three main classes of tattoo-associated dermatopathies: allergic/granulomatous/lichenoid, inoculation/infection, and coincidental lesions. However, it is very likely, that a great number of skin reactions on tattoos is not reported.

Acute inflammatory reactions are associated with physical tissue injury and the injection of pigment dyes or metals into skin. This reaction usually recedes without consequence within 2-3 weeks and is an expected side effect of the tattooing process.

Once acute inflammatory changes have resolved, the most frequent reaction observed with tattoos is an allergic sensitivity to one of its pigments. Patients may manifest sensitivity to a particular pigment in several ways. Histopathologic evaluation of involved skin may reveal a spongiotic, granulomatous, or lichenoid type of tattoo reaction.

When a hypersensitivity reaction to a tattoo pigment is identified, the dermatitis most often is contact or photoallergic dermatitis. These may manifest clinically as localized eczematous eruptions or, rarely, as an exfoliative dermatitis. Histopathologic findings include acanthosis, spongiosis, and a lymphocytic perivascular infiltrate³².

3.3.1 Allergic Reactions

An allergic reaction is an acquired, abnormal immune response to a substance (allergen) that does not normally cause a reaction. Sensitisation, or an initial exposure to the allergen is required; subsequent contact with the allergen then results in a broad range of inflammatory response. Allergic conditions include eczema, allergic rhinitis or acute catarrhal inflammation of the nasal mucous membrane, hay fever, bronchial asthma, urticaria (hives) and food allergy. Allergens may be introduced by contact, ingestion, inhalation or injection.

There are several cases reported in the literature regarding tattoo and allergy, which state that cutaneous allergic reactions to pigments in tattoos are not infrequent.

- A) A case of an allergic reaction to India ink in a black tattoo is described³³.
- B) A case of urticaria in a tattooed patient due to hypersensitivity to the cobalt chloride contained in the blue ink used for tattoo has been reported. The patch test with the

³¹ Jacob CI: Tattoo-associated dermatoses: a case report and review of the literature, *Dermatol Surg* 2002 Oct;28(10):962-5

³² Tanzi EL; Michael E: Tattoo reactions, <http://www.emedicine.com/derm/topic512.htm>.

³³ Gallo R; Parodi A; Cozzani E; Guarrera M: Allergic reaction to India ink in a black tattoo, *Contact Dermatitis* 1998 Jun;38(6):346-7

series of International Contact Dermatitis Research Group was positive only for cobalt chloride. Cobalt chloride is believed to be responsible for contact urticaria through a non-immunological mechanism³⁴.

- C) A 42-year-old man presented with an allergic reaction in the red parts of his tattoos. Histologically a chronic granulomatous, partly fibrous inflammation with transfollicular elimination of pigment granules was found. Spontaneous regression in a part of the inflammatory reaction was observed, simultaneously with depigmentation and scarring of the overlying skin. The pigment used for tattooing was found to be an aromatic azo derivative. In addition to a positive cutaneous reaction to the dye, the patient also showed a positive patch test to Naphthol AS, used for the coupling of different dyes in the textile industry³⁵.
- D) An investigation³⁶ on nickel allergy from piercing was carried out in Denmark between March 1999 and March 2000 involving 427 girls in public schools (mean age 12.4 years, range 10-14) and 534 girls in high schools (mean age 18.8 years, range 17-22). They all filled out a questionnaire concerning ear piercing, use of oral braces and former patch testing for nickel sensitivity. 305 girls (71.4%) in public schools and 275 girls (51.5%) in high schools/production schools were patch tested. 17.1% of girls in high schools demonstrated a positive patch test reaction to nickel. In contrast, the prevalence of nickel sensitisation in the public schools was only 3.9%. Comparing girls with and without pierced ears, the prevalence of nickel sensitisation was significantly higher in girls with ears pierced before, but not after 1992 (odds ratio 3.34 and 1.20 respectively). The study concluded that implementation of the nickel-exposure regulation in 1992 in Denmark protected the female population from becoming allergic to nickel.
- E) Eighteen patients who developed cutaneous reactions to red tattoos were studied to identify the chemicals responsible for the reactions to modern red tattoo pigments. Biopsies from the tattoos were examined histologically and the chemical composition of the red pigments was analysed by X-ray microanalysis. A variety of metallic elements including aluminium, iron, calcium, titanium, silicon, mercury and cadmium were detected. Patch tests were performed to the relevant chemicals in nine cases, and only one patient reacted to mercury. This study demonstrates that although reactions to mercury still occur, other red dyes containing a variety of inorganic pigments may provoke a cutaneous inflammatory response³⁷.

³⁴ Bagnato GF; De Pasquale R; Giacobbe O; Chirico G; Ricciardi L; Gangemi S; Purello d'Ambrosio F: Urticaria in a tattooed patient, *Allergol Immunopathol (Madr)* 1999 Jan-Feb;27(1):32-3

³⁵ Waldmann I; Vakilzadeh F: Delayed type allergic reaction to red azo dye in tattooing, *Hautarzt*. 1997 Sep;48(9):666-70

³⁶ Jensen CS; Lisby S; Baadsgaard O; Volund A; Menne T: Decrease in nickel sensitisation in a Danish schoolgirl population where ears pierced after implementation of a nickel-exposure regulatin, *Br J Dermatol* 2002 Apr;146(4):636-42

³⁷ Sowden JM, Byrne JP, Smith AG, Hiley C, Suarez V, Wagner B, Slater DN. Red tattoo reactions: X-ray microanalysis and patch-test studies. *Br J Dermatol* 1991 Jun; 124(6): 576-80[[Medline](#)].

- F)** A 42-year old white woman presented with oedematous, pruritic, crusted and tender lips after receiving red cosmetic tattoos.³⁸ The subject had undergone two tattoo procedures in the previous month; the second to define further the colour and borders of the tattoo. The patient was treated with a topical corticosteroid ointment. The reaction to the tattoo improved but did not completely clear. The ingredients of the material in this patient included iron oxide, organic red (naphthanyl red), alcohol and glycerin.
- G)** A patient presented with skin ulceration 1 month after a new tattoo. On examination, there was full-thickness skin loss in the areas of the red dye, but no damage in the areas of black, green, yellow or blue dye. The patient had a tattoo 4 years earlier, which was asymptomatic. However, this tattoo had shown an inflammatory response following his new tattoo, with only the red pigment being affected³⁹.

3.3.2 Granulomatous/lichenoid reactions

A granulomatous reaction is the growth of small rounded outgrowths, made up of small blood vessels and connective tissue, on the healing surface of a wound or an ulcer. A lichenoid reaction is any skin disease that resembles an extremely itchy skin. Shiny flat-topped may occur anywhere on the body.

In most cases the reactions are reported to be caused by different red pigments. While in the past these reactions have been ascribed to mercury salts (cinnabar) and cadmium sulphide, now synthetic inorganic azo dyes have also been found to be responsible for such reactions.

- A)** A case on a potential etiologic role of nickel was published⁴⁰.
- B)** On the effects of azo dyes a case report⁴¹ describes allergic reactions in the red parts of tattoos of a 42-year-old male. Histologically a chronic granulomatous, partly fibrous inflammation with transfollicular elimination of pigment granules was found. Spontaneous regression in a part of the inflammatory reaction was observed, simultaneously with depigmentation and scarring of the overlying skin. The pigment used for tattooing was found to be an aromatic azo derivative. In addition to a positive cutaneous reaction to the dye, the patient also showed a positive patch test to Napthol AS, used for the coupling of different dyes in the textile industry.

³⁸ Duke, D; Urioste, SS; Dover, JS; Anderson, RR: A reaction to a red lip cosmetic tattoo, *J. Am. Acad. Dermatol.* 1998 Sept; 39(3):488-490.

³⁹ White, N; Rauf, G: Sensitization to red tattoo pigment. *Br. J. Plast. Surg.* 2002 Jun;55(4):365-366.

⁴⁰ Corazza M; Zampino MR; Montanari A; Pagnoni A; Virgili A: Lichenoid reaction from a permanent red tattoo: has nickel a possible aetiologic role?, *Contact Dermatitis* 2002 Feb;46(2):114-5

⁴¹ Waldmann I; Vakilzadeh F: [Delayed type allergic reaction to red azo dye in tattooing] [Allergische Spätreaktion auf roten Azofarbstoff in Tätowierungen.], *Hautarzt* 1997 Sep;48(9):666-70

- C) Eighteen patients who developed cutaneous reactions to red tattoos were studied to identify the chemicals responsible for the reactions to modern red tattoo pigments. The patients complained of discomfort and swelling affecting their red tattoos. Examination revealed swelling, induration and tenderness of the red areas of the tattoos. Biopsies from the tattoos were examined histologically and the chemical composition of the red pigments was analysed by X-ray microanalysis. A variety of metallic elements including aluminium, iron, calcium, titanium, silicon, mercury and cadmium were detected.⁴²
- D) A patient developed a granulomatous reaction to iron oxide after undergoing permanent pigmentation of the eyebrows. Treatment with systemic and topical steroids resulted in marked improvement at 6-month follow-up.⁴³
- E) A 56-year-old man presented with lumps developing over 1 year in the red areas of tattoos on both upper arms and forearms. The tattoos had been present for 37 years. The lumps became scaly and itchy, and bled and discharged on trauma. Histological examination showed that the dermal collagen contained several large necrobiotic areas, some with a rim of histiocytes. Some of these areas were immediately subadjacent to the epidermis, which was covered by inflammatory exudates, and degenerate collagen could be seen among epidermal cells, indicating perforating granuloma annulare. Energy-dispersive X-ray spectroscopic microanalysis gave strong signals for mercury and sulphur, consistent with the pigment being mercuric sulphide.⁴⁴

3.3.3 Pseudo-Lymphomas

A lymphoma is a usually malignant lymphoid neoplasm. A pseudo-lymphoma is a reaction of the skin that resembles a lymphoma but is not.

In a review article⁴⁵ in the Journal of the American Society of Dermatology the generation of pseudo-lymphomas by tattoos is listed as tattoo-induced lymphocytoma cutis. Additionally, there are several case reports:

- A) Three cases with pseudo-lymphomatous hypersensitivity reaction to tattoo pigment are described⁴⁶. One of the cases showed histological features of Spiegler-Fendt pseudo-lymphoma. Awareness of this type of reaction to tattoo pigment can help prevent

⁴² Sowdin, JM; Byrne, J.P.H., Smith, AG; Hiley, C.; Suarez, V; Wagner, B; Slater, DN: Brit. J. Dermatol. 1991 124:576-580.

⁴³ Rubianes, EI; Sanchez, JL; Granulomatous dermatitis to iron oxide after permanent pigmentation of the eyebrows. J Dermatol Surg Oncol 1993 Jan;19(1):14-16.

⁴⁴ Gradwell; Evans: Perforating granuloma annulare complicating tattoos. Br. J. Dermatol. 1998 Feb;138(2):360.

⁴⁵ Ploysangam T; Breneman DL; Mutasim DF: Cutaneous pseudolymphomas, J Am Acad Dermatol 1998 Jun;38(6 Pt 1):877-95; quiz 896-7. Review

⁴⁶ Blumental G; Okun MR; Ponitch JA: Pseudolymphomatous reaction to tattoos. Report of three cases, J Am Acad Dermatol 1982 Apr;6(4 Pt 1):485-8

erroneous diagnosis of lymphoma. Several published reports are cited in which pseudo-lymphomatous reaction to tattoo pigment was erroneously diagnosed as lymphoma.

- B)** A 35-year-old patient developed swellings in the red coloured areas of his tattoo indicating a lichenoid pseudo-lymphomatous tattooing reaction⁴⁷. Histological examination revealed a lichenoid, pseudo-lymphomatous infiltrative pattern that could be distinguished from frank lymphoma by means of electron microscopy, immunohistochemistry and molecular biology. The presence of dermal dendritic cells suggests a dermal-allergic pathogenesis of non-granulomatous tattoo reactions. Therapy of choice is an excision of the inflamed areas.

3.3.4 Lymphadenopathy

Lymphadenopathy is an abnormal enlargement of the lymph nodes. In the literature the case of a left inguinal lymph node enlargement in a young man has been reported. A tattoo was present in close proximity to the lymph node and had preceded its enlargement by several years. The lymph node was removed surgically, and pathologic examination showed it to contain dark pigment material characteristic of a tattoo. The clinical significance of this finding was analysed, and the relationship of tattoo lymphadenopathy to inflammatory skin reactions and to dermatopathic lymphadenopathy was considered⁴⁸.

3.3.5 Sarcoidosis

Sarcoidosis is a chronic multisystem disease of unknown aetiology characterized by infiltration of the affected organs by T lymphocytes, mononuclear phagocytes, and granulomas that alter the tissue architecture. The clinical symptoms may be generalized or focused on the affected organs. Skin changes, including erythema nodosum, plaques, maculopapular eruptions, and subcutaneous nodules, occur in approximately 25% of the cases.

In the literature there are several cases reported which were caused by tattoos.

- A)** A patient with sarcoidosis who presented with a granulomatous tattoo reaction is described. Although tattoo granulomata usually represent a local hypersensitivity reaction to tattoo pigments, they can be a manifestation of systemic sarcoidosis. In this case the lesions were confined to the red areas of tattoos suggesting that tattoo sarcoid may be more than just an example of the Koebner response⁴⁹.

⁴⁷ Amann U; Luger TA; Metze D: Lichenoid pseudolymphomatous tattooing reaction, *Hautarzt* 1997 Jun;48(6):410-3

⁴⁸ Zirkin HJ; Avinoach I; Edelwitz P: A tattoo and localized lymphadenopathy: a case report, *Cutis* 2001 Jun;67(6):471-2

⁴⁹ Sowden JM; Cartwright PH; Smith AG; Hiley C; Slater DN: Sarcoidosis presenting with a granulomatous reaction confined to red tattoos, *Clin. Exp. Dermatol.* 1992; 17:446-448

- B) A first case of systemic sarcoidosis presenting in only the black dye of a tattoo is reported. The skin manifestations of sarcoidosis and the histological differential diagnosis of granulomas are reviewed⁵⁰.
- C) A 42-year-old white female with hepatitis C, who developed systemic sarcoidosis shortly after therapy with IFN-alpha2b. The disease was heralded by the appearance of a cutaneous sarcoid/ foreign body granulomatous reaction at the site of an old tattoo. The sarcoidosis responded to a short course of oral prednisone therapy. We also reviewed the other reported cases and discussed the possible immunological mechanisms involved⁵¹.
- D) A patient presenting with nodules in his tattoos was referred for laser treatment, following which there was a diagnosis of cutaneous and pulmonary sarcoidosis. Nodular change involving several different tattoo colours is characteristic of sarcoidosis⁵².
- E) A 29-year-old Caucasian man who developed cutaneous sarcoidosis manifesting itself as a tumour at the left outer canthus clinically mimicking a basal cell carcinoma and nine tattoo granulomas was described. Subsequent investigation revealed that the patient was also suffering from systemic sarcoidosis⁵³.

3.3.6 Malignant Lesions

Malignant lesions include melanoma and non-melanoma skin cancer. A melanoma is a malignant, darkly pigmented mole or tumour of the skin. Three types of melanoma tend to grow superficially and expand radially, and do not penetrate deeply. Nodular melanoma is deeply invasive and quite likely to metastasise.

Several malignant lesions have occurred in tattoos, possibly coincidental, including basal cell carcinomas, squamous cell carcinomas and malignant melanomas.

3.3.6.1 Melanoma

Malignant melanoma has been reported to occur in vaccination scars, in tattoos and in tattoo sites used for radiotherapy fields marking.

⁵⁰ Jones MS; Maloney ME; Helm KF: Systemic sarcoidosis presenting in the black dye of a tattoo, *Cutis* 1997; 59:113-115

⁵¹ Nawras A; Alsolaiman MM; Mehboob S; Bartholomew C; Maliakkal B: Systemic sarcoidosis presenting as a granulomatous tattoo reaction secondary to interferon-alpha treatment for chronic hepatitis C and review of the literature, *Dig Dis Sci* 2002 Jul;47(7):1627-31

⁵² Tran D; Ashton RE; Cotterill JA: Sarcoidosis presenting as tattoo granuloma inadvertently treated with laser therapy, *J Cutan Laser Ther* 2000 Mar;2(1):41-3

⁵³ Papageorgiou PP; Hongcharu W; Chu AC: Systemic sarcoidosis presenting with multiple tattoo granulomas and an extra-tattoo cutaneous granuloma, *J Eur Acad Dermatol Venereol* 1999 Jan;12(1):51-3

- A) Mercury-cadmium pigment used in tattooing has been suggested to give a photo-allergic reaction due to the red pigment and to be a factor in the development of melanoma⁵⁴.
- B) According to a 1997 study⁵⁵ seven documented cases of malignant melanoma occurring in tattoos were previously reported in the English literature.
- C) Another study describes the eighth case of a patient with malignant melanoma in a tattoo⁵⁶. One, a 47-year male, had a four-year history of a “mole” in a multicoloured tattoo in his abdomen. This lesion had appeared 16 years after the placement of the tattoo and had doubled in size in the last 2 years. The tumour was classified as a Clark’s level III superficial spreading malignant melanoma with a Breslow thickness of 0.75 mm.
- D) Another study describing a case of patient with malignant melanoma in a tattoo was published in 1997⁵⁷. The colours of the tattoo in the forearm of a 44-year-old male were dark blue and black. The patient had not been aware of any lesion on his forearm prior to the tattoo and only noticed 25 years later a change when the tumour started to ulcerate and extend outside the tattoo boundaries. Histology confirmed a Breslow thickness of 0.9 mm malignant melanoma.
- E) Several reports describe cases of tattoo pigment masquerading as secondary malignant melanoma^{58,59,60}. In all these cases tattoo pigments migration through lymphatic drainage was initially considered as evidence of metastatic tumours.

3.3.6.2 *Non melanoma skin cancer*

- A) Basal cell carcinomas arising in tattoos have been reported previously in four patients. The fifth reported case of a basal cell carcinoma arising in a tattoo that was at a site not frequently exposed to ultraviolet radiation and briefly review malignancy in tattoos⁶¹.

⁵⁴ Wolfort et al.: Superficial Melanoma in a tattoo, Br. J. Plast Surg. 1974, 27: 303-4

⁵⁵ Soroush V; Gurevitch AW; Peng SK: Malignant melanoma in a tattoo: case report and review of the literature, Cutis 1997 Mar;59(3):111-2

⁵⁶ Soroush V; Gurevitch AW; Peng SK: Malignant melanoma in a tattoo: case report and review of the literature, Cutis 1997 Mar;59(3):111-2

⁵⁷ Khan IU; Moiemem NS; Firth J; Frame JD: Malignant melanoma disguised by a tattoo, Br J Plast Surg 1999 Oct;52(7):598

⁵⁸ Hannah H; Falder S; Steele PR; Dhital SK: Tattoo pigment masquerading as secondary malignant melanoma, Br J Plast Surg 2000 Jun;53(4):359

⁵⁹ Moehrle M; Blaheta HJ; Ruck P: Tattoo pigment mimics positive sentinel lymph node in melanoma, Dermatology 2001;203(4):342-4

⁶⁰ Anderson LL; Cardone JS; McCollough ML; Grabski WJ: Tattoo pigment mimicking metastatic malignant melanoma, Dermatol Surg 1996 Jan;22(1):92-4

⁶¹ Wiener DA; Scher RK: Basal cell carcinoma arising in a tattoo, Cutis 1987 Feb;39(2):125-6

B) Another case is reported about a Squamous-cell carcinoma arising in a tattoo⁶².

3.3.7 Other skin diseases

3.3.7.1 Psoriasis

Psoriasis is a common, chronic disease of the skin consisting of erythematous papules that coalesce to form plaques with distinct borders. If the disease progresses and is untreated, a silvery, yellow-white scale develops. New lesions tend to appear at sites of trauma.

Case reports provide indication of tattoo reactions on disorders, such psoriasis, which are known to exhibit the Koebner response^{63,64}.

3.3.7.2 Photosensitization, phototoxicity, photogenotoxicity

Photosensitization is a condition in which the skin reacts abnormally to light, esp. ultraviolet radiation or sunlight. It is due to the presence of drugs, hormones, or heavy metals in the system. Phototoxicity is the harmful reaction produced by light energy, esp. that produced in the skin. Simple sunburn of the skin is an example of phototoxicity. Photogenotoxicity is the process of injury to the chromosomes of the cells due to exposure to light.

Titanium dioxide, a pigment widely used in tattoos, has been shown to be phototoxic^{65,66,67} and photogenotoxic⁶⁸ in several *in vitro* studies. Several cases for these radiation damages have been reported in the literature.

A A 63-year-old male presented with an inflammatory reaction to a tattoo performed 18 months previously. The symptoms were confined to the red areas of the tattoo, and were photosensitive. Symptoms had begun 6 months after the initial tattooing, following exposure to sunlight, and included intense pruritus with induration and erythema confined to the red areas. Although the symptoms eased when the tattoo was

⁶² McQuarrie DG: Squamous-cell carcinoma arising in a tattoo, *Minn. Med.* 1966 49,799-801

⁶³ Jacob CI: Tattoo-associated dermatoses: a case report and review of the literature, *Dermatol Surg* 2002 Oct;28(10):962-5

⁶⁴ Punzi L; Rizzi E; Pianon M; Rossini P; Gambari PF: Tattooing-induced psoriasis and psoriatic arthritis, *Br J Rheumatol* 1997 Oct;36(10):1133-4

⁶⁵ Cai, R; Kubota, Y; Shuin, T ; Sakai, H ; Hashimoto, K ; Fujishima, A : Induction of cytotoxicity by photoexcited TiO₂ particles. *Cancer Res.* 1992; 52:2346-2348.

⁶⁶ Wamer, WG; Yin, J-J; Wei, RR: Oxidative damage to nucleic acids photosensitized by titanium dioxide. *Free Rad Biol Med* 1997; 23(6):851-858.

⁶⁷ Ireland, JC; Klostermann, P; Rice, EW; Clark, RM: Inactivation of *Escherichia coli* by titanium dioxide photocatalytic oxidation. *Appl Environ Microbiol* 1993; 59:1668-1670.

⁶⁸ Nakagawa, Y ; Wakuri, S ; Sakamoto, K ; Tanaka, N: The photogenotoxicity of titanium dioxide particles. *Mutat Res* 1997; 394(1-3): 125-132.

protected from sunlight, a degree of itching still remained. Antihistamines and steroid creams did not improve the condition. Tissue analysis showed the presence of cadmium in the red areas of the tattoo, but mercury was not found.⁶⁹

- B) Of 24 patients with yellow tattoos, 18 observed a swelling reaction in the tattoo when exposed to sunlight. Four of these patients also observed swelling in the red portion of tattoos. Tattoos done experimentally with cadmium sulphide were shown to give swelling when exposed to light having wavelengths of 380, 400 and 450 nm.⁷⁰
- C) Concomitant allergic reactions to manganese and cadmium sulphide developed in a patient in tattooed areas. Although the reaction was elicited by sunlight, attempts to reproduce it with artificial long-wave ultraviolet light were unsuccessful.⁷¹

3.3.8 Transport of tattoo pigments and admixtures in the body

It is known that part of the colouring agents and its admixtures is transported into the body, at least to the lymph nodes. Since blood vessels are harmed during the tattoo process, part of the colouring agents can also be distributed in the human body by blood vessel system. Unfortunately, to what extent other organs are involved, is still unknown. So far, there are some reports on tattoo pigments in lymph nodes.

- A) A 42-year-old man with metastasising melanoma from an unknown primary is presented. Initially a subcutaneous metastasis in the scapular region and a single lung metastasis were resected. Thorough examinations did not show any evidence of a primary tumour. From the site of the metastasis on the right scapular region, lymphoscintigraphy with axillary sentinel lymph node biopsy was performed. One axillary lymph node could be identified intra-operatively with the gamma probe as sentinel node. The sentinel node and 4 adjacent lymph nodes clinically showed black pigmentation. However, histopathological examination of the lymph nodes did not detect micrometastases. The pigmentation of the lymph nodes was due to decorative tattoos of the scapular skin⁷².
- B) The benefits of elective lymph node dissection (ELND) in the treatment of melanoma remain controversial, however, it may be beneficial in some patients. Tattoo pigment from decorative tattoos may migrate to the regional lymph nodes. In patients who develop malignant melanoma and who have been tattooed, this pigment may clinically mimic metastatic disease. ELND for malignant melanoma, in a patient with a history of decorative tattoos that had been removed by dermabrasion, was performed in a

⁶⁹Yazdian-Tehrani, H; Shibu, MM; Carver, NC: Reaction in a red tattoo in the absence of mercury. Br. J. Plast. Surg. 2001 Sept;54(6):555-556.

⁷⁰Bjornberg, A: Reactions to light in yellow tattoos from cadmium sulfide. Arch Dermatol 1963 Sept;88:83-87.

⁷¹Nguyen, LQ, Allen, HB: Reactions to manganese and cadmium in tattoos. Cutis 1979 Jan;23(1): 71-72.

⁷² Moehrle M; Blaheta HJ; Ruck P: Tattoo pigment mimics positive sentinel lymph node in melanoma, Dermatology 2001;203(4):342-4.

recent study⁷³. Black lymph nodes that clinically resembled metastatic disease were identified. Subsequent histological examination revealed normal lymph node architecture with a heavy collection of black pigment. Mass spectrophotometry showed this pigment to be consistent with tattoo dye. A patient who had undergone dermabrasion for removal of decorative tattoos developed malignant melanoma in the same extremity. Clinically suspicious black lymph nodes were identified during ELND. Histological examination did not reveal metastatic disease. Additional therapy was not considered intra- or postoperatively even though the clinical suspicion of metastatic disease was high. The patient was not subjected to any unnecessary emotional or physical distress pending histological confirmation. Tattoo pigment in the lymph nodes may clinically mimic metastatic melanoma. Histological confirmation of metastatic disease should always be obtained before additional therapy is considered.

3.3.9 Risks of the laser treatment of tattoos

The absorption of the light pulses in the tattoo pigments is the first and important step to tattoo removal using Q-switched lasers. The absorbed energy is converted to heat (photothermal effect) or breaks chemical bonds inside the pigment (photochemical effects). After the ultrashort heating of the pigment surface shock waves are induced leading to a mechanical destruction of the pigments. As a response, a multitude of mechanisms may occur at the same time. Large aggregates and agglomerates break down into smaller crystals. Particles pulverize and form a solution of pigment molecules. Molecules can break up, resulting in decomposition products or molecular structure change. Due to fragmentation of the tattoo pigments, small pigment particles, unknown decomposition products and newly generated chemical compounds may be then removed from the skin via blood vessels or the lymphatic system. On the other hand, the pigments remaining in the skin may exhibit different chemical characteristics as compared to non-irradiated pigments. Thus, there might be again a reaction of the immune system. Moreover, it was shown that carcinogenic amines are generated by a laser-induced cleavage of azo dyes⁷⁴.

3.3.9.1 Allergy

As described above the laser treatment induce old/new chemical compounds in the skin leading to allergic reactions.

- A)** Cinnabar (mercuric sulphide) is the most common cause of allergic reactions in tattoos and is probably related to a cell-mediated (delayed) hypersensitivity reaction. The purpose of these case presentations is to describe a previously unreported complication of tattoo removal with two Q-switched lasers. Two patients without

⁷³ Anderson LL; Cardone JS; McCollough ML; Grabski WJ: Tattoo pigment mimicking metastatic malignant melanoma, *Dermatol Surg.* 1996 Jan;22(1):92-4

⁷⁴ Baeumler et al.: *Lasers in Surgery and Medicine*, Volume 30, Issue S14, 2002

prior histories of skin disease experienced localized as well as widespread allergic reactions after treatment of their tattoos with two Q-switched lasers. The Q-switched ruby and neodymium-yttrium-aluminium-garnet lasers target intracellular tattoo pigment, causing rapid thermal expansion that fragments pigment-containing cells and causes the pigment to become extracellular. This extracellular pigment is then recognized by the immune system as foreign⁷⁵.

- B)** A first reported case of an immediate cutaneous reaction to Q-switched laser tattoo removal was published recently⁷⁶. A 26-year-old female presented with two 6-year-old tattoos placed at different times. These were of different colours and had remained entirely asymptomatic since placement. There was a Mardi Gras mask on her thigh and a Tasmanian devil on her chest. With laser treatment of the Tasmanian devil, she experienced no untoward effects. However, with treatment of the Mardi Gras mask tattoo, she developed an extensive urticarial and indurated reaction 30 minutes posttreatment. The identical reaction occurred twice with subsequent laser treatments. Dermatology consulted allergy to provide prophylaxis against possible systemic reaction with subsequent Nd:YAG laser therapy. The patient was treated with 3 days of prednisone, cetirizine, and ranitidine before subsequent laser treatments.

3.3.9.2 Transport

It is obvious, that after laser treatment the transport of pigment particles through the body is newly started. Moreover, chemically altered molecules (e.g. cancerogenic amines) are transported through the body. Comparable to the situation before laser treatment, there are no investigations on this issue.

3.3.9.3 Others

- A)** According to a recent study in the USA⁷⁷ computer simulations carried out in this study suggest that the breakup of tattoo particles is photoacoustic. Cavitation bubbles can damage tissue surrounding the tattoo particles.
- B)** According to a UK study⁷⁸ the Nd:YAG laser effectively removes or lightens amateur and professional tattoos. This study examined biopsies obtained from 35 amateur and

⁷⁵ Ashinoff R; Levine VJ; Soter NA: Allergic reactions to tattoo pigment after laser treatment, *Dermatol Surg* 1995 Apr;21(4):291-4

⁷⁶ England RW; Vogel P; Hagan L: Immediate cutaneous hypersensitivity after treatment of tattoo with Nd:YAG laser: a case report and review of the literature, *Ann Allergy Asthma Immunol* 2002 Aug;89(2):215-7

⁷⁷ Ho DD; London R; Zimmerman GB; Young DA: Laser-tattoo removal--a study of the mechanism and the optimal treatment strategy via computer simulations, *Lasers Surg Med* 2002;30(5):389-97

⁷⁸ Ferguson JE; Andrew SM; Jones CJ; August PJ: The Q-switched neodymium:YAG laser and tattoos: a microscopic analysis of laser-tattoo interactions, *Br J Dermatol* 1997 Sep;137(3):405-10

professional tattoos (including coloured tattoos), treated on three or more occasions with the Nd:YAG laser. Biopsies taken immediately after laser treatment showed vacuolation with complete clearance of tattoo particles in the most superficial layers of the dermis, as assessed by light and electron microscopy. The study proposes that the 'disappearance' of the tattoo particle arises from the formation of atomic species and gaseous products, which are rapidly dissolved in the extracellular fluid. Residual fragmented particles that are commonly found in the mid- and lower dermis are rephagocytosed. The interaction between the Nd:YAG laser and black tattoo particles at 1064 nm, and red tattoo particles at 532 nm, appears to be specific, as there was little evidence of thermal damage to adjacent cells or stromal collagen.

- C) Particulate matter incorporated into the skin of former miners was compared to ornamental tattoos with regard to composition and cutaneous reaction pattern. The specimens were examined histologically and immunohistochemically followed by scanning electron microscopy and element analysis. In the skin biopsies containing dirt particles, silicon and aluminium were regularly found and the particles were positively birefringent under the light microscope. Even years after the initial foreign particle incorporation strong reactions against quartz-containing substances deposited perivascularly and perifollicularly continued to take place. Reactions ranged from strong macrophage activation to pre-granulomatous changes. Anthracotic pigment was demonstrated in all layers of the dermis depending on the degree of traumatic insult and the colour pigments of the ornamental tattoos showed variable spectra of elements depending on the type of dye used. Fibrous reactions were only discrete, however, strong macrophage activation and sometimes capillary proliferation as well as non-specific lymphocytic infiltration could still be confirmed even decades after the initial incorporation. In conclusion, the cutaneous incorporation of ornamental tattoo dyes and accidental dirt particles is not an inert process. Even years later, non-specific macrophage activation as well as discrete inflammatory changes in an attempt to degrade the foreign material can still be documented. A clear correlation between subcutaneous incorporated quartz particles and progressive systemic sclerosis was not found in this study⁷⁹.

3.3.10 Tattoos and body piercings as markers of risk-taking behaviour

A recent study⁸⁰ assessed tattoos and body piercings as markers of risk-taking behaviours in adolescents. A 58-question survey, based on the 1997 Centers for Disease Control and Prevention Youth Risk Behavior Survey, was offered to all adolescent beneficiaries that came to the Adolescent Clinic. The survey contained standard Youth Risk Behavior Survey questions that inquire about eating behaviour, violence, drug abuse, sexual behaviour, and suicide. Questions about tattoos and body piercings were added for the purposes of this study. Participants with tattoos and/or body piercings were more likely to

⁷⁹ Muller KM; Schmitz I; Hupe-Norenberg L: Reaction patterns to cutaneous particulate and ornamental tattoos, *Pathologie* 2002 Jan;23(1):46-53

⁸⁰ Carroll ST, Riffenburgh RH, Roberts TA, Myhre EB: Tattoos and body piercings as indicators of adolescent risk-taking behaviors, *Pediatrics* 2002 Jun;109(6):1021-1027

have engaged in risk-taking behaviours and at greater degrees of involvement than those without either. These included disordered eating behaviour, gateway drug use, hard drug use, sexual activity, and suicide. Violence was associated with males having tattoos and with females having body piercings. Gateway drug use was associated with younger age of both tattooing and body piercing. Hard drug use was associated with number of body piercings. Suicide was associated with females having tattoos and younger age of both tattooing and body piercing. Tattoos and body piercings were found to be more common in females than males. In summary the authors contend that tattoos and/or body piercings can alert practitioners to the possibility of other risk-taking behaviours in adolescents, leading to preventive measures, including counselling. Tattoo and body piercing discovery should be an important part of a health maintenance visit to best direct adolescent medical care.

Another report⁸¹ sought to determine the prevalence and sociodemographic characteristics of tattooed adolescents in a nationally representative sample and to evaluate the association between tattooing and several high-risk behaviours. Within a secondary analysis of the National Longitudinal Survey of Adolescent Health Public Use Dataset (which provides a nationally representative sample of 6072 adolescents collected in 1995 and 1996), the association among permanent tattoos, sociodemographic factors, and high-risk behaviours was evaluated. Of the total sample of youths, 4.5% reported having permanent tattoos. Permanent tattoos were found to be strongly associated with high-risk behaviours among adolescents. In the clinical setting, the presence of a tattoo noted during clinical examination of an adolescent should prompt in-depth assessment for a variety of high-risk behaviours.

A very recent study⁸² surveyed a cohort of 550 military recruits using a modification of the Youth Risk Behavioral Survey (YRBS), a validated instrument used to assess health risk behaviours in adolescents. All individuals entering basic training in the US Marine Corps or the US Air Force from June through September 1999 were eligible to participate. The primary outcome variables of interest were tobacco use, alcohol use, seatbelt use, suicidal behaviours, depression, and physical violence. The survey response rate was 91% (n = 499 of 550). Overall, 27% of respondents had tattoos (n = 125) when entering military service. Women entering military service were more likely to have a tattoo than men. Controlling for age and gender, individuals with tattoos were more likely to smoke, drink heavily, use smokeless tobacco, and ride in a vehicle with someone who had been drinking than non-tattooed individuals. In a population of military recruits, tattoos were associated with predictable adverse health-risk behaviours. This represents an important opportunity for targeted preventive counselling.

⁸¹ Roberts TA, Ryan SA: Tattooing and high-risk behavior in adolescents, *Pediatrics* 2002 Dec;110(6):1058-63

⁸² Stephens MB: Behavioral risks associated with tattooing, *Fam Med* 2003 Jan;35(1):52-4

4. Conclusions

This review on health impacts and risks associated with tattooing and piercing as reported casually in the medical literature shows that a systematic observation and registration of health impacts is widely missing.

The origin and chemical structure of colouring agents used for tattooing are hardly known. Pigments are mainly industrial organic pigments with high microbiological and impurities and a load of metals such as cobalt and mercury.

The observed health effects, which are potentially associated with tattooing and piercing, include

- Viral infections such as hepatitis, AIDS, and cutaneous infections;
- Bacterial infections such as impetigo, toxic shock syndrome, tetanus, chancroid, tuberculosis and leprosy;
- Fungal infections such as sporotrichosis and zygomycosis;
- Allergic reactions such as cutaneous irritation and urticaria;
- Granulomateus/lichenoid reactions;
- Pseudo-lymphomas;
- Lymphadenopathy;
- Sarcoidosis;
- Malignant lesions such as melanoma and skin cancer;
- Behavioural changes;
- Other skin diseases such as psoriasis, photosensitisation, phototoxicity and photogenotoxicity.

Little is known with respect to the transport and metabolism of the colouring agents in the body both with respect to tattooing and removal of tattoos by laser treatment. Risk assessment studies for these substances are only emerging. At present, existing knowledge is insufficient to quantify the administered dose of harmful substances.

The scientific evidence reported here leads to the following recommendations

- The ingredients of substances used for tattoos should be analysed and a systematic risk assessment with respect to potential health impacts performed; the same applies to materials used in piercing. An appropriate methodology needs to be developed.
- The awareness of studios for tattooing and piercing and their customers on the health impacts should be raised.
- A list of substances and materials leading to adverse health effects (“negative list”) should be developed. These substances and materials should not be applied.

- Adverse health effects associated to tattooing and piercing should be avoided by applying only substances and materials (“positive list”), which are not harmful, do not dissolve in the blood stream, do not contain heavy metals and are compatible with the skin and blood vessels.
- Ingredients of colours and materials should be properly labelled.
- It should be obligatory to have licensed colours and materials to be used in tattoo and piercer studios.
- The hygienic conditions of tattoo and piercing studios should be standardized and regularly controlled. Minimal hygiene rules should be made obligatory.
- Regular training courses on the potential health impacts should be performed for tattooers and piercers.
- An accreditation bureau/laboratory should be established for education of tattooers and piercers and supervision of their studios.
- Surveillance of occupational diseases of tattooers and piercers mandatory. Harmonised schemes should be developed at the European level.
- There is a need for epidemiological studies on the prevalence and causal association of tattoo- and piercing-related adverse effects.
- The debate on epidemiological studies of tattoo- and piercing-related viral hepatitis needs to be clarified.
- A warning should be given to clients informing them on the potential adverse health effects in vulnerable individuals due to even admissible colours and materials. Vulnerable individuals include
 - Pregnant women
 - Children and infants
 - Atopic individuals
 - Individuals with heart diseases
 - Individuals with dermatous diseases
 - Individuals exposed occupationally to heavy metals, VOCs, PAHs, UV.

The implementation of these recommendations would provide systematic data for upgrading this report. The JRC and DG SANCO would consider the possibility of updating this report once a year by review of the surveillance process, the additional information gathered in this process and scientific publications. An Editorial Committee would ensure the scientific standard of the annual review.