A REPORT FROM

THE COUNCIL ON HEALTH AND DISEASE PREVENTION
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TATTOOS – HEALTH, RISKS AND CULTURE

WITH AN INTRODUCTION TO THE 'SEAMLESS PREVENTION' STRATEGY

BY JØRGEN SERUP, NIELS HARRIT, JEPPE TROLLE LINNET, BO MØHL, OLE OLSEN, HENRIK WESTH

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With an introduction to the 'seamless prevention' strategy

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The report may be freely downloaded at
www.vidensraad.dk

THE COUNCIL ON HEALTH AND DISEASE PREVENTION WAS FOUNDED BY
TrygFonden AND Lægeforeningen

The Council on Health and Disease Prevention's website includes a number of relevant appendixes (in Danish) and links to websites on tattoos. You can see more at www.vidensraad.dk

PREFACE

It has become more common to get a tattoo. Once tattoos were reserved for special subgroups, such as seamen and motorcycle gang members (bikers), but now getting tattoos is prevalent in other segments of the population. A tattoo sends a signal about identity, belonging to a group and/or decoration.

There are many myths about tattoos, and there are many unanswered questions. Most people have heard about individual side effects, regretting tattoos, dangerous tattoo ink, contaminated needles and the risk of hepatitis. But are there adverse side effects from the various pigments that are injected into the skin and exactly how widespread are these adverse effects? Do poisons accumulate, which cannot be expelled from the body? And are there safer ways to decorate your body?

The Council on Health and Disease Prevention has decided to investigate the scientific literature regarding the health effects of tattoo ink, as well as the risks involved in the tattooing situation. We will also investigate whether the control systems regarding tattoos are sufficient.

This report is intended for healthcare professionals, who are involved with patients with tattoos and their consequences, as well as the general public in order to provide more thorough information about the advantages and, especially, the disadvantages of getting tattoos. It is also hoped that the report can be used both nationally and internationally in order to develop a legal and supervisory means of improving tattoo safety. Therefore, the report has been translated into English in a slightly revised form.

Morten Grønbæk
Chair of the Council on Health and Disease Prevention

TATTOOS IN DENMARK FROM A EUROPEAN PERSPECTIVE

Approximately 600,000 people in Denmark have tattoos, and in Europe the number of tattooed people is estimated to be about 100 million. Tattoos probably represent the most extensive exposure of people to chemical substances and microparticles and nanoparticles of our time. The ingredients of tattoo ink are largely unknown and bacterial contamination of new ink products is not uncommon. Concurrently with the tattoo trend, the medical and sociocultural complications and potential risks have become obvious, and there is a need for a joint prevention effort in Europe.

Denmark and other European countries, as well as the EU, are now actively involved in regulating the area, which would be most appropriate to be based on a joint strategy for large regions, such as Europe. The countries' requirements for tattoos are insufficient and dissimilar in sharp contrast to the EU requirements that exist for medical products and injections for humans. It is difficult to regulate and control tattoos because, among other reasons, the area is anchored in popular cultural ownership, and is many-faceted and fragmented.

This report examines and analyses the tattoo phenomenon from a health perspective, primarily based on Danish conditions, but also from a European perspective. Lack of knowledge is, with the exception of infections, the greatest obstacle to the launching of efficient prevention activities of a more technical nature with the prospect of obtaining measurable effects on the known problems, which include allergies in coloured tattoos, agglomeration problems in black tattoos, sun-related discomfort and, not least, the psychosocial problems, including regret. The content of carcinogens in the ink gives, de facto, no measurable clinical cancer. These conditions mean that regulation of chemical constituent substances in tattoo ink, as, for example, expressed in Council of Europe Resolution ResAP (2008)1, regardless of the fact that tattoo ink, obviously, cannot contain absolutely anything all without restriction, has not proven to function in the prevention of complications related to tattoos.

Innovation is needed when it comes to prevention. This report introduces an integrated strategy,'seamless prevention', in which all parts of the tattooing process that present a risk are included and subjected to pragmatic action. The action focuses on the customer-tattooist relationship, which is the focal point of risks related to tattooing. Influencing this relationship and the conditions during the tattooing process, and through a dialogue with the players and professionalising them, provide the greatest prospects for making real progress regarding prevention. As is the case for other types of prevention that have significance for the effect, the strategy of 'seamless prevention' must be consistent in a large geographical area, and ideally it should be at a European level that is supported by European health authorities.

THE COMPOSITION OF THE WORKGROUP

The chair of the workgroup is designated by the chairmanship of the Council on Health and Disease Prevention, while the members of the workgroup are designated jointly by the chair of the workgroup and the chairmanship of the Council on Health and Disease Prevention. They are selected on the basis of their professional competences within the topics that the report contains:

- Jørgen Serup (chair), Professor, Chief Physician, MD, Department of Dermatology/ Tattoo Clinic, Bispebjerg University Hospital, University of Copenhagen.
- Niels Harrit, PhD, Associate Professor Emeritus, Institute of Chemistry, University of Copenhagen.
- Jeppe Trolle Linnet, Anthropologist, PhD, Lecturer at Aalborg University and Aarhus University. CEO Linnet Research.
- Bo Møhl, Professor, Special Psychologist in Psychiatry, Master of Arts, Master of Psychology, Psychiatric Centre Copenhagen, Aalborg University.
- Ole Olsen, MSc, CEO, Medico Chemical Lab ApS.
- Henrik Westh, Professor, Chief Physician, MD, Department of Clinical Microbiology, Hvidovre Hospital, and Institute for Clinical Medicine, University of Copenhagen

Peter Gjerndrup Aagaard, Consultant, MSc, of the Council on Health and Disease Prevention's secretariat has been the project manager and technical editor for the workgroup.

Declarations of legal capacity for the members of the workgroup may be obtained by contacting the Council on Health and Disease Prevention's secretariat.

The workgroup wishes to thank:
Eva Jacobsen, MSc in chemistry and mathematics, Head of Section of the Chemical and Microbiological Laboratory of Life Science at the Technological Institute for participating in the preparation of the chapter on chemical substances in tattoo ink.

METHODS AND THE STRUCTURE OF THE REPORT

The starting point for identifying literature that provides the basis for this report is the generally available databases of scientific literature within the different professional areas, as well as published analyses and reports etc. of what is also available. The sources are stated in the references indicated. The report contains the references that are relevant to clarifying the topic.

Thus, this is not a systematic review of the literature. Danish studies have been given special consideration. In general, the scientific literature about the connection between tattoos and health is very limited.

The review of the literature was completed in February 2015. Details regarding the search for and selection of literature that provide the basis for the individual chapters are available by contacting the Council on Health and Disease Prevention's secretariat.

The perspectives that were chosen in the individual chapters in the report are based on the workgroup's assessment of the most important negative health effects related to the report's presentation of the problem taking the existing scientific literature and its level of quality into account. The current public debate and myths about the area were also taken into account when selecting the perspectives in the chapters.

The report consists of 12 chapters. When combined, these chapters cover the most relevant perspectives within the area of tattoos and health. Chapter 1 provides a short history of tattoos and the prevalence of tattoos in different societal groups over time, while Chapter 2 presents the current pattern of the incidence in Denmark today. Chapter 3 delves deeper in the psychological and social mechanisms that motivate people to get tattoos, as well as people's opinions about and impressions of people who have tattoos. Chapters 4 and 5, respectively, provide a short review of the various types of both permanent and temporary tattoos and a description of the elementary processes that take place when tattoos are subjected to light. Chapter 6 describes the incidence and types of the common forms of discomfort that result from tattoos, while the more serious diseases and clinical complications are reviewed in Chapter 7. Chapter 8 reviews the health problems that may be connected with chemical constituent substances in tattoo ink. In Chapter 9, we present the current Danish and European legislation regarding tattoos. Chapter 10 explains methods used to remove tattoos and the problems related to them. Chapter 11 presents a proposal for an integrated strategy for the prevention of risks and complications resulting from tattoos. Finally, in Chapter 12, we present a number of research perspectives on tattoos. At the end of the report, there is an appendix, which provides an overview description of the elements of the prevention strategy presented in Chapter 11.

The conclusion of the report summarises the content of the 12 chapters.

The report is comprised of the work of a number of authors and the individual chapters may be read independently.

The report can be downloaded from the Council on Health and Disease Prevention's website.

On the Council on Health and Disease Prevention's website, there are a number of links to relevant websites and further information about tattoos, including a couple of Danish information campaigns (The Danish Ministry of the Environment's and the Danish Ministry of Health's tattoo campaign, 'Think before you ink' (www.thinkbeforeyouink.dk) and the tattoo campaign by the Tattoo Clinic at Bispebjerg University Hospital 'Tatovering, tænk før du tør' [Tattoos – Know your risk] (www.bispebjerghospital.dk/topmenu/Nyt+og+Presse/tatovering). You can see more at: www.vidensraad.dk. An English translation of the campaign is provided by the European Society of Tattoo and Pigment Research. See www.ESTPresearch.org.

"'I think tattoos are a good way to express your feelings. My philosophy is that you should be able to read a man's life in his tattoos, almost like a notebook. There is almost always a story connected with them. It's almost poetry.

All of the details have to be just perfect so you can think about the details of the design for months. I like my tattoos, but it's the story itself I'm proud of. Proud of what I accomplished out here and what I experienced together with Squad 10. I think that tattoos are an art form that is on exhibition. It's nice; in a way it's like when people write a letter or a poem and put their feelings into it. I just show my feelings through my tattoos. I also think it's a joy to see myself in the mirror and experience my history. Then I don't forget the important milestones in my life. I've had them tattooed.'"

Jesper, 24 years old, Lance Corporal, deployed to Afghanistan (1)

1

INTRODUCTION AND BACKGROUND

THIS CHAPTER DESCRIBES THE HISTORY OF TATTOOS AND THE INCIDENCE IN DIFFERENT SOCIAL CLASSES OVER TIME. THE DEVELOPMENT OF TATTOOING TECHNIQUES AND TYPES, AS WELL AS TATTOO MACHINES, ARE ALSO DISCUSSED.

HISTORY AND PRACTICE

Tattoos have been used in many places around the world for thousands of years, and tattoos have come into existence spontaneously and practiced in completely different cultural, geographic and climatic situations.

The oldest known tattoo goes back 5,300 years to the late Stone Age. In 1991 in the Ötztaler Alps in Austria near Innsbruck, a frozen mummy was found, the Iceman – popularly called 'Ötzi'. The well-preserved mummy had black tattoos in the form of parallel lines that were tattooed into the skin across the large joints, such as the wrist joints, knee joints and foot joints, as well as on the back (2). It is assumed that the tattoos were medically performed in order to heal joint discomfort. In 1979, in the village of Qilakitsoq in Greenland, the remarkable discovery of the mummies of six women and two children was made. They had been lying in the ice since approximately 1460 (3). Several of the women had linear face tattoos, which are also known among Inuits in Canada, and which have similarities to the tattoos practiced by the Maoris in New Zealand (photo 1.1).

Tattoos are known from ancient Egypt, from South America, as mentioned from Eskimos in Greenland and Canada, and from Africa and the Pacific Ocean region, where they were very common.

Tribal tattoos, also known as ethnic tattoos or magic tattoos, have had markings that were characteristic for the section of the population in question. Among the Maoris and Inuits, tattoos have most often been designed as linear face tattoos carried out by pricking pigment into the skin or inserting it with blackened threads. In Africa, they have most often been designed as linear body tattoos cut into the skin with the possible intention of scarification; that is, scar formation, and in Asia there have been many different forms carried out using a variety of techniques and have been place on very different parts of the body. (4).

In many cultures, tribal tattoos have been for men, women and children. Tattoos have often been carried out when a person reached a certain age, as a mark that the person has had a kind of confirmation of being included in the tribe's communal life and responsibility, or as a sign that the tattooed person was now to be considered as adult and sexually mature.

The classic tattoo pigment was simply whatever was at hand, which was typically soot; that is, carbon from burnt wood that was used as black pigment. Black was the dominant tattoo colour, but sometimes pulverised coloured minerals from nature were used for tattoos.

It is essential for classic tattoos to be permanent. By using a suitable technique or operation, the natural pigment was placed between the collagen fibres in the skin's corium (synonymous to dermis), which is a relatively stationary and mechanically bearing tissue, which can function as a matrix for the pigment for a lifetime. The pigment can be pricked into the skin or rubbed into small cuts in the skin, carried out using a cutting object, with or without wanting to create scar formation in addition to the tattoo.

In the Pacific Ocean area, a technique was practiced where the needle was placed at an angle of about 90° on a stick. The stick was hit or hammered with frequent blows so that the pigment placed on the skin was put in the corium in almost the same way as modern tattoo machine. A straight stick with a shape nearly like a drumstick was used as a hammer. It is likely that the word Tattoo is an onomatopoeia; that is, a word that sounds like the special sounds this technique makes. The word tattoo is English in origin and attributed to Captain Thomas Cook who wrote about his travels in Polynesia in 1766-1779. In a narrative referred to in the ship's log for HMS Endeavour on 29 July 1769, published in 1773 with the title 'Captain Cook's First Voyage', he explained the origin of the word as being an adaptation of the Polynesian word tatow:

'Both sexes paint their bodies "tatow" as it is called in their language. This is done by inlaying the colour of black under their skins in such a manner as to be indelible' (5).

Electric tattoo machines were introduced as a patented tattoo machine in 1891 by the American Samuel F. O'Reilly. This machine was powered by a small rotating electric motor. In 1899, the Englishman Alfred Charles developed the tattoo machine that was based on two coils and electromagnetism, which conquered the world, and which is the dominant type today. However, recently improved rotary machines are making a comeback.

Tattoo machines were the technical prerequisite for the very large prevalence of tattooing in Europe and other industrialised societies, introduced by seafarers everywhere, starting in the seaports. Since the 1700s seafarers have been tattooed when they were out in the world on dangerous voyages with sailing ships to faraway lands. It was the seafarers and the opening of the seven seas that brought tattoos to Europe. The history of tattoos in Denmark and the other Nordic countries is described by Jon Nordstrøm in two books (6, 7). An example of the basic design of older tattoo machines is Tattoo Jack's [Tatovør Jack's] machine from the beginning of the 1900s (Photo 1.1A) and here is an example of a modern factory-produced tattoo machine (Photo 1.1B).

At about 1900 tattoos were disliked, disapproved of and not very prevalent in cultural circles in Europe as well as in the general population. Leviticus, verse 19:28 says:

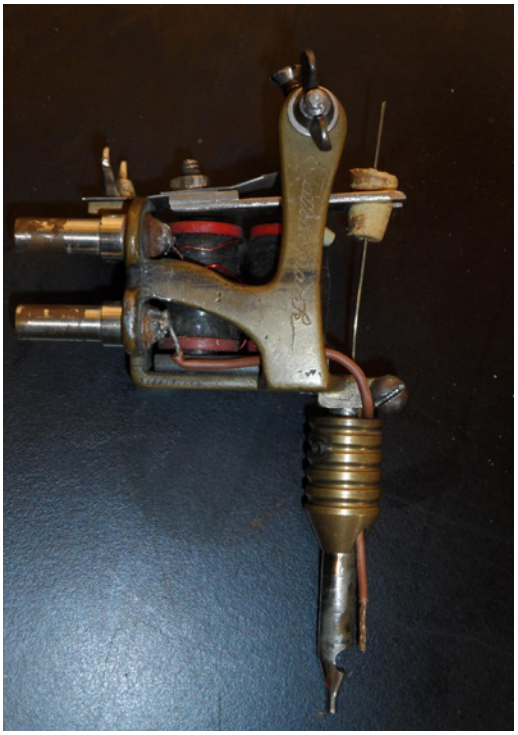
'Ye shall not make any cuttings in your flesh for the dead, nor print any marks upon you: I am the LORD. I am the LORD' (8).

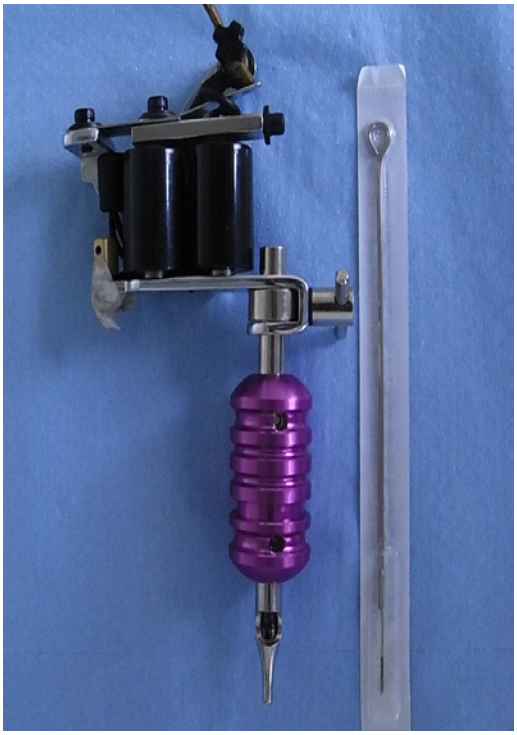
The church and its missionaries around the world had argued against tattoos for centuries. At the Catholic council of Calcuth in Northumberland in 787, the church banned markings/tattoos on the skin. Also the Koran was and is against tattoos – the dead must not be marked. Tattoos were and are regarded as barbarian by the great religions. The Roman Empire was also against tattoos and they were forbidden by Emperor Constantine (307-337). Therefore, hardly anyone in civilised

→ PHOTO 1.1 A OG 1.1 B

A: Antique tattoo machine from the beginning of the 1900s by Tatovør Jack at Nyhavn 17 in Copenhagen. Nyhavn was the starting point for tattoos in the Nordic countries. Reproduced with the permission of Frank Rosenkilde.

B: Modern factory-produced coil machine imported from Asia. The coil machine can be bought via mail order as a low-cost product, which is popular among amateur tattooists as part of a start-up kit. Sterile needles and a small assortment of colours are included. The needles are labelled with a fake CE label on one side and 'sterile' on the other side.





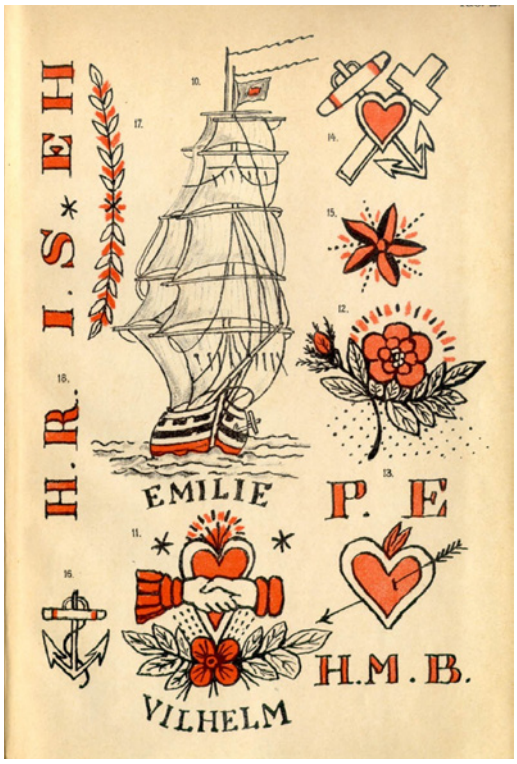
Europe had tattoos until modern times, with the exception of certain purposes, such as marking criminals and foundlings (9). The Vikings, however, continued to believe in the Nordic gods and sometimes had tattoos.

In 1891, Professor Rudolph Bergh (1824-1909) from Vestre Hospital in Copenhagen wrote an article in a hospital newsletter, 'Hospitalstidende', in which he reviewed European literature about tattoos up through the 1800s (10). Rudolph Bergh found that 80 out of 804 prostitutes, that is about 10%, had tattoos; 49 of them had the same tattooist, who had a background as a sailor. The others had tattooed each other as amateurs. With 10% of the prostitutes being tattooed, which corresponded to the prevalence among criminals, tattoos were found to be 'as sign that proves the concordance between the nature of criminals and prostitutes' and a sign of degeneration; a stigma. At that time, the medical concept of 'the degenerate nature', connected with low social class, crime, body structure, prostitution, tattoos etc., was widely accepted.

As mentioned, in the 1700s and 1800s, Europe experienced changes and an increase of the preva-

→ PHOTO 1.2

Tables of tattoos that Rudolph Bergh found in 1891 among ladies of the night and published in 'Hospitalstidende'. 'Sailor motifs' were popular and remained popular for the next half century. The designs were sailing ships, anchors, the Danish flag, roses, voluptuous women and faith, hope and love symbols. The colours were black and red; the later in the form of mercury salt, cinnabar and other substances. Also yellow colouring containing cadmium was used, as well as green and blue chromium salt.



lence of tattoos especially in special groups, primarily seafarers and navy and army personnel. And primarily in the form of what one might call amateur tattoos carried out using primitive equipment. The increased prevalence of tattoos also led to obvious clinical complications in the form of death, amputations and other types of mutilation or disease, which was described precisely by the French navy in 1869 in a book published by Ernest Berchon, illustrated with casuistries; that is, descriptions of specific medical case histories and numerous calculations (11). French technical literature regarding tattoos, including complications, became quite extensive and had detailed descriptions, including a book from 1881 by A. Lacassagne (12). This resulted in the French navy prohibiting tattoos, and the French prohibition was followed by a similar prohibition by the Italian navy. After the fall of the tsar in 1917, the Soviet Union introduced a prohibition against tattoos, a prohibition that was maintained until the fall of the Berlin Wall and the dissolution of the union in 1989. Japan also introduced a restriction. As described in detail in Chapter 9, there was no legislation about tattoos in Denmark until 1966 (13); a law with only a few lines, which was followed-up by a new law in 2013 (14).

Thus, on the basis of the unfortunate effects of tattoos for many years and in various forms, they were prohibited and attempts were made to regulate tattoos in order to limited the extent of tattoos and prevent complications.

Starting in about 1900 and during the decades to follow, the introduction of the electric tattoo machine and an increased interest on the part of the lower social classes in the population, there was a tendency for tattooists to become professionals. They now established themselves in permanent tattoo companies, which in Copenhagen were primarily centred in the vicinity of Nyhavn in Copenhagen. The starting point was amateurism and being self-taught, and the low social status of those who were tattooed and the practitioners, the 'devil-may-care' attitude, rather sinister environments, societal contrasts, the provocative effect of tattoos and condemnation by well-established society. Despite this, tattoos moved on from seafarers to landlubbers and non-sailors, from vagabonds to the middle classes, and even to the King of Denmark and other nobility with a rebel in their gene pools.

In 1966 and 1967, the doctors Michael Pers and Torben von Herbst studied the frequency of tattoos among Danish men and found that out of 17,000 conscripts, 4.8% had tattoos. Among young men who were institutionalised, there was also a high frequency of tattoos; in homes for apprentices, 19%, in youth custody centres, 42%, in homes for those with intellectual disabilities, 44%, in young offenders' prisons, 72%, and in community homes, 80% (15, 16). In 1967, in a very large and detailed study covering three representative Swedish counties, Lars Hellgren found the frequency of tattoos to be nearly 4%, most frequently in areas near ports, which is at the same level mentioned in the Danish studies (17). In the entire group of the population that was studied, Hellgren found that 6.3% were male and 0.07%, were female, which is a very significant difference between the genders. In a number of studies from the United States during the same period of time, referred to by Hellgren, the frequency of tattoos was indicated to be 9% for white males, but there were large variations among the ethnic groups in the United States, and a significantly lower occurrence of tattoos among females (gender ratio male/female: 7:1). The frequency of tattoos in Denmark about 50 years ago was about 3-4%. At that time, men were much more frequently tattooed than women, and tattoos had a substantially greater frequency among weak subcultures among men, including prison inmates. The conditions in Denmark were comparable to those in countries such as Sweden and the United States.

TATTOOS TODAY

Within the last 10-20 years, the prevalence of tattoos has nearly exploded as part of an international trend. During the last 20 years, and especially during the last five to eight years, there has been a dramatic increase in the popularity of tattoos, which are in demand by all classes of society today. The nature of this phenomenon has changed dramatically and has entered the realm of normality, and has become generally accepted.

Tattoos have become a billion DKK multinational industry, following the latest trends in globalised culture. The industry includes manufacturers of tattoo ink, distributors and sellers of ink, needles, tattoo machines and equipment, as well as tattooists with many different skill levels. The last links of the chain are the primary and secondary healthcare sectors, which become involved when health damage and diseases occur. Due to the extensive prevalence of tattoos, even rare injuries are notice-

able in the healthcare sector. This development gives rise to requirements for research and medical insight in connection with anthropological, psychological and social understanding of the phenomenon. Such knowledge is necessary for society to tackle the challenges at a general level through the development of legislation and regulations. In this way, while respecting the undisputed right of the individual to be in charge of his or her body (and skin), society can offer those with tattoos disease prevention, safety and medical treatment that is at the same level as the service provided in other healthcare areas, regardless of whether or not the damage was self-inflicted.

In Denmark, as in other countries, there are many amateur tattooists, or so-called scratchers, who, to a greater or lesser extent, practice tattooing privately. The industry is, therefore, extremely inhomogeneous. At the core, the tattooists who are professional and practice their metier on the basis of mastery of the craft and artistic ability have developed their professions for a number of years through personal experience. The Danish tattoo guild, Dansk Tatovør Laug, is an exponent for the core segment, supplemented in the debate by a network group called the independent tattooists, De Uafhængige Tatovører. The core group of tattooists is under pressure from tattoo companies with financed ownership by investors without tattoo experience and the practitioners are often Eastern European tattooists. The industry is also under pressure from the many scratchers. Bikers, who to a certain extent run tattoo businesses, also influence and control others. Bikers represent the segment in which tattoos are most closely connected with a certain social group with an aberrant set of norms. Part of becoming a member of groups such as Hells Angels and Bandidos involves having the group's emblem tattooed on the member's skin. Bikers have taken over the position as having tattoos as part of their identity from seafarers and have contributed to tattoos becoming a form of expression in a male culture, signifying physical strength and crudeness. The association of sailors with tattoos came and went with the era of sailing ships.

Tattoos reflect time and society, and change as they change. Even though tattooing of the tattooed person is experienced as living in the moment and is a type of photograph on the skin of the time and the person, tattoos are still a practice that comes and goes in waves over decades and centuries. Since the time of the seafarers, tattoos have definitely been part of international culture. Tattoos are often heartfelt by the person, who knows that they are permanent and who therefore is typically careful about the choice of design. Because they are self-elected and have the properties of a permanent decoration on the person's own skin, tattoos are deeply anchored in popular ownership, where it is difficult for authorities to become involved. Tattoos still have a significant element of provocation with regard to society and its control and setting of norms. In the past and in the present, tattoos signify: 'I am who I am' (see photo 1.3).

→ PHOTO 1.3

Modern tattoo carried out in neat, inclined handwriting and old-fashioned typography.

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2

THE CURRENT PREVALENCE AND PATTERNS OF TATTOOS

FROM BEING UNUSUAL IN THE PAST, TATTOOS, ESPECIALLY IN RECENT YEARS, HAVE BECOME PREVALENT AND VERY VISIBLE IN PUBLIC. TATTOOS HAVE, SO TO SPEAK 'EXPLODED' AND HAVE SPREAD FROM SUBCULTURES TO MAINSTREAM.

SUMMARY

It is estimated that 13% of the adult population of Denmark has tattoos. In recent years there has been an increase in the prevalence of tattoos. With regard to age, the frequency of tattoos is approximately twice as much among young people (23% among 18-29-year-olds) and, similarly, less among older groups (4% among 60-74-year olds). The increase of the prevalence of tattoos among the very young is substantial. Today, women are tattooed just as frequently as men.

The tattoo trend in Denmark corresponds to the trend in other European countries, and the trend is international. The frequency of tattoos has been calculated in Denmark and a number of other countries correspond to approximately 600,000 Danes and approximately 100 million Europeans having tattoos.

Concurrently with this, a large tattoo industry has grown. As part of this trend, completely new societal groups want to be tattooed and today, tattoos are widespread at all levels of society. The mechanism is a so-called trickle-up or trickle-across dynamic, where styles move by social groups being inspired by and partially copying each other. Today, tattoos have become mainstream, especially among young people and there is broad acceptance on the part of the middle class, but there are also many opponents. There is still an interface or division between those who regard tattoos as being beautiful and those who regard them as being ugly and degrading. Thus, 24% of the Danes who were asked in 2013 thought that tattoos were »beautiful«, 34% were indifferent, while 42% thought that tattoos were »ugly«. This division between attitudes indicates that tattoos are still a matter of socio-cultural conflict.

INTRODUCTION

With their prevalence and expression, despite the solid roots in the past and a constant, dynamic development, tattoos are a matter of adjustment that takes place very quickly and concurrently with the modern industrialised cultural trends in many other ways. In our time, communication tools have multiplied and imagery has become more commonplace than previously. Tattoos are a person's own imagery and comprise a personal statement or expression directed towards the surrounding world.

PREVALENCE OF TATTOOS IN DENMARK

Based on a number of sources, in 2012 it was estimated that 13% of adult Danes had tattoos, corresponding to approximately 600,000 people (1). This estimate was based on panel studies carried out by TNS Gallup (2) and by YouGov (3),

→ PHOTO 2.1

Modern tattoo covering a large area. Tattoos send out a broad range of signals.

as well as on a recent calculation among patients at the Department of Dermatology at Bispebjerg University Hospital (4).

In a recent follow-up panel study (5) carried out by YouGov on 1,007 representatively chosen people between the ages of 18-74 years old, an increase of the frequency of tattoos from 12% in 2009 to 15% in 2013 was identified. The survey also found that there was a change from there being a higher frequency among men in 2009 (men: 12% and women: 11%), to there being a slightly higher frequency among women in 2013 (men 13% and women: 17%) (3). There was a shift in the age distribution in the age group of 18-29 year olds from 10% having tattoos in 2009 to 23% in 2013, and for the age group of 30-39 year olds from 21% in 2009 compared to 26% in 2013 (Table 2.1).

Thus, there are indications that the popularity of tattoos continues and that women and young people are especially actively participating in the tattoo trend. The fact that women now have the most tattoos is a historic break in the curve. In the same study, 21%, corresponding to approximately 850,000 adult Danes replied that they are considering getting a tattoo (5).

Opinions about tattoos

The figures from the panel study carried out by YouGov (5) showed that a certain positive opinion about tattoos transcended political party boundaries and, in all, 24% from 'left wing' parties and 24% from 'right wing' parties thought that tattoos were beautiful and artistic. Forty-two per cent from both wings found tattoos to be ugly and frightening, and 34% were indifferent. Thus, there is a clear division in the population regarding tattoos, where the largest group perceived tattoos as being negative. Finally, the panel study showed that the opinions about tattoos are evenly distributed geographically in Denmark. Thus, it is not decisive whether you come from the greater Copenhagen area, other places on Zealand and the islands, or Jutland with regard to the extent to which people find tattoos to be beautiful, ugly or neither beautiful nor ugly (5).

Localization, size and colours in tattoos

The localization of tattoos on the body in terms of area size and colour combinations have been studied in detail among young Danish clients consisting of 154 people and 342 tattoos (Table 2.2) (6). Women had smaller tattoos than men. Only men had tattoos that covered more than 10% of the total area of the skin. In this study, 80.5% were pleased with their tattoos, while 13.6% regretted them and some were indifferent. With regard to professions, the study showed that tattoos were used by people within a broad range of professions, including 8.4% of employees in the healthcare sector and 1.9% employed by the military or the police.

→ TABLE 2.1

Overview of the prevalence of tattoos among adult Danes in 2009 and 2013. The studies are based on interviews with 1,007 (both years) of representatively selected people between the ages of 18-74 years old by YouGov Zaperas Danmarkspanel for MetroXpress. The question was: 'Do you have one or more tattoos?' (5).

		GENDER		AGE (YEARS)				
YEAR	TOTAL	WOMAN	MAN	18-29	30-39	40-49	50-59	60-74
2009	**12%**	11%	12%	10%	21%	17%	11%	4%
2013	**15%**	17%	13%	23%	26%	20%	13%	4%

→ TABLE 2.2

The prevalence in percentage of tattoos with regard to area of the body studied among 145 young Danes who had 342 tattoos. The study was carried out during the period from December 2010 to May 2011 (6).

	WOMEN (N = 151)	MEN (N = 191)	TOTAL (N = 342)
BODY	47.7%	28%	**37.1%**
ARMS	25.2%	51.3%	**39.8%**
SHOULDER	0%	3.7%	**2.0%**
LEG	7.9%	8.4%	**8.2%**
HEAD/NECK	4.0%	4.7%	**4.4%**
HANDS	4.6%	2.1%	**3.2%**
FEET	10.6%	0.5%	**5.0%**
GENITALS	0%	0.5%	**0.3%**

The colours of the tattoos were also registered in the calculation. Some of the tattoo designs had two or more colours in the design itself, and the total number colours used therefore exceeds the number of tattoos. In the calculation, black lining of the coloured tattoo was registered with the colour of the design. A total of 327 designs were black, 52 red, 37 green, 35 blue, 35 yellow, 23 white, 21 pink, 18 violet 15 grey, 15 orange and 22 consisted of variations of the ordinary colours mentioned. A number of the colours are mixtures of pigments, and red pigment often is used in colours such as orange, pink and violet (6).

PREVALENCE OF TATTOOS IN OTHER COUNTRIES

The prevalence of tattoos in Denmark is at the same level as the prevalence in other industrialised countries around the world. This is shown in a large number of studies from many countries; studies that have recently been summarised (7). Based on epidemiological studies in a number of European countries, it can be estimated that about 100 million adult Europeans have tattoos (7). In addition to covering different countries and cultures, the studies also cover different age groups, including special groups of young people, such as undergraduates and high school students. In general, the prevalence of tattoos among young people is greater than among old people or with regard to a broad range of ages. In Denmark, the prevalence of tattoos in relatively younger clients consisting of bathers at Danish beaches was measured at 31% (8) corresponding to approximately 13% of a broad range of ages among the adult population as referred to at the beginning of this section (1).

THE PATTERNS AND SOCIO-CULTURAL DYNAMICS OF TATTOOS

As described in Chapter 1, as was the case for piercing, tattoos were previously regarded as subcultural expressions and a sign of aberration, but this is no longer the case. In the industrialised world, tattoos have become part of mainstream culture – especially among young people, where people of all social classes, age groups and cultural observances get tattooed and have piercing done. In connection with the prevalence of tattoos in recent years, tattoo culture has been the object of extensive media coverage, among other things through English and American reality shows, where you follow people live, who have carried out tattoos. In addition to these spectacular shows, the exposure of celebrities with tattoos has contributed to the spreading of tattoos throughout modern culture.

Although people with higher educations and high social status are increasingly seen to have tattoos, it still appears that relatively more people with the traditional subcultural backgrounds (including gang members, prostitutes, prison inmates and psychiatric patients, especially those with personality disorders) who get tattoos. Recent studies also show a higher frequency of tattoos among people who are out of work and among women who do not live in permanent relationships (9). They presumable get tattoos for different reasons and with completely different designs, as described further in Chapter 3.

The spread of tattoos from groups with fewer resources to a middle class with good resources may be understood as part of a general tendency for the middle class in Western society to copy aesthetic expressions and types of behaviour from groups that have lower social status. They use them as an expression of taste, in which the

tattooed middle class person emphasises his or her refinement and achieves a certain 'edge' with regard to social norms, without it seriously damaging this person's ascent through established society, but actually makes this easier if he or she has a creative profession. The insight that this style migration and copying is widespread in the consumer society, also exemplified by the spread of hip-hop as music and fashion, has led to the concepts of trickle-up and trickle-across, which both challenge classic assumptions and theories about fashion: that styles migrate downward through the social space through a trickle-down dynamic; that social classes always try to raise their status by copying the elite above them, whose lives they themselves would like to live. This assumption was to a high degree valid in a society with less social mobility and a more penetrating social consensus about prestige and authority (10). In the large social, historic picture, tattoos today are spread as a trickle-up dynamic. This is not to say that the individual consumer of tattoos gets the idea from people who have a lower status: In social relationships it is likely that people become inspired by the aesthetic choices made by others if these choices are perceived as having a higher 'cultural capital' – that is, greater refinement and an ability to interpret and use various forms of aesthetics without much effort, as well as navigate between existing and new expressions. However, there is a lack of research on tattoos that can clarify the relationship between, on the one hand, the big picture; that the social classes adopt symbols from each other and transform them into something partly new by using them in their own universe, and on the other hand concrete stories from people with tattoos about how and from whom and when they became inspired to get their tattoos.

The world of tattoos is an environment that provides a service for money, but also defines itself sharply in contrast to what is commercial otherwise (11). The authenticity and rawness of tattoos appeals to the consumers' need to feel that aesthetic objects, surroundings and actions are not designed for them as a manipulation carried out by a marketing machine or an established societal system; but instead has emerged 'from below' and originates in a living environment directly anchored in its history. The same hunt for authenticity and spontaneity characterises, for example, tourism, and there is a lot of money in it: The tattoo industry has a turnover that is of a substantial financial size. The growth of the industry and economic potential illustrates the general, and to some people, paradoxical, tendency towards 'the rebel seller': That some of the most lucrative consumer phenomena within art, style and fashion originate within environments that distance themselves from the established norms and market dynamics of society at large (12). There is a constant acquisition of creativity and innovation from below, which is transformed into large-scale marketing.

In addition to the traditional groups, subcultures in the tattoo environment have come into existence, where 'collectors' have many, often large, ingenious tattoos, and thus a high status. In connection with this environment, newspapers and magazines are published, and conventions and festivals are organised, in which the participants can meet other tattoo enthusiasts and see other people's tattoos, show off their own and get new tattoos.

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3

THE PSYCHOLOGY AND SOCIAL DYNAMICS OF TATTOOS

THIS CHAPTER DESCRIBES SOME OF THE PSYCHOLOGICAL AND SOCIAL MECHANISMS THAT MOTIVATE PEOPLE TO GET TATTOOS. THE CHAPTER DESCRIBES PEOPLE'S OPINIONS AND JUDGMENTS ABOUT PEOPLE WHO HAVE TATTOOS. THE CHAPTER ALSO DEALS WITH REGRETTING TATTOOS AND CLARIFIES THE REASONS FOR REGRET.

SUMMARY

Tattoos are a kind of body art, which is used to present and express the modern person's sense of self. Previously, tattoos were a sign of social marginalisation, but with the large prevalence that has taken place over the last 20-30 years, it has become mainstream, particularly among young people, and it has become part of middle class culture. However, there is still a tendency to moralise in the research that has to do with tattoos, and thus there is a focus on the aberrant characteristics that are found in psychological studies of people with tattoos.

Many studies show that people with tattoos are generally more outgoing and willing to take risks that people without them, which is a point when dealing with influencing tattoo culture in order to prevent discomfort and complications that result from tattoos. For some people, the risk and transgressive aspects of getting tattoos is part of the fascination of doing so. For these tattooed people, information campaigns based on rationality and common sense will not have the same appeal. From a disease and complication prevention point of view, it is important to know the subcultures there are in the tattoo environment because they must be addressed differently with different messages and types of campaigns.

Approximately 13% of people with tattoos say that they regret them, while approximately 16% state that they want to have their tattoos removed completely. Quite a few people who would like to have their tattoos removed cannot afford to do so and accept their situation even though they regret them. Many people regret their tattoos because they are afraid of being considered to be ordinary and have bad taste, because the tattoos they chose when they had them made has, over time, become popular, which diminishes the original motivation of being special and unique.

INTRODUCTION

In postmodern culture, setting the stage to present your body is used to tell who you are or would like to be. A well-cared-for, physically trained body tells a different story about a person than an overweight, uncared for body, and styling using clothing, hair styles and makeup are signals to the world about how a person wants to be seen. Identity is no longer something static and unchangeable, but something that the modern person constructs in cooperation with others. Today, to be seen and be

reflected in the social mirror is a key aspect of the individual's self-perception and sense of identity.

In this perspective, it is no wonder that over the last 20-30 years, the Western world has experienced a dramatic prevalence of practices that are used for designing the body and thus modify the signals that are sent to one's surroundings. Body design comprises part of a rapidly expanding industry that lives on procedures that modify the body, done voluntarily and without medical indication. The procedures that modify the body may be more or less permanent and more or less invasive, and are intended to create or maintain an identity. The use of cosmetics, hair colouring, artificial nails or eyelashes are examples of reversible procedures, while, for example, self-injuring behaviour in the form of cutting or branding oneself, plastic surgery, silicone injections in the lips, breast implants, the operation of foreign objects into the body, such as 'horns on the forehead' and so-called body art with a large number of variations are examples of more permanent changes to the body.

Body art includes tattoos, piercing and scarring, where especially the skin and body surfaces are in focus. By modifying the surface of the body, which forms the boundary between the self and culture, the individual can revise signals to the surrounding world in a way that emphasises the individual's story about himself or herself. Some people even speak of using the 'skin as a canvass' or about a 'social skin', which can both create and express culture (1).

A tattoo is permanent, and it is its permanency that makes it a modern phenomenon because you can create your own story to tell the world about your identity yourself and, at the same time, challenge the possibility of constantly recreating yourself, which is a characteristic of modernity.

The latter because after getting a tattoo, to some extent, you bind yourself to the image of who you are that the tattoo expresses, and thus declare a certain consciousness with regard to the surrounding world and your own decision to stand by the decision. Tattooed people may actually perceive their tattoo as a picture that anchors them (2, 3).

→ PHOTO 3.1

Women are tattooed more often than previously. Breaking and changing norms, and the meeting between soft values and hard values illustrated in a modern tattoo.

THE WEAKNESSES OF THE MORALISING PERSPECTIVE

A general weakness in research on tattoos is the moralising tone by which researchers imply that those who have tattoos are more irrational or mor-

ally weak than the rest of the population. As stated in a new review of the literature in the area:

'Research based on tattooed individuals has several flaws. First, and most significant, is that many of the studies in the category of Psychological Dispositions and Social Misfits overemphasize the connection between deviant behaviour and being tattooed. Studies continue to perpetuate the long-standing myth that tattooed people are somehow abnormal or deviant. This overlooks the set of findings by Sanders (4) and Atkinson (5), which show that tattoo wearers engage in many pro-social behaviours in the process of attaining a tattoo, and being tattooed. Sociological and anthropological research have been able to challenge the assessment that tattooing is evidence of some form of behaviour pathology' (2).

The moralising perspective is problematic as an analytic perspective for three reasons: It is often maintained that a tattooed person compensates for various kinds of loss of status, for example masculinity or femininity being under pressure, or a socially marginalised situation. This may well be the case, but if you view tattoos as a kind of consumption that supports an identity project, the same can be said about the purchase of a number of other experiences and consumer goods. To maintain that people strengthen a vulnerable identity through visual presentation of themselves is much too simple a perspective, which really only points out a general characteristic of modernity. The other reason is that the perspective does not provide a comprehensive understanding of the motivations among people who get tattoos. Thus, it will not be able to support communication directed towards tattooists or their customers that can change their behaviour, for example by using other kinds of ink. Effectively changing behaviour, in addition to legislation, is based on understanding the language, the motivations and the internal groupings among those you are addressing, and in a respectful manner being able to offer alternatives to their existing behaviour so that these alternatives appear to be more attractive. Thirdly, a moralising perspective that focuses on tattoos as compensation for low status is increasingly untenable the more members of society's 'elite' get tattoos, which has been the tendency over recent decades, just as Western societies have also experienced previous waves of increasing numbers of tattoos in high status groups.

This chapter takes the users' perspective and therefore paints another picture of tattooed people than them being basically irrational and/or dangerous to themselves, which can be seen in the perspective described above: irrational and ignorant, because people with tattoos either do not have insight into or even act despite their knowledge about the physically injurious properties of the ink, which research has shown. Dangerous to themselves because research also shows a connection between deviant and other risky behaviour among people with tattoos, and one may wonder why the demonstrability of such connections does not prevent people from getting tattoos.

THE BODY AS A CANVASS: INDIVIDUALISATION AND AGENCY

When a modern person chooses to get a tattoo, it is an example of agency, a concept that indicates ownership, or that people are agents for their own lives, which can, among other things, express an interaction with a structure (6): People do not just accept living with and reproducing the predefined frameworks they are given by nature or society, whether these are social structures or the body's limits and the world's physical arrangement. People want to experience themselves as co-creators of their surroundings and of their fates and appear-

ance. Getting a tattoo may cause a strong feeling of influencing the conditions that one is given; that is, the physical makeup of one's body. This is an example of exercising the agency to create and communicate the picture of one is. One might find it paradoxical that people feel like they are unique when making this choice, when so many others make the same choice. But that is not necessarily a relevant observation when trying to understand people's motivation. They may perceive the decision to get a tattoo as being basically acceptable because others do so. They may be inspired by the decisions of others in this area and sense that the existence of many tattooed people from a number of social groups means that they will be 'interpreted' by their surroundings in the way they want to be – not as being deviant to a problematic degree, but as aestheticians. Within this basic framework of general similarity to other people, there is a wealth of opportunities to arrive at individual designs and styles, which to the tattooed person provides the experience of making a unique choice.

Getting a tattoo is a consumer choice like so many others. You can choose not to do it, but you cannot choose not to send out signals. With the individualisation and emphasis on appearance and pictures that Western society has experienced, one's body will be interpreted by the surroundings as an indication of lifestyle and taste, and among other things, give rise to a more or less conscious feeling of aesthetic appreciation, community, lust, provocation, fear or social distance.

The concept of agency and the interaction with and redesigning of structure that it implies, suggests that the decision to get a tattoo should not be understood as a destruction of the body's physical frameworks, but as a bodily and existential experience that is also a creative and communicative act. Neither does it result in a total release from the limits of the body, but a dialogue with them. The person takes an initiative, but also runs into some frameworks that limit what can be done; both to the body as physical material and the materials used for tattooing (for example, types of ink and equipment available for embedding into the skin). The activity of getting a tattoo is in itself a complex phenomenon, which expresses itself as what, to use a current theoretical concept, is called assemblage. That is, the meeting between the individual's cultural motivations, financial priorities and personal dispositions, the social structures that the individual reacts with and against, the historic developments that support the use of tattoos right now among specific groups and the frameworks for the action, which are set by a number of commercial and political players, who influence the technological possibilities, legislation and access to alternatives. The network of relevant players, who form the context for individuals' decisions regarding tattoos, is called a 'world of art', which includes style creators, who influence society's aesthetic preferences, as well as players who distribute equipment and information – such as the publishers of this report (2, 7).

SOCIAL CLASS, COMMUNICATION AND BEHAVIOUR CHANGES

If the goal is to change behaviour, for example through communication that creates a demand for ink types that are less dangerous to health but may also be more expensive, it is important to keep in mind the growing proportion of the population that gets tattoos is a heterogeneous group, which spans across a number of social layers. The understanding of the dynamics between these is not just important for understanding the motivation of the middle class consumers, as mentioned in the section above. A point that is just as important to attempt to make regarding any attempts to

change behaviour, is that there is a risk of losing the group that has fewer resources, which might be the most important to reach because it already engages in the most unhealthy types of tattooing practices. As Lane writes on the basis of an American perspective:

'Tattooing is divided into two classed worlds. First there is the high-art world, a middle-class perspective emphasizing the artistic nature of the practice. This approach to tattooing justifies the legitimacy of collecting tattoos and being a professional tattooist. DeMello (8) also found there is a biker/lower-class tattoo world that rejects the elite-centric approach to tattooing. Those who are involved in the biker/lower-class world are characterized by lowbrow culture and a general disdain for the effects of the elite-centric approach to tattooing. These transformations occur as members of different social groups adopt the practice' (2).

The danger of educative scare campaigns is that the communication that plants new criteria and perceptions of risks in the middle class may not have any effect on groups with a lower status. The latter group might perceive that the information campaign postulates associations that do not resonate with their own experience and knowledge, or that safer but more expensive ink types are launched by actors who are just trying to make financial gains, monopolise the market and protect themselves from competition from less expensive ink types.

One consideration is the extent to which communication should focus on risks at all. If a demand for more healthy types of ink is to be created, it would probably work better if these offer obvious advantages, which are already relevant to the consumers' aesthetic criteria, for example greater durability with regard to fading when affected by sunshine. Here lies the task with regard not just to communicating, but also regarding product development: New or improved properties must be seen by users as both relevant, and so superior to existing alternatives, that this justifies price difference.

Regardless of which target group is addressed, and regardless of whether the focus is on the risk of potential injury or on advantages that the consumer would experience with certainty, communication about the effects should be concrete and pedagogic. Inspiration may be found in how, using computer graphics and the naming of complex chemical substances that are already marketed for their properties, for example within cosmetics, dietary supplements and a number of other staple goods, even though the existence of these substances cannot be directly experienced through the consumers' senses, but can only be an object of human perception, and the substance's existence can only be confirmed by its assumed effect.

It may be tempting to believe that communication about tattoos with a subsequent change of behaviour would be able to be carried out by making comparisons to how smoking has been reduced successfully, having smokers choose light types of cigarettes and totally change behaviour and social acceptance with regard to where and with whom people smoke. But it must be remembered that the comparison is not as simple, because smoking can rightly be said to annoy those nearby and can thus be made the object of strong moral sanctions in the form of the disapproval of those nearby. Tattoos are not and should not be a phenomenon that is subjected to moralisation, and an attempt to do so would probably give rise to a dramatic and justified resistance to 'the nanny state's' attempt to control every attempt to test the boundaries of freedom, passion and aesthetics in the lives of citizens.

Communication activities in the area should be tested qualitatively in the target group and adjusted in accordance with its feedback. This test must be spread over enough segments of gender, age and social class so that it takes into account the warning about lack of relevance for important social groups, as mentioned above. Whether the relevant social differences for the study segmentation among Danish tattoo consumers is the same as between American 'middle class elite' and 'low culture' cannot be taken for granted and should be clarified by prior studies.

CREATING YOURSELF WITH A TATTOO

As somewhat of a surprise to most finance people, in 1996 tattoos suddenly appeared in the top six list of the most rapidly expanding industries in the American economy, side-be-side with high tech industries and Internet services (9).

The tattoo industry is still a growth industry, and in addition to media exposure, the large prevalence and popularisation of tattoos, is due in part to a general tendency in modern culture, that is, the desire to be special or unique; to be someone who is different from others. This is actually a narcissistic project, which, as mass culture, has its roots back in the 1970s, which the American contemporary historian Christopher Lasch described as the modern person's 'struggle to create himself and obtain a personal identity' (10). Tattoos have been used to identify oneself as something unique (*'be different'*), authentic (*'to be myself'*) and in an independent way (*'be who I want to be'*).

At the same time, tattoos have become a fashion trend, which means that having a tattoo is no longer in itself something unique and exceptional. But tattoos still make it possible to present your body in a unique way, and with the many new designs and styles that have been introduced in recent years, an enormous expansion of the stylistic expression has taken place that also has subcultural significance. Today, many people consider tattoos to be an art form, where the individual tattooist can express unique characteristics on a person, and in this way the person has something original and very special (11). The designs have developed from the traditional old school style, among other reasons because the artists and especially the female artists to an increasing degree have more influence on the tattoo environments. The designs may be cool, humoristic, ironic, decorative, traditional or new, like the latest new 'supermarket product' (12), but will always be part of a freely flowing system of signals with mutual references that anchor every tattoo in a greater universe of meaning.

A project that illustrates the anchoring of the individual tattoo in a meaningful system took place during the summer of 2003, when the American author Shelley Jackson tattooed a novel, word by word, on 2,095 volunteers who had one word tattooed one place or another on their bodies. Although each of them was different in that they had different words, they belonged to a large community. Shelley Jackson says that, for example, groups of friends contacted her to have a word tattooed, which when put together could comprise a sentence and thus indicate a community within the larger community. The novel was never printed or published in its entirety, but still lives its life on the 2,095 bodies around the world. Tattoo culture has become more academic and it seems to be a new trend to have literary texts tattooed on your body.

Tattoo culture can be understood as a language. Using a language – to be tattooed – is nothing unique, but the opportunity to articulate and express your individuality lies within the possibilities that language presents. By choosing the 'right'

symbols or words you can signal your individuality as something quite special, but this project is always under constant pressure because the others in the culture can choose to express their individuality in the same way, making the expression refute itself. The fact that many others have chosen to get the same tattoo is one of the most frequent reasons why people regret tattoos and, perhaps, want to have them removed or covered by others (13).

The linguistic formulation or tattoo becomes part of fashion statement or a mass movement, and when it comes to tattoos, there is also the paradox that tattoos are permanent and indelible, while fashion is something changeable and dynamic A tattoo is an indelible 'mark for life', although more and more people suffer from tattoo remorse and therefore want to have them removed (13). Some researchers have pointed out that the great prevalence of tattoos since the 1990s is connected to the fact that a stable, predictable life with a permanent job, marriage and family is being replaced by a life that is characterised by flexibility, discontinuity, insecurity and risks, and therefore a lack of anchorage. For the individual, this has resulted in vulnerability, insecurity and identity problems, which on the one hand have created a need to be able to express one's individuality and different identities in different social contexts ('to be someone special') and on the other hand to seek something constant and something permanent. By using the body as a canvass with tattoos to write one's story, the individual can maintain his or her identity as something permanent, but also changeable, because change is written in the form of new tattoos. It is not uncommon for people with many tattoos – the so-called 'collectors' – to use the body as a kind of autobiographic memory system, which is clearly stated by the following vignette (12):
'The tattoos are mine and a sign that only I can make decisions about my body. No one else affects what I look like. And my tattoos tell about who I am. They tell my story. I got my first one together with my girlfriend then. It brings back good memories. I got my second tattoo as a remembrance of my mother, who passed away right when I moved away from home. She is always with me. I got the third one when I came home after having crossed the Atlantic in a sailboat together with three friends. The others also got tattoos with the same design. I had the last two made when my son and daughter arrived. My tattoos tell about some of the most important things that have happened in my life. And I'm going to have more. So in my old age I will be able to tell the story of my life by pointing at different parts of my body where I had tattoos made. It is a process to have this story made. It requires reflection and has nothing to do with impulsiveness' (40-year-old man).

The quote illustrates how the different tattoos are connected with pivotal life events and tell a story (14) with different elements to understand his identity. He retains meaningful moments and embodiment of the story of his life is a developmental process that corresponds to a social construction: his body displays a significant part of what he considers to be his identity and subjectivity. Maybe the different tattoos will mean different things to him in the course of his life, but he keeps them alive, so to speak, by having new tattoos made when he experiences new life events. He is not just collector tattoos, but also a collector of otherwise fragmented, isolated biographical events.

Many researchers consider this understanding of tattoos as a form of life story and thus a symbol of one's identity to be an expression of the individual taking control and ownership of his or her own body. This point makes sense when we take a look at the social history of tattoos, which is also the history of the different functions tattoos have had over time. This history, however, says nothing

about the individual's psychological reasons for getting a tattoo. We will get back to this later.

TATTOOS – FROM STIGMA TO RECONQUERING THE BODY

As mentioned previously, decorating the body with tattoos has a long history (see also Chapter 1). The oldest tattooed body we know of is the approximately 5.300-year-old Ötzi the Iceman, who was found with both ear piercings and soot (carbon) tattoos in the form of simple pricks and lines (cf. Chapter 1). The newer history of tattoos, however, starts with James Cook's descriptions of his voyages to Polynesia between 1766 and 1779. In the ship's log, he has described how 'both sexes paint their bodys. Tattow as it is called in their Language' (15). When Cook and his people returned to Europe, a number of his people had had tattoos made in the South Pacific Islands, which presumably contributed to tattoos becoming a part of seafaring culture. The classic sailor tattoos often had symbolic meaning, which both had to do with the dangerous life at sea and the longing for close, intimate contacts, which they could not maintain while they were away. The swallow was a frequent design, which partly indicated that the sailor had sailed more than 5,000 nautical miles, and partly the yearning to return safely home. The swallow is one of the birds that returns to the same nest year after year. Hearts and roses symbolise the love they have for those at home, whose names can also be tattooed on the sailor's body. A full-rigged ship, an anchor and King Neptune are symbols that the sailor has been certain places (for example, rounding Cape Horn) and thus gives witness to his achievements and status in sailor hierarchy.

Because there was now a concept of marking the body with indelible ink it gradually became possible to combine a long cultural history about voluntary decoration of the body for different reasons, as we know them today, but also about compulsion, punishment and stigmatisation of marginalised individuals.

Jones points out that the Greek word, stigma, referred to tattooing (the root of the word, stig, means to prick), which was a physical mark of 'the others' as people who were looked down on, for example, slaves and criminals (16). By tattooing slaves and criminals in the face they were easily identifiable and stigmatised, as both their crime and punishment as ownership was indelibly imprinted and therefore sealed their fate. They could not hide or flee from their past. Compulsory tattooing indicating which crime the person was guilty of continued up through the Middle Ages in Europe.

Fisher (17) points out that this contributed to reinforcing the perception of tattoos as a symbol of aberration and marginalisation. Around 1880, when tattooing criminals was no longer compulsory, Italian and French criminologists were interested in studying voluntary and self-chosen tattoos among people in criminal environments because they wanted to understand and decode the meaning of them, which they considered to be physical signs or even proof of having committed a crime. Lambroso (18) perceived criminals as being ill and that the fact that they could stand having tattoos made was simply an indication of their high pain threshold and primitiveness. This line of reasoning was an expression of how closely related tattoos and criminality were at the end of the 19th century, but even in contemporary studies, some authors conclude that the incidence of tattoos among patients may be a sign of criminal activity or psychiatric disorders (19, 20).

To this day, prison tattoos also have symbolic meaning and internal codes. For example, tears

tattooed under an eye means either that the person in question must remain in prison for a long time or that he or she has committed murder. Other designs indicate time (for example, a clock without hands) or an affiliation with certain groups and may, therefore, function as a kind of protection against abuse or harassment (21). The Canada Border Services Agency Organized Crime Section has published a handbook (22) with a systematic overview of the hidden purposes and meanings that may lie behind tattoos. The information was gathered from criminal inmates. The tattoos are about personal messages to fellow inmates and others in the criminal environment, for example, group affiliation, status and attitudes, which may be important for prison authorities to decipher.

During the American Civil War, mass tattooing of soldiers took place. Symbols or signs were made that indicated their military affiliation so that it was clear which side they were fighting on. During a politically inscrutable period of time, tattoos were used to indicate differences between otherwise identical men from the northern states and the southern states, respectively. Tattoos were used to indicate both the difference (between them and us) and the similarity within a group (for example, the southern states), which was important in order to be able to tell the difference between friend and foe (23). The use of tattoos to indicate group affiliation had previously been practised by Christian pilgrims who had Christian symbols tattooed to indicate their religious affiliation (1). Here you can see a precursor for the modern use of tattoos as an indication of reference groups and identity.

At the end of the 1880s, tattoos were in fashion among people from high social classes in England and the United States. However, this did not result in a community regarding tattoos across social groups because, among other reasons, there was a stylistic and aesthetic difference in the tattoos that people from high social classes had made and the tattoos that sailors and workers had made. There was a clear dividing line because the tattoos that were made on people from lower classes were still considered to be signs of deviance (17). Representatives from higher social classes had ethnic tattoos made, inspired by or carried out by Japanese tattooists who went to the United States or Europe. These ethnic tattoos signalled that the tattooed person was a man of the world who had been on exotic journeys to other cultures (which, however, was not always the case). Fisher (17) summarises the difference between tattoos in the well-to-do segment of society and the traditional working class: among the well-to-do, tattoos were used to impress, while in the working class, designs were chosen that signified personal experiences or class affiliation to express something to others.

In addition to the Japanese influence on the designs, there is no doubt that it played a role for the understanding that tattoos had become modern among the upper class precisely during this period that a change had taken place in tattoo techniques. The invention of the electric tattoo machine was patented in 1891 by a tattooist from New York, Samuel F. O´Reilly. The tattoo machine, with the improvements introduced after the patent had the result, in part, that it was possible to improve the quality of tattoos and have more variety and complicated designs, and in part because the tattoos were less painful to have made. The machine formed the basis for the quick development in the prevalence of tattoos (see also Chapter 1).

After a short period of around 20 years, during which many people from upper social classes had tattoos made, interest waned around the turn of the century, which is attributed to the fact that also more 'deviants' from the working class had tattoos

made and the designs became increasingly vulgar. At the beginning of the 20th century, it also became more common that scantily dressed tattooed women performed in circuses, which contributed to creating an aura of vulgarity around tattoos.

Tattoos had always played a major role for indicating affiliation and commonality in the military. Soldiers had symbols or signs of their military group tattooed, which strengthened both identity and a sense of community among the soldiers. However, after the Second World War, tattoos did not have the same status and social approval in civilian life that the soldiers returned to after their military service was over. The widespread opinion about tattoos as being vulgar or a sign of deviance remained in civilian society and when survivors of concentration camps arrived in the United States and Europe with their compulsory tattoos from the concentration camps, this certainly contributed to giving tattoos a bad reputation in the post-war years.

Today, tattoos have renewed popularity among soldiers, which is stated in a Danish book about tattoos among the Royal Life Guards, where tattoos, among other things, indicate affiliation to a community of Danish soldiers who have been deployed to international missions in, for example, Afghanistan. Many of them have tattoos of the Royal Life Guards' regimental symbol, the sun, but all of them have their personal explanation of what the sun means to them. For some, the sun is the symbol of individual missions, comradeship, but also of personal development. Some have had the sun tattooed with dates of children's birthdays, wedding days and dates of the deaths of fallen fellow soldiers. In this way, the joint symbol is given specific, private significance (24).
In the slipstream of the 1950s, security and conformity was cultivated in the United States, where tattoos were condemned and looked down on by the public, a counterculture was created, in which, among other things, tattoos were used as visible sign of rebellion and independence.

Teenagers and other individuals who wanted freedom and independence used tattoos to emphasise their nonconformity, and in advertisements and films, tattoos began to signal individuality and independence, for example, by characters like The Marlboro Man and Popeye. From the end of the 1960s and up through the 1970s, tattoos were once again used as signs of independence and rebellion against established society, and maybe also as an expression of solidarity with marginalised groups, which traditionally had tattoos. Tattoos were in fashion among hippies and rock musicians, which both articulated rebellion and other life values than those that dominated established society. Janis Joplin and the Rolling Stones are often mentioned as examples of well-known musicians who have tattoos. In recent years, also well-known sport stars, photo models, actors, writers and politicians have been photographed with tattoos, which has contributed to destigmatising and thus normalising tattoos.

As indicated by this brief outline of the social history of tattoos, there is still movement between tattoos as the desire for: 1) conformity and group affiliation, which in its most extreme expression is compulsory tattoos where the person's individuality is obliterated or toned down, and 2) independence and individuality, where the tattoo is used as a sign of something unique and special, and thus indicates the individual's control and ownership of his or her own body. Susan Benson (25) has stated that it is precisely the groups, whose bodies have been exposed to violent regulation or suppression (for example, criminals and people from the working class), who have been the largest consumers of tattoos, and she interprets this as their

way of expressing ownership of their own bodies – an ownership that, historically, has not been a matter of course. The increased use of ever more visible tattoos by young women may be viewed in the same light: Women use tattoos to indicate ownership of their own bodies and sexuality, which is relatively newly gained seen from a historical perspective. At the same time, a woman indicates what type of femininity she stands for, a femininity that can easily be in opposition to that which is praised and practiced by women in other social classes (2, 26).

PSYCHOLOGICAL RESEARCH

Despite the fact that there continues to be more people from even broader segments of the population have tattoos made, it is remarkable how little research has been made on the psychosocial aspects of tattoos. Most of the research in the area is anthropologic and sociologic, and the relatively few empirical studies that have been made are full of methodological weaknesses, which make the results difficult to generalise. As Jill Fisher (17), has formulated it with a touch of sarcasm, the academic interest in body art, including tattoos, is typically considered to be a 'deviant interest in deviancy'. This formulation points out the moralising position that has characterised a large amount of the research.

The moralising position seems to be changing, however, due, among other things, to more researchers approaching the topic with a different understanding and insider knowledge of the tattoo environment. More new research has come in this area in connection with the prevalence of tattoos and the increased medical interest (see Chapters 6 and 7). However, there is still a need for increased knowledge at the biomedical level, but also psychosocially, in order to achieve a deeper understanding of who has tattoos made and of their personal motivation and fascination, as well as the psychosocial consequences of getting a tattoo.

ATTITUDES TOWARDS PEOPLE WITH TATTOOS

When you consider how popular tattoos have become, you may wonder why nearly all studies about attitudes towards people with tattoos show that more negative properties are ascribed to people who have tattoos than to those who do not have tattoos. The negative perception of people with tattoos may reflect that the tattooed person sends out signals of nonconformity, rebelliousness or indicating himself or herself as being deviant.

In 2000, Durkin & Houghton (27) published a study with 340 children aged 6 to 16 years, were presented with a series of illustrations of three men, one of whom had a visible tattoo. For each illustration they were requested to decide which individual had been involved in a negative, positive or neutral activity. The participants indicated significantly more frequently that the tattooed man had been guilty of negative activities (for example, had hit someone else, had taken drugs, was carrying a knife, hated the police, made problems and was looking for a fight). In another study published in 2001, untattooed and unpierced college students were asked to evaluate themselves compared with people with tattoos and piercing, and in generally, they evaluated the people with tattoos and piercing as being more neurotic and less open, friendly and trustworthy than themselves. In other words, their perception was that the tattooed and pierced people had more negative attributes (28).

In a recent study published in 2012, among 2,016 adult Americans, 45% of those without tattoos considered people with tattoos to be less attractive, and 27% considered them to be less intelli-

gent, while 50% said that they considered people with tattoos to be more rebellious than those without tattoos. Twenty-four per cent thought that people with tattoos were more prone to do things that most people would consider as being deviant. This figure has decreased from 29% since the last study in 2008, which can be interpreted as an expression of increasing acceptance of tattoos (29).

In 2007, Swami & Furnham carried out a study in which drawings of women with and without tattoos were shown to university students. Here they also found that the tattooed women were rated more negatively than those without tattoos. The tattooed women were perceived as being less physically attractive, more sexually promiscuous and as having greater alcohol consumption than women without tattoos. The more visible tattoos they had, the more negatively they were rated by the students (30). This study is also interesting because 14% of the students themselves had one or more tattoos, and 71% of all participants stated that they were considering getting a tattoo themselves, which is quite remarkable, when the participants in the study had negative perceptions of others with tattoos. This could indicate a disagreement between the perception of others and one's own self-image. A study by Drews et al. (31) from 2000 shows that people with tattoos have a positive image of themselves because they consider themselves to be more adventurous, creative, artistic, individualistic and willing to take risks than is the case of those without tattoos.

In 2001, Degelman & Price (32) studied 196 high school and college students' ratings of photographs of the same women with and without tattoos. The study shows the same results as the previous one; that is, that the tattooed women were rated more negatively than those without tattoos: They were perceived as being less athletic, attractive, motivated, generous, mysterious, religious and intelligent than untattooed women. Also in this case negative properties were attributed to the tattooed women. The value of these studies depends, of course, on the population studied. It has been stated that people with a more conservative attitude regarding gender differences perceive tattooed women more negatively than those with a more liberal attitude. It has also been stated that that people who are tattooed themselves generally have a less negative attitude towards others who have tattoos than those who do not have tattoos.

An early study from 1991 shows that career-oriented women with tattoos experienced tremendous stigmatisation, particularly on the part of older men in their networks (33). There are also studies that show that tattoos are perceived as being negative during job interviews. Fewer than 30% of the employers in an Australian study from 1995 would employ a tattooed person (34). In 2006, a similar negative attitude was found in a study of HR staff who were to evaluate applicants in the hotel and restaurant industry (35).

In an American study from 1998 of the attitude of doctors, nurses and students toward tattooed people found unequivocally that they were assessed more negatively than untattooed people, which is otherwise a problem because the negative attitude may affect the attitude in general, so that tattooed people risk receiving suboptimal treatment in a healthcare sector that is characterised by dissociation and negativism (36).

Even though tattoos are no longer a sign of involuntary marginalisation and deviation, tattooed people are perceived negatively compared to those who are not tattooed. There is a need for new studies that do not just look at variations among tattooed people (whether they have one

or more visible tattoos), but also among the group that perceives their fellow human beings. It has been documented that conservatively inclined people are more critical of tattoos than liberally inclined people, and over time it is expected that the attitude will generally become more liberal and accepting as tattoos become increasingly prevalent in all social segments.

PSYCHOLOGICAL AND BEHAVIOURAL TRAITS AMONG PEOPLE WITH TATTOOS

There has been great interest in describing differences in psychological and behavioural traits among tattooed people and untattooed people, respectively. In this part of the research, the focus has been on the individual behind the tattooed skin and not so much of the groups or relationships to which the individuals in question belong. This part of the research is also characterised by an attitude of condemnation, in which the focus has been on the negative rather than the positive characteristics of tattooed people. A number of studies focus on personality traits in the so-called five-factor model (28), that is, openness, conscientiousness, extraversion, agreeableness, and stability versus neuroticism, as well as the willingness to take risks and sensation-seeking behaviour. Other studies focus on actual psychopathology and especially on personality disorders.

Particularly older studies have found an increased incidence of personality disorders in people with tattoos (21). In a study from 1972 of detainees with who had receive disciplinary punishment in The Royal Navy, it was seen that the incidence of personality disorders increased proportionally with the number of tattoos: Forty-eight per cent of those who did not have tattoos had a personality disorder, and the figure increased to 58% of those who had between on and four tattoos and to 82% of those who had more than 16 tattoos (37). It must be expected to find a high incidence of personality disorders among a group of people who were studied, precisely because they are detained on the basis of disciplinary offences. Particularly in earlier studies there has been a tendency to link tattoos to personality disorders. In their study from 1990, Raspa & Cusack (19) found that the connection between having a tattoo and a personality disorder was so clear that they stated that 'finding a tattoo on physical examination should alert the physician to the possibility of an underlying psychiatric condition'.

In a study from 2002 of inmates in prisons in Colorado and had violated the prohibition against having tattoos made in prison, by using MCMI-III, which is an instrument used to study the incidence of, among other things, personality disorders, and increased score on the scale that registers the incidence of antisocial, sadistic/aggressive and negativistic personality disorders, as well as borderline personality disorders, but also an increased incidence of mania, drug abuse, post-traumatic stress disorder, and thought disorder (21). It is clear that the 8,574 inmates involved in the study are in no way representative for the general population, and therefore the study's findings cannot be applied in general to men with tattoos. Nevertheless, in other, also recent, studies there seems to be documentation that young people with tattoos have different behaviour than young people without tattoos (38). For example, in one study with college students, it was found that the tattooed men had higher cigarette consumption, more sexual partners and had been arrested more frequently than untattooed men (31). The number of sex partners among college students seems to be higher among those who are tattooed than those who are not tattooed (39), and Tiggerman & Golder (40) found that

people with tattoos had a greater need to feel that they are unique than untattooed people. Finally, there is documentation to support a connection between having tattoos and the consumption of drugs and alcohol (41, 42).

Tate & Shelton's (43) study of personality traits of college students with piercings and tattoos from 2008, it was found that the tattooed students, compared with untattooed students, were significantly less friendly and reliable, and that they had a greater need to feel that they were unique than the untattooed students. Although these findings are statistically significant, the authors point out that they only explain a small part of the difference between the tattooed and untattooed students, and they warn against connecting people with piercings and tattoos with extreme personality traits or psychopathology. This is included in the title of their article, 'Personality correlates of tattooing and body piercing in a college sample: The kids are alright'. They conclude that tattoos and piercing are part of mainstream culture, and when about 25% of middle class college students have tattoos, which was the case in their own study, it does not make sense to view tattoos as a sign of social deviation or a breach of character.

There are, however, a number of ambiguous findings regarding depression and anxiety among people with and without tattoos, respectively. Fredrick & Bradley (44) have found that tattooed subjects in their study have significantly lower depression scores than those who are not tattooed. No significant differences have been found in other studies (45), while Roberti & Storch (46) found that the tattooed and pierced subjects scored higher in the depression and anxiety scales.

A study from 2011 indicates that both men and women experience increased enjoyment and satisfaction with their bodies, increased self-confidence and less anxiety about being seen by others right after they had a tattoo made. Self-confidence and a positive perception of the body remained the same for both genders in a follow-up study three weeks later, but only the men experienced that the positive benefits with regard to anxiety about being seen by others remained the same. In contrast, the women experienced increase anxiety anchored in their body image and thus also anxiety about being seen by others (11). These findings could be related to the sensitivity of the women subjects about the more negative reaction to tattoos on women, as described above (for example, in (32)).

There are, however, more studies that show that tattooed people are more outgoing, willing to take risks, adventurous, individualistic and sensation-seeking than untattooed people (47), which corresponds to the self-image that is described by Drews et al (31), who find that people with tattoos perceive themselves to be more outgoing, creative, artistic, individualistic and willing to take risks than is the case for people without tattoos. A study of 2,016 adult Americans from 2012 found that 86% had never regretted that they had a tattoo made. Thirty per cent stated that tattoos made them feel more sexy, 25% that they felt more rebellious and 21% indicted that tattoos gave them the feeling of being stronger and more attractive (29).

THE BODY IN THE MOMENT – TATTOOS ARE MORE THAN IDENTITY

As described in this chapter, the symbolic meaning of tattoos is regarded as an identity project that is the general motivation factor behind getting tattooed, regardless of which social groups are looked at. However, an extensive critical movement has been taking place in recent years in the social sciences that is distancing itself from the analytical

angle, where actions are seen as attempts to create symbolism and a story.

Another analytical view can be applied via a non-representational perspective, which can enrich the understanding of tattoos (48). The latter perspective attempts to explain human motivations as driven by a direct involvement with the body's experience and material objects, and with emotions that arise situationally when experiencing other people and physical places. This analytical dimension focuses on more immediate dimensions of experience than deep contemplations about identity and may be more suited for understanding intense experiences that give rise to impulsive decisions, such as getting tattooed. As Bell says, not all tattoos have great significance, and it may be the act of getting a tattoo itself that gives meaning (49). A source of the appeal of tattoos, which expands the analytical understanding of not just focusing on identity, is the meeting of the potential tattoo customer and the tattooist, as well as the physical environment itself where the tattooing takes place. Here, the authenticity and contrast to established society, which the tattoo symbolizes, is experienced as an experience of the senses, which appeals spontaneously without being the object of deeper reflection or putting into words. The relationship with the tattooist and the feeling of trust about the tattooist's personal appearance and aesthetic guidance may be decisive. The tattooing location itself, as is the case with other consumption environments, can motivate the individual by comprising an environment steeped in atmosphere, composed of a range of sensory and cultural references that are both visual and auditive in nature, such as the music that is playing at the site and the humming sound from the machinery when a body is being tattooed. Experienced at once with all human senses, such factors create a strong atmospheric experience that overwhelms and envelops the person (50), which not only can alienate potential tattoo customers and make them turn around and walk out the door, but also attract them towards a quick decision to charge right into the experience. Finally, the feeling of being on the couch and getting a tattoo made can be a unique physical experience, which in its own way has the power of attraction that is not about the communication of signals to the world at large.

A perspective of this nature, which includes the immediate social and physical experience of getting a tattoo, is needed to understand the motivation behind tattooing – and thus for finding the 'push-buttons' that may be addressed in communication to the tattoo customer about new possibilities and existing risks. This also emphasises the lack of research on which role the interaction between the customer and the tattooist plays, including the latter as the supplier of information. This does not mean that the research must ignore the combination of social groups and behaviour, just that a clarification of these may take us far away from the immediate meaning and motivation that people themselves experience as being decisive. Consumer decisions are distributed to some extent according to social class and background in 'post-modern' society; the same is true for the decision to get a tattoo. Tattoos will also often lead to major decisions by the consumers about their own motives and aesthetic preferences, both because they are financially expensive and because the sanctions of making a bad decision are perceived as being high. But the perspective implied here, which has its roots in analytic traditions and phenomenology (6), emphasise that when the individual is in the situation and says 'OK, I'll do it', this often takes place based on an experience of immediate presence; that things just seem 'right' with no real need for more consideration (51).

INDIVIDUAL MOTIVATION FOR GETTING TATTOOS MADE

When you ask people about why they had a tattoo made, the most common answers are: '*to be different*', '*to express myself and remember something important in my life*' or '*because it is beautiful*' (11). There may, however, be numerous more or less conscious reasons to have a tattoo made, and often many elements are involved in the final decision. For example, a 24-year-old woman, who had numerous tattoos and was a patient at a psychiatric day hospital, said that she had a new tattoo made because she was '*feeling down*' and was in bad shape. The pain in connection with having a tattoo made was one of her motives to have it done quite impulsively, but she stressed that also the beauty and expectation of admiration and recognition on the part of her closest friends and family played a major role. The pain could distract her and even give her a kick. For a number of years she did self-inflicted cutting and in order to stop doing so, among other reasons, she had a butterfly tattooed on the inner side of her left wrist, which was to '*remind myself that I must not ruin my skin with scars*'. As implied by the quote, she was actually getting a tattoo as a self-inflicted injury carried out by proxy – she described how her experience of pain could make her calm down in the same way as cutting. However, her choice of designs was not impulsive. She told about how she had planned to have a tattoo made of a certain flower, which to her symbolized character, because it was her deceased mother's favourite flower, but the specific time for carrying out the tattoo itself was often quite impulsive.

As described above, the experience of planning and having a tattoo made in a very special environment is part of the experience and motivation. A 32-year-old woman explained that she 'loves to plan' her next tattoo. She spends time together with the tattooist to discuss designs and details, and over time she had got to know some of the other tattoo customers who went to her tattooist, which is also part of the experience. 'Once the decision is made and we start tattooing, it almost feels like redemption', she says and describes it as a strong sensual experience of pain, sounds, smells and sensations, which 'have their very own intensity'.

NEGATIVE CONSEQUENCES AND REGRET

In addition to the risks of complications by having tattoos made, there is a risk of psychosocial reactions, such as disappointment about the quality or design of the tattoo, feelings of shame when the individual experiences that others do not react positively to the tattoo, low self-esteem and the experience of stigmatisation because of having a tattoo. Some people regret tattoos because they have developed psychologically and socially in another direction since they had it made, and therefore cannot identify themselves with the person they were when they got the tattoo. Finally, many people say that they have regretted that they had a tattoo made because they experience that it can make it difficult for them with regard to work and a career. Some even speak of suffering from 'tattoo remorse'.

For some people, the remorse can be so great that they want to have the tattoo removed or covered by a new tattoo. The exact number of tattoos that have been removed is not known, but it is estimated that in the United States alone, 100,000 operations have taken place to remove tattoos, and according to the American Society for Aesthetic Plastic Surgery , the number of people who want to have tattoos removed has increased by 43% from 2011 to 2012 (13).

Braverman reports that a study carried out among 2,016 adult Americans, 14% of tattooed people have regretted at least one of their tattoos (29). A British study (52) of 1,200 tattooed people carried out by a company that experienced an increase of 32% in the sales of concealers, which are used to conceal tattoos, among other things, showed that four in ten people regret at least one of their tattoos, and one in six want to have them removed.

A Danish account of 154 tattooed people showed that 17.3% of the women, 10.1% of the men and an average of 13.6% of all of the tattooed people asked had regretted their tattoo (53). In an interview survey carried out by Yougov in 2013, 16% (13% of the women and 19% of the men) stated that they wanted to have their tattoos removed (54). The desire to have tattoos removed was greatest in the age groups 18-39 years of age and among tattooed people over 60 years of age. Interview surveys do not, however, always provide a correct picture of how many people regret their tattoos. Many of those who regret them may have learned to live with them, while others may think that removal is expensive, painful and without any guarantee that the results will be satisfactory, and that the removal can take place without complications. The studies referred to above, including European studies compared with American ones (13, 29), may therefore well be comparable regardless of differences in the results, because the differences may be dependent on the design and question-asking techniques used in the studies.

One of the most frequent reasons for regret and the wish to have a tattoo removed is the fear of stigmatisation and therefore many people have especially wanted tattoos on the lower back (known in Denmark as 'Amager licence plates' or 'tramp stamps'), which were popular in the years after 2000, but later have been considered to be vulgar and a 'sign of bad taste'. Fifty per cent of those who regret tattoos do so because they are afraid of being considered as being ordinary and as having banal or bad taste (13). Thirty-four per cent are afraid of what they will look like when they grow older, and 50% think that a person with visible tattoos has fewer opportunities to get by on the labour market. Thirteen per cent have covered or concealed a tattoo because they do not want an employer or a friend to see it. Most people in the study got their first tattoo when they were 18-20 years old and 12% got it because they were inspired by a well-known person. Forty-eight per cent say that their parents were against them getting a tattoo and one-fifth have concealed a tattoo from their parents. One third would be cautious about going on a date with a person with a visible tattoo, which is remarkable and indicates a tendency to have a negative perception of others with tattoos, which has also been found in other studies.

Madfis & Arford (55) have made a qualitative study of reasons for regretting tattoos. In addition to those who regret tattoos because they are technically poor, contain spelling errors or are placed incorrectly on the body, they point out that some people feel pressured by demands of others to be able to explain the symbolism or the very special story behind the choice of design. Thus, there is an expectation that the tattooed person must be able to explain the deeper meaning behind the tattoos – a meaning that basically reflects the middle-class norms of responsibility, rationality and pride. Compared with the flash style of previous times, when the tattooed person signalled his or her marginalised status, the new tattoo consumer has to legitimise the tattoos with a narrative, and if this narrative for one reason or another is not sufficient, a conflict arises between the individual's self-image and the signals that this person communicates to

others. Although everyone changes with age, for many people it is not easy to accept previous tattoos as an expression of life history, which does not necessarily harmonise with the current self-image of the individual. They wrote that 'understanding tattoos as markers of the past rather than indicators of stable identity' is important (55).

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4

TYPES OF TATTOOS

THIS CHAPTER PROVIDES A BRIEF REVIEW OF THE DIFFERENT TYPES OF BOTH PERMANENT AND TEMPORARY TATTOOS.

SUMMARY

Tattoos can be permanent or temporary, and can be divided into types based on a pragmatic approach.

Tattoos that are made by putting pigment in the skin using needles are intended to be permanent. Decorative tattoos are the most common type and the largest group of permanent tattoos. The decorative tattoos have a broad range of designs. Emblem tattoos (originally called tribal tattoos) belong to the permanent decorative tattoos as a sign of a voluntary affiliation with a certain group (for example, bikers or a military regiment). Identification tattoos are compulsory identity markers, a type that is primarily of historic significance. Extensive tattoos are large in area and intimate tattoos are tattoos on certain and unusual parts of the body.

Medical tattoos can be what are called medical alerts, for example, tattoos of a person's blood type, but can also be reconstructive tattoos carried out at clinics and hospitals to remedy illnesses, for example tattooing of mammary papillae after a breast cancer operation or the marking of a specific place on the skin or in the intestine as part of cancer treatment.

Permanent tattoos can also be dictated by situations as with what are called impulse tattoos or as group tattoos as a sudden impulse or while under group pressure.

Cosmetic tattoos or permanent makeup used as permanent tattooing of, for example, lips, eyebrows or around the eyes. There is also temporary ink for cosmetic tattoos.

The temporary tattoos include henna tattoos, which are especially used at tourist spots, where traditional tattoo designs are painted on the surface of the skin with a colour that only binds temporarily.

INTRODUCTION

There is no stringent classification of tattoo types. Classification may be determined by the tattoo's message, its circumstances and where on the skin or body it is placed. Type classification is a practical tool that is based on where there are significant groups of areas of use or applications (1-4).

PERMANENT TATTOOS

Decorative tattoos

Decorative tattoos are the normal type of tattoo. A text, a symbol, an ornament or a figure is tattooed into the skin. Tattoos can be individually determined by the person himself or herself, or drawn on the skin based on a pattern chosen from a collection of pictures that the tattooist shows to the customer. Pieces of text may represent names of close acquaintances or proclamations. Dates of special events may also be used. There are many designs of picture tattoos, for example in the form

of flowers, skulls, weapons and portraits of close relatives. Portraits can be ingeniously executed with what are called shadow tattoos. The selection of a picture may also be determined by affiliations with groups or occupations. Sailor's tattoos were often of sailboats, sometimes of a sinking ship, a 'sailor's grave' and attractive women with voluptuous bodies supplemented with the text, 'man's ruin', the lonely sailor's porno picture always close at hand. The illustration of faith, hope and love is a classic theme, sometimes as three small dots on the loose skin between the thumb and the index finger (the so-called 'pimple mark').

→ PHOTO 4.1

Black tattoo with grey shadows and a masculine signal.

Cosmetic tattoos

Cosmetic tattoos or permanent makeup are used as permanent tattoos for the colouring, expanding or marking of lips, as a dark frame around facial openings in the form of eyeliner and marking or changing eyebrows. They are often carried out by cosmetologists who have specialised in this. Special encapsulated machines are used, which have thinner needles and special ink, which typically contains a mixture of a number of or several pigments that are traditional tattoo pigments. Cosmetic tattoos carried out as permanent tattoos on the face were prohibited by the Danish act on tattooing from 1966 (5).

There are inks for cosmetic tattoos that disappears in the skin over a period of a few months, which makes the tattoo temporary. However, some of these tattoos turn out to be permanent anyway. In other cases, the colour can spread to the surrounding facial skin. Cosmetic tattooing is a specialist area with many variables and special customer requests. Tittooing is the designation for tattooing a woman's breast nipples and areola, that is, the coloured area that surrounds the breast nipple. Tittooing is used for cosmetic reasons if the woman wants a darker colour than what she has naturally. Tatteeth is the designation for tattooing of teeth and tooth crowns.

Tribal tattoos

Tribal tattoos are also called magic or ethnic tattoos. This is the original form of tattoo. It has been practiced for centuries and is still used in large parts of the world, but is dying out as a tattoo type. The Maoris of New Zealand are known for their special facial tattoos, a tradition that is still practiced. Classical, that is, ethnic tribal tattoos are often combined with scarring and piercing skin or body parts, for example, the nasal septum and ears. Biker tattoos or tattoos such as emblem tattoos signal a certain social affiliation to a group and are, therefore, to some extent tribal tattoos. Biker groups use the group's emblem as a sign of full membership, for example eagle wings or a Mexican. Soldiers' tattoos of regiment symbols are

also emblem tattoos, which to this day is practiced and are worn with pride (6).

Medical tattoos

Medical tattoos provide individual medical information. They have been used by the military, including the German SS soldiers during the Second World War, with tattoos of the person's blood type. Today they are used as medical alerts, which a person has tattooed, for example, 'penicillin allergy', 'diabetes', 'epilepsy' as information to medical staff in case of an acute situation. In hospitals, medical tattoos are currently used extensively as tattoos that mark radiation fields, for example as part of the treatment for breast cancer. Reconstructive tattoos of breast nipples and the surrounding areola are often made after breast cancer operations, with the tattooing being done by a tattooist or healthcare professionals, including doctors. Tattooing of eyebrows for patients with eyebrow loss due to alopecia areata (loss of patches of hair) also belongs to the category of reconstructive tattooing. Toning of the skin by tattooing patients with permanent spontaneous loss of the skin's pigment is used for the skin disease, vitiligo, that is, an autoimmune disease with blotches of well-defined milky white areas in the skin. Those who perform endoscopy use tattooing of the intestine's mucous membrane and intestinal wall for marking localisation, where biopsies are taken in the intestine so that the location of the biopsy can be found in case of subsequent operation for cancer in the gastrointestinal tract.

Identification tattoos

Identification tattoos are tattoos of the person's name, date of birth or similar identification. Identification tattoos have been used by seafarers, soldiers and civilians, and as compulsory tattooing of criminals and outcasts, as well as for making prisoners in concentration camps during World War II. In Auschwitz, number stamps were used, which were hammered on the skin.

Intimate and mucous membrane tattoos

Intimate and mucous membrane tattoos of the outer gentiles, transitional mucosa and mucous membrane in intimate places. Mucous membrane or mucosal tattoos also cover tattooing of the mucous membrane of the oral cavity, including the inside of the lips and cheeks. Eye tattoos are a rare form of mucous membrane tattoos, where the white of the eye, the sclera is permanently tattooed.

Extensive tattoos

Extensive tattoos are defined as tattoos that cover a large area, which can cover more than 80% of a person's skin. Extensive tattoos have a long history. At the beginning of the 1900s, heavily tattooed people, usually women performed in marketplaces as stars of shows in the same way as sword swallowers, dwarfs, giants and bearded women. Also today there are corps of international stars who make a living by performing at tattoo conventions, for example, Zomby Boy. Extensive tattoos are also found in the segment of decorated tattooed people who develop a kind of addiction, where the person has a tremendous urge to get new tattoos. These people are also called collectors.

Impulse and group tattoos

Permanent tattoos can also be dictated by situations with a more or less random design. Tattoos are impulse tattoos when the tattooing takes places based on a sudden impulse of an otherwise normal person or a person with impaired judgement due to inebriation, or taking drugs or medicine, which affects the psyche and judgement. A special situation in the category of impulse tattoos is when people in a group get tattooed while they are in high spirits during a festive event (also called tattoo parties). The may also be other situations or gatherings of

people where the situation influences attitudes, for example for prison inmates, athletes and sports fans on tour, at festivals and marketplaces.

Amateur tattoos and professional tattoos
Because there are no educational or authorisation requirements or rules that set norms for being qualified to work as a professional tattooist, there is no precise way to differentiate between professionals and amateurs. The latter are often called scratchers. Anyone can start a tattoo business and this does not, on its own, make a practicing tattooist 'professional'. The basis for experience as a qualified tattooist is artisanal experience, an aesthetic qualification, insight into the use of ink and equipment and knowledge about medical conditions, especially regarding infectious diseases and hygiene.

Effect tattoos
Effect tattoos are a form of tattoos that are intended to give a very special and unusual impression. They may be in the form of fluorescent tattoos that light up in indoor lighting. The pigment is special, with a florescent substance coated on the outside of a particle, which is coloured or uncoloured. 3D tattoos are a special art form in tattooing, where the design, through refined shadowing and toning of colours appears as if it is extending out of the skin. The designs may be large insects that crawl on the skin, bullet holes, extra mouths on the neck and extra life-like eyes on the face, but there are also examples of less taboo-breaking uses. Effect tattooing makes great demands on the artisanal skill of the tattooist.

TEMPORARY TATTOOS

Henna tattoos are a popular form of tattoos, which are especially used abroad and at tourist spots, where traditional tattoo designs are painted on the surface of the skin with a colour that only binds temporarily. The colour is rejected by the skin over a period of two to four weeks concurrently with the spontaneous renewal of the epidermis and exfoliation of scales of dead skin. The colour used is natural henna, which may contain the addition of paraphenylenediamine (PPD) to make the colour darker and more intense. PPD as a well-known skin sensitising substance, and upon first contact it can result in an allergic reaction after two to four weeks, possibly with eczema spreading to large areas of the skin (see also Chapter 8). The allergic sensitisation lasts for a lifetime and is released in one to two days after a second exposure once the primary sensitisation has occurred. In henna tattoo allergies, hair dyes with substances that have a chemical similarity to PPD may provoke acute allergic contact dermatitis of the scalp.

There is a gradual transition between henna tattoos and body paint, where large areas of skin are coloured, for example, in connection with carnivals or when used by street artists. There is also a gradual transition to cosmetic cover creams and makeup used by actors. When body paint is used on large areas of skin, the exposure of the skin and body to chemical substances is probably substantial and at the level of the potential exposure to chemical substances of tattoos, if not greater.

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5

LIGHT, COLOURS AND TATTOOS

THIS CHAPTER DESCRIBES WHAT HAPPENS WHEN TATTOOS ARE EXPOSED TO LIGHT. INSIGHT INTO THESE PROCESSES IS A NECESSARY PREREQUISITE FOR THE PREVENTION OF POSSIBLE DISCOMFORT AND COMPLICATIONS WHEN EXPOSED TO STRONG SUNLIGHT.

SUMMARY

Many tattooed people have problems when their tattoos are exposed to powerful sunlight. Therefore, it is important to understand the physical and chemical processes regarding the particles that comprise the physical tattoo itself, when these are exposed to light.

Light contains energy and tattoos absorb this energy. But where does the energy go?
First and foremost it turns into heat. The absorbed energy can also start chemical reactions in and around the colour particles in the tattoo. This is the most likely reason why many tattooed people have problems with sunbathing. Therefore, the chapter describes the basic physical and chemical processes that take place when tattoos are exposed to light.

But our knowledge in this area is limited. Comprehensive scientific investigation is required before the necessary knowledge is available as a prerequisite for legal regulation of the area of prevention of light-induced discomfort and complications in tattoos. To become efficient, regulation must be rationally justified based on physical, chemical and epidemiological knowledge. There is, moreover, a need to develop safe technologies for removing tattoos effectively using lasers.

INTRODUCTION

Tattoos are meant to be seen. Or concealed if they are not really meant to be seen. But tattoos can be seen because they absorb more light than the surrounding skin. For the tattooed person, the interaction between the tattoo and light is, therefore, an existential condition that is also discussed in other chapters in this report (see Chapter 3, among others).

This chapter primarily describes the physical and chemical process that take place when a tattoo is exposed to light, in the form of sunlight or artificial light. In many cases, sunlight results in large and small forms of discomfort that can force the tattooed person to find shade and, sometimes, treatment. Completely different light intensities are used if the tattoo is to be removed by powerful laser treatment (see Chapter 10).

These processes are explained below – to the extent that they are understood – without requiring more than an elementary understanding of the natural sciences.

Knowledge about the physical and chemical processes that occur in tattooed skin due to light is limited. The review is, therefore, based on hypotheses. There is also a lack of quantitative research

studies on the effect of exposure of tattoos to light and the consequences for health.

TATTOO INK, CONSTITUENT SUBSTANCES AND COLOUR

As shown in the report's chapter on the chemical composition of tattoo ink pigments (see Chapter 8), tattoo ink contains coloured particles. Ideally, the colorant particles should be indelible, chemically inactive and have a size that makes its permanent anchoring in the corium possible. These ideal conditions are far from being fulfilled in the real world. The chemical composition of the commercial products in the Danish market has been the object of thorough study in an expert report prepared for the Danish Environmental Protection Agency (1). Not only are they impure, but to a surprising extent the content is unknown.

Tattoos fade. Many people experience that the colour becomes weaker over time. This may take weeks or years, and the different colours exhibit varying degrees of resistance (2). There may be different reasons for this. Maybe the pigment gradually dissolves or the particles are so small that they are gradually transported away by the lymph. Chemical transformation of the substances may also take place. The fact that light plays an active role in this process is an experience that is shared by most tattooed people.

Seen from a chemical point of view, tattoo pigments can be divided into two main groups: The inorganic colour substances and the organic, synthetic, molecular colour substances.

Inorganic colour substances
Almost all inorganic salts do not have an independent existence as molecules in solution. If they dissolve at all, it takes places as oppositely charged ions. The colour of the pigment is often conditioned by the crystalline state. The most commonly used inorganic tattoo pigments are graphite (black), iron oxide (red, brown, black) and titanium dioxide (white). None of them can dissolve in the bodily fluids. Previously, for example, also cadmium sulphide (yellow), mercuric sulphide (cinnabar, reddish brown), mercuric oxide (yellow, orange or red) and chromic oxide (green) were used. These pigments are now only found in old tattoos. I all cases, the colour is due to the current crystal structure.

The most commonly used tattoo ink is black or blue-black, and the most common pigment is carbon black. It is also called soot, or – more precisely – graphite. In graphite, the carbon atoms lie in layers. The fact that the black colour is connected to the crystal structure can be understood by comparison with diamond, which is also pure carbon material. But in a diamond, the atoms are bound together in a different way.

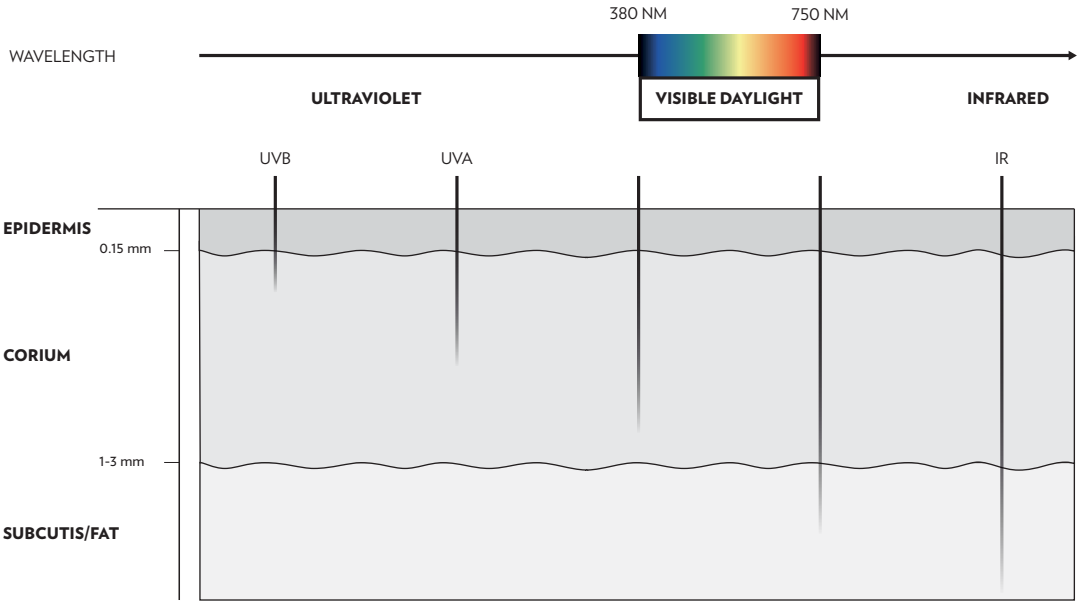
Carbon black is used industrially as a black pigment, for example in printer's ink. It is produced in vast amounts by pyrolysis of raw oil (3). Therefore, it is no surprise that the product is classified as cancer-causing (1). The Danish Environmental Protection Agency's report (1) states that in many cases, no special cleaning is carried out when carbon black is used in tattoo ink.

There are many combinations of iron and oxygen. Some are black; others are red. Rust is a common example of red iron oxide. Both types of colour are used in tattoo colours.

Titanium dioxide is the most used white pigment and is used in nearly all white paint. In addition to the use in white tattoos, titanium dioxide is also used to make other tattoo colours lighter. It can,

→ FIGURE 5.1

Schematic illustration of the penetration of light in normal skin. The depth of the penetration of ultraviolet, visible, and infrared light, respectively, is indicated in millimetres. The long-waved infrared (heat) radiation penetrates deeply, while the short-waved health-damaging ultraviolet radiation is absorbed in the outer layers.



for example, be mixed with a bright red colorant to get a 'pink' effect.

Organic colorants

To be more precise, organic pigments should be called 'molecular pigments'. They are organic colorants, which are produced synthetically. As a general rule, they are poorly soluble in water. But if they are dissolved, whether it is in the bodily fluids or in an organic solvent, such as turpentine, their colour is retained. As a rule, the dissolution has a colour that is very close to the visual expression of the permanent crystals.

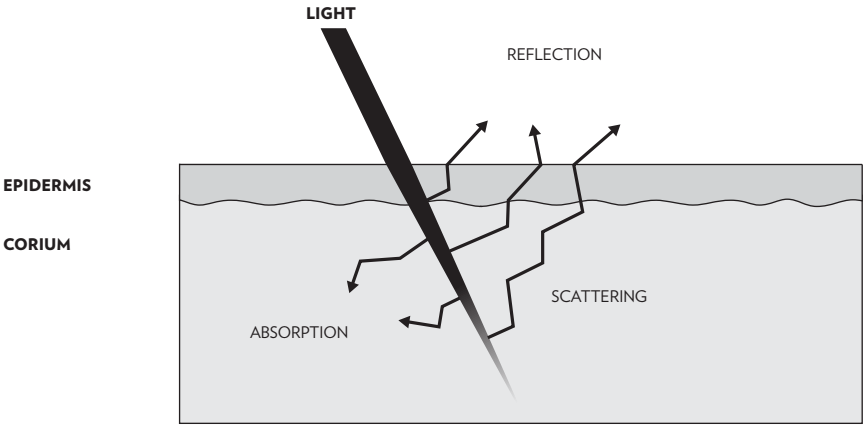
These differences in structure and solubility are crucial for how the inorganic and the organic tattoo pigments behave in light.

THE OPTICAL PROPERTIES OF SKIN

Visible light is electromagnetic radiation with a wavelength from 380 to 750 nanometres (nm, one-millionth of a millimetre). If the wavelength is shorter, we call it ultraviolet light. If the wavelength is longer, we call it infrared light. The part of the ultraviolet spectrum that is closest to the visible area is called UV-A. The ability to go into and through the skin depends on the wavelength. This is illustrated in Figure 5.1. Visible light and UV-A penetrates down into the corium. Shorter wavelengths (UV-B) penetrate the epidermis and reach the outer corium. In contrast, the long-wave infrared light penetrates all the way into the subcutis and can be the source of heating up the subcutis.

→ FIGURE 5.2

Reflection and absorption of visible light in the layers of skin. Different structures in the skin scatter the light's direct path and make the light diffuse (scattering). Some of the light is absorbed by the skin. See also Figure 10.1B.



The depth of the penetration is determined by reflection and absorption. In normal skin, most of the visible light is reflected from the surface itself, from the epidermis and from the corium. The rest becomes absorbed to a degree that increases with the depth of the penetration. This is illustrated in Figure 5.2.

PHYSICAL AND CHEMICAL PROCESSES INTRODUCED BY LIGHT

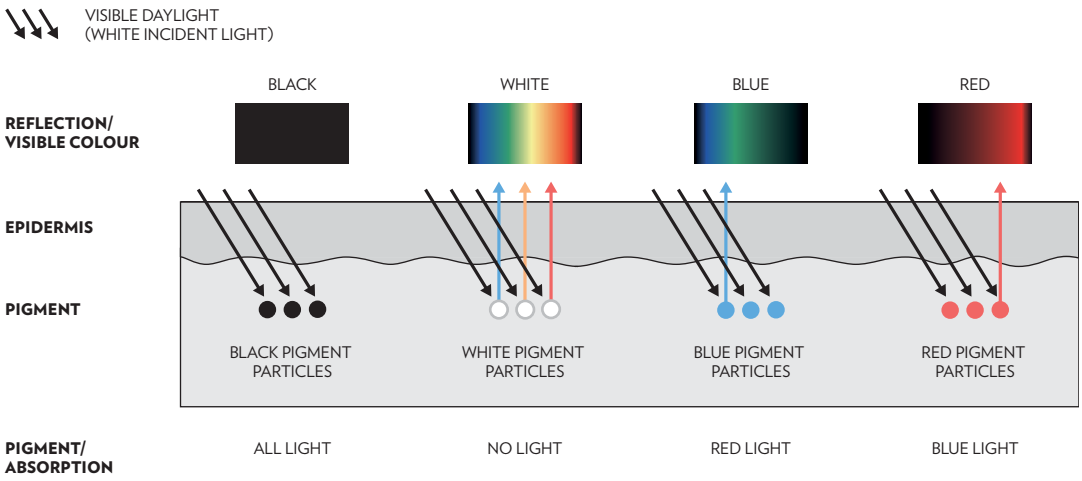
Daylight contains all colours. The colour you see in a tattoo is the light that is not absorbed, but is reflected to the observer's eye and appreciated as the resultant colour of the tattoo. White pigments reflect nearly all incident visible light. Black tattoos absorb all colours. Red tattoos absorb the blue-green part of the light spectrum, while blue colorants absorb red/orange light. In other words, you see the complementary colour for the part of the spectrum that has been absorbed. This is illustrated in Figure 5.3.

Light contains energy. Therefore, some energy is imparted to a colour particle when it absorbs light. When a molecule or a crystal lattice has absorbed light energy, it is said to be in an excited state. This state is short-lived. The energy is typically used or converted in the course of a nanosecond. It can take place in four ways:

1) Emission of light with lower energy. The phenomenon is called fluorescence and must not be confused with reflection. The process has no significance for the clinical problems with tattoos. Fluorescent tattoos have attracted more attention with the advent of active fluorescent tattoo pigments (4). These are not crystalline. The fluorescent substances are dissolved as isolated molecules in transparent plastic, which comprises the actual pigment particle. Because fluorescence is an extremely sensitive and specific detection method, these new tattoo pigments provide interesting possibilities for monitoring the interaction with the tissue, just as the further fate of the substances in the organism can be followed (see Chapter 10).

→ FIGURE 5.3

Illustration of the interaction between incident white daylight indicated with black arrows and the reflected light of different colours, depending on the tattoo pigment inside the skin in differently coloured tattoos. The incident daylight penetrates the epidermis and contains all of the primary colours. Black pigment absorbs all light, in contrast to white pigment, which reflects every part of the spectrum. Coloured pigments absorb the complementary colour to the reflected light, which appears as the tattoo's colour. The red pigments absorb, for example, the blue-green part of the light, but not the red part, which then can be reflected and create the tattoo's visible colour seen from outside as being red.



2) Transfer of energy. The energy that a colorant molecule has absorbed may also be imparted to another molecule. It is said that the receiving molecule quenches the excited state. The most common quencher in the skin is oxygen, which thus goes into an excited state itself, which is called singlet oxygen (5). It has the symbol $^1O_2$. Singlet oxygen is a very aggressive molecule. It is, for example, the active ingredient in photodynamic therapy, which is used to kill cancer cells by first incubating them with a sensitizer, which generates singlet oxygen, and subsequently illuminating the tumour with light, which selectively damages cancer cells while sparing the healthy tissue.

3) Chemical process. Many substances are transformed by light in a photochemical process. There are many examples of this in day-to-day life. The commonly used tattoo colorants are usually selected precisely because they are only broken down very slowly by light. They are photostable and thus permanent. But even though the colour industry's chemists do all they can to achieve this resistance, they are never completely successful. Thus, sun-bleaching of textiles is a known phenomenon and can, for example, be seen in all older jeans. Electron transfer to oxygen is an important example of a bimolecular chemical process that has special significance for the dermatological effects of illumination. It is an alternative reaction route to

the formation of singlet oxygen when the excited colorant molecule collides with oxygen. The product is the superoxide ion, O_2–, which is at least as harmful to the tissue as singlet oxygen.

4) Transformation into heat. Most often, all of the absorbed light energy is imparted to the surroundings in the form of heat. This is particularly the case with colorants that distinguish themselves by not noticeably bleaching in the sun. But also in the case of fluorescence, photochemical processes or the transfer of energy, there will be an excess of energy. Therefore, heat will always be imparted either to the crystal or to the surrounding fluids.

PHOTOTOXICITY

If a substance in a tissue exhibits a damaging effect when the tissue or the person is illuminated, the substance is said to be phototoxic. In many cases, the effect is individually determined. This is also the case with tattoos. Phototoxicity in tattoos is a widespread problem as described in other chapters in this report (see Chapters 6 and 7).

In addition to the individual factors, phototoxic events depend, of course, on the pigment, which the doctor in the clinic only seldom has the possibility to identify. Therefore, the reports on the phototoxic effects are normally correlated to the tattoo's colour. Possible causes of phototoxicity are discussed below.

The formation of singlet oxygen and reactive oxygen species

The further reactions of singlet oxygen ($^1O_2$) and superoxide (O_2–) may involve other reactive oxygen species (ROS) as hydrogen peroxide (H_2O_2) and the hydroxyl radical (–OH). Singlet oxygen is the most important. The substances that are found in the skin and that lead to the formation of ROS are called endogen photosensitizers. A number of them occur naturally (6).

The organism has enzymatic defence mechanisms for dealing with natural levels of ROS. But for certain tattoo pigments, apparently a concentration and possibly an increase of the ROS production exceed this capacity. The result is oedema, itching, pain etc.

It is obvious that research is needed to study the different commercial pigments' ability to generate singlet oxygen/ROS and, possibly, to correlate the differences with clinical experience.

It has been shown that black tattoo colour contains various amounts of aromatic combinations. These can generate singlet oxygen when exposed to ultraviolet light (3).

In addition to chemical reaction, singlet oxygen can decompose as a result of the emission of 1.270 nm infrared radiation (5). The radiation is weak and it is within the spectral region where detectors have low sensitivity. But with the latest technological, development in this area, it can be expected that it will be possible to detect radiation from tattoos in vivo and in this way, measure how much singlet oxygen is formed from different tattoos (7).

Photolytic decomposition of pigments
Inorganic pigments – including graphite – do not undergo photochemical processes at ordinary intensities. Only if an attempt is made to remove the tattoos using laser light does a process take place (see below).

Organic colorants do not always fulfil the requirement for photo resistance. They are, to a varying degree, photoactive and can be decomposed by

illumination. The reactivity will be greatest if the substance is being dissolved, possibly right next to the surface of the pigment particle. There are only a few studies of the photo reactivity of colorants and only one study in vivo (8). After tattooing mice with the azo-colorant pigment red 22 (a red colorant) a 32% reduction of the pigment volume was observed after 42 days (8). However, this loss was 60% greater if the mice were exposed to simulated sunlight for 32 days. These are surprisingly high numbers and may be the explanation for why it is red tattoos that often result in phototoxic effects (9).

In vitro, the photolytic decomposition products from pigment red 22 (10) and pigment yellow 74 have been identified (11).

Sun lotion to prevent sensitivity to light

As demonstrated in the Danish Beach Study that the Bispebjerg University Hospital group has completed (9) (for more information about this study, see Chapter 6), many tattooed sunbathers successfully use suntan lotion to prevent discomfort caused by light. This experience contains important and interesting information. Suntan lotion only blocks the ultraviolet part of the spectrum (see Figure 5.1) and is normally used to avoid skin cancer. UVA penetrates into and through the corium. But the primary purpose of tattoos is that they absorb the visible spectral region. Tattoo colours, however, also absorb the ultraviolet part of the spectrum. But the photochemical consequences of light absorption are normally independent of the wavelength of the absorbed radiation. In other words: Any photochemical reactions are the same, whether or not the substance is illuminated with ultraviolet or visible light. Therefore, it is possible to present two possible explanations for the soothing effect:

1. Ultraviolet light contains more energy than visible light, and on a cloudless Danish summer day, there is plenty of intensity in the UVA part of the spectrum. Naturally, when a tattoo is illuminated, more energy is imparted to the pigment particles than to the surrounding tissue. The result of a broad spectrum of exposure (visible and UVA) could therefore be that a more powerful heating up of the particles than would be the case if only the visible light reached them. Because of the small size of the particles, the heating is very localised on a scale of micrometres. The fact that thermic effects could play a role is supported by it being the dark colours that cause the worst problems for tattooed sunbathers (9). A research project in which this hypothesis is to be studied should, therefore, include a simple measurement of the temperature in the tattooed tissue in different, controlled illumination conditions.

2. Alternatively, the beneficial effect of sun lotion may be attributed to impurities in the ink that was used, which do not absorb visible light, and which therefore are protected by the sun lotion. Possible candidates are the aromatic compounds that exist in industrially produced carbon black (3). The phototoxic reaction could thus be the formation of singlet oxygen and ROS, initiated selectively by UVA.

The elementary physical and chemical principles for the interaction of light and tattoos is well known and completely understood. But it always gets more complicated and less unambiguous when the processes take place in living organisms. A better basis for preventing discomfort introduced by light must therefore be established in research cooperation between specialists within the relevant medical and nature science disciplines.

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6

DISCOMFORT IN CONNECTION WITH TATTOOS

THIS CHAPTER DESCRIBES THE INCIDENCE AND TYPES OF THE COMMON FORMS OF DISCOMFORT THAT MAY ARISE IN CONNECTION WITH TATTOOS, BOTH IMMEDIATELY AFTER TATTOOING AND IN THE FORM OF CHRONIC DISCOMFORT.

SUMMARY

Two in three state that they have had acute skin problems such as bleeding, scabs, itching and swelling during the weeks just after they had a tattoo made. These are normal reactions resulting from the many needle pricks when the tattoo is carried out. About one in three experience periodic discomfort in their tattoos. Itching and swelling caused by the sun are the dominant types of discomfort. A large proportion of the discomfort types result from the effect of sunlight and are most often in the dark tattoo colours.

Although tattooists are aware that tattooing may occasionally result in discomfort, the phenomenon was not recognised until recently in the medical world. This is because of the relatively high threshold that tattooed people have with regard to seeing a doctor about tattoo-related discomfort. In addition, the discomfort often disappears after simple self-treatment, including wearing clothes and using sun lotion.

In case of reactions that result from the effects of the sun, symptoms, clinical signs and the course of events are variable. The duration of the discomfort may last for a few hours or for days. The mechanisms behind the occurrence of the discomfort are thermal, photochemical or otherwise caused by instability of the tattoo pigments in the corium or disturbance of the skin's physiological functions.

INTRODUCTION

People who have discomfort in connection with their tattoo typically do not consult a doctor (1). Therefore, it was not documented until recently that discomfort often results even from a 'normal' tattoo. Many tattooed people avoid seeking medical treatment, perhaps because they are afraid that the discomfort will be regarded as being self-inflicted and therefore not be taken seriously (1). The extent to which doctors and other healthcare providers consider tattoos to be a low-priority health area is not known, and therefore it is not known whether the fear of consulting a doctor is justified. Tattooed people with discomfort may also be in doubt about which doctor or specialist they should consult, because treatment of discomfort and complications resulting from tattoos is not defined or generally known and accepted as an area of medical expertise. Many doctors will not quite understand the problem because it has not been recognised until recently.

Only three studies exist that describe the incidence and types of common discomfort that result from tattoos. Therefore, the review below is based on these studies.

Definition of discomfort in connection with tattoos.

Discomfort in connection with tattoos is defined as local or general objective or subjective discomfort that the tattooed person has incurred by being tattooed and which is the result of the tattoo. Discomfort may be acute or immediate in connection with tattooing, but temporary concurrently with the healing of the tattoo, or chronically as permanent or continuously recurring discomfort.

COMMON TYPES OF DISCOMFORT

For obvious reasons, discomfort is more frequent in the days and weeks after the tattoo is made. During the first hours after tattooing is performed the skin is swollen and sensitive because the thousands of needle pricks (the tattoo machine makes approximately 5,000 pricks per minute) due to the needle and prick trauma releasing histamine and a degree of a nettle-rash-like reaction. These reactions disappear spontaneously within 24 hours. Then the skin is infiltrated with white blood corpuscles, which release a longer-lasting inflammation, during which scabs on the surface of the skin are desquamated. The healing phase ends with a period of dryness and cracking. Needle traumas and healing will normally be finished in three to four weeks.

In connection with tattooing, it is common that the tattooist gives guidance to the tattooed person about treatment with ointments, often and traditionally containing provitamin of vitamin B5.

It can be difficult to assess whether the degree of discomfort is normal and expected, whether there is an element of infection or whether part of the reaction in a tattooed person, who is known to have a nickel or metal allergy, is due to a nickel allergy reaction. All inks contain trace elements of nickel, and in those who have nickel allergy to begin with, this could result in serious discomfort or even acute and generalised contact dermatitis shortly after or later during the tattoo's healing period, which might be misinterpreted as being an infection and be treated as such (2). Nickel salt is eliminated in the course of a few days and metallic nickel in the body does not normally result in an allergic reaction based on experience with prosthetic materials that contain nickel. Thus the generalised dermatitis is self-limiting along with spontaneous excretion of free nickel ions.

E. Klügl et al, in an Internet-based study in 2010 carried out in Germany, described self-reported discomfort and complications in connection with tattoos (3). A total of 3,411 people responded to an invitation to report their discomfort and complications of any kind in connection with tattoos on the Internet. Sixty-seven per cent described skin problems and 7% systemic reactions during the weeks after tattooing took place. The skin problems were bleeding, scabs, itching, swelling, blistering and bacterial skin infections. The systemic reactions were dizziness, headaches, nausea and fever. Only 1% consulted a doctor, and medicine was prescribed for two-thirds them. Eight per cent had health problems four weeks after the tattoo was made and 6% reported continued problems with regard to their tattoo in the form of swelling, itching, papules, changed sense of feeling and scar formation. Three per cent also reported other problems, such as psychological problems and sensitivity to light in the tattooed area. Coloured tattoos cause more problems than

black tattoos. The size of the area of the tattoo was also related to the frequency of skin problems. The authors concluded that the results show that millions of people in the Western world can be assumed to have temporary or constant health problems after getting a tattoo. They emphasise that complications can be expected because tattooing involves injecting a number of grams of colorants into the skin; colorants that may spread throughout the body and cause many kinds of health problems that are not known to us today. The study is based on spontaneous self-reporting in a German-speaking population group of an unknown size and geographic location. The study neither documents incidence; that is the number of new cases in a specific geographic area in a defined period of time, nor prevalence; that is the frequency at a specific time in a geographic area, despite the title of the article, which indicates that incidence was measured. But the study does show that the number and types of discomfort and complications based on an Internet invitation with an open and unselected number of participants can be calculated and counted in the thousands. The study is, as mentioned, based on the participants' own information.

There are two recent Danish studies, in which the prevalence of discomfort or minor complications are identified in connection with tattoos among selected and relevant groups of people who reside in the greater Copenhagen area (1, 4). In both studies, participants were studied by personal interview and medical examination. In the first study with 154 randomly recruited people with a total of 342 tattoos from a sexually transmitted disease clinic, 27% of them reported chronic or periodic discomforts in one or more of their tattoos, especially in black and red tattoos. Itching and swelling caused by the sun are the dominant discomforts (4).

In a subsequent study, 'Beach Study', which comprised 467 sunbathers, of which 146 (31%) had 301 tattoos, the question about sensitivity to light, that is, photosensitivity and photodynamic events in the tattoos is gone into in detail. The study was carried out on Danish bathing beaches in the summer. Forty-two per cent of the people with tattoos had discomforts in their tattoos. The discomforts included 52% caused by the effects of exposure to the sun. The sun-related discomforts were most frequent in the dark tattoo colours, black, red and blue. Many also had discomforts that were not dependent on the sun (1). Mild discomforts registered in the two Danish studies referred to are compared in Table 6.1 (5).

The two Danish studies make it possible to assess the frequency; that is the prevalence, of mild discomforts in tattoos. The findings are actually comparable to the results of the German Internet-based study (3). Remarkably, the studies show that discomforts in connection with tattoos are frequent and include itching, swelling, and a burning sensation when the tattoos are exposed to sunlight. Many people use sun lotion or cover their tattoos with clothing to avoid discomfort. But there is also a larger number and types of discomforts that do not depend on the sun and which, for example, are caused by heat or cold, or occur at random with no apparent provocative exterior circumstance.

→ TABLE 6.1

Comparison of the results of two independent Danish studies on discomforts in tattoos. One of the studies was carried out with clients at a clinic for sexually transmitted diseases (the STD clinic) (4); the other one was carried out as a study of sunbathers at Danish beaches (1). In all cases, the people's tattoos were studied and analysed based on a study protocol. Patient information was obtained systematically by doctors or nurses. The discomforts among the people in the STD study were what they had previously experienced; in the 'Beach Study', they are current and previously experienced discomforts.

	STD CLINIC	**"BEACH STUDY"**
STUDY POPULATION	**169 TATTOOED PEOPLE**	**467 SUNBATHERS (146 WITH TATTOOS)**
NUMBER OF TATTOOED PEOPLE INCLUDED	› 154	› 144
NUMBER OF TATTOOS INCLUDED	› 342	› 301
NUMBER OF TATTOOS PER PERSON (AVERAGE)	› 2.2 (interval from 1 to ≥ 10)	› 2.1 (interval from 1 to 9)
COLOURS IN TATTOOS (WITH REGARD TO FREQUENCY)	BLACK > RED > GREEN > BLUE > YELLOW > WHITE > PINK > PURPLE > GRAY & ORANGE	BLACK > RED > GREEN > BLUE > YELLOW > WHITE > ORANGE > PINK > PURPLE
NUMBER OF PEOPLE WHO REPORTED DISCOMFORT IN THE TATTOOS (TOTAL)	› 41/154 (27%)	› 60/144 (42%)
NUMBER OF PEOPLE WHO REPORTED DISCOMFORT IN THE TATTOOS (RELATED TO EXPOSURE TO THE SUN)	› 24/154 (16%)	› 31/144 (22%)
RELATIONSHIP BETWEEN DISCOMFORT RELATED TO EXPOSURE TO THE SUN AND TOTAL	› 24/41 (59%)	› 31/60 (52%)
DISCOMFORT RELATED TO EXPOSURE TO THE SUN IN RELATION TO COLOURS IN THE TATTOOS	BLACK: 26 RED: 3 PINK: 2 BLUE: 1 GREEN: 2 YELLOW: 1 ORANGE: 1 BROWN: 1 OTHER: 2	BLACK: 24 RED: 17 PINK: 2 BLUE: 10 GREEN: 4 YELLOW: 5 ORANGE: 1 PURPLE: 2 WHITE: 1
SYMPTOMS INDUCED BY THE SUN PER PERSON	› Itching/prickly pain: 19/24 (79%) › Swelling/inflammation: 17/24 (71%) › Lumps: 3	› Itching/prickly pain: 16/31 (52%) › Swelling/reddening: 26/31 (84%)

→ PHOTO 6.1

Discomforts in black tattoos in the form of prick-formed swelling, which come and go, depend very much on the sun. The linear drawing of the elements of the skin imply that the discomfort also has a technical background. The tattooist may have put too much black ink in the skin; a volume that is at the limit of what the skin can cope with, at least for periods of time. Causes itching and discomfort in the skin.

The background for the occurrence of the discomfort may be thermal, photochemical or is due to some other reason such as instability of the tattoo pigments in the corium or disturbance of the skin's physiological functions. The latter may include induction of vasodilatation, the formation of reactive oxygen species (ROS), cellular reactions etc. Probably a number of mechanisms are involved. Chapter 5 describes the skin's optical properties and photochemical reactions in tattooed skin related to tattoo pigment.

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7

CLINICAL COMPLICATIONS IN CONNECTION WITH TATTOOS

THE DISEASE PANORAMA IN CONNECTION WITH TATTOOS SPANS FROM DISEASE LOCALLY IN THE TATTOO TO RARE CASES OF DISABLING OR LIFE-THREATENING DISEASE. SOME PEOPLE SUFFER FROM PSYCHOLOGICAL AND SOCIAL COMPLICATIONS.

SUMMARY

The most significant causes of clinical complications that occur in tattoos or that result from tattoos are related to the tattooing procedure itself, caused by the tattoo ink or individual reactions to them.

The clinical complications in connection with tattoos have not been systematically analysed. But seen in relation to the prevalence of tattoos, the general impression is that tattoo complications have increased concurrently with the increasing frequency of tattoos.

Infections range from bacterial skin and soft tissue infections to serious infections caused by blood-borne viruses (HIV, hepatitis B, hepatitis C) and serious systemic infections with bacteria that enter into the blood (sepsis).

Allergic reactions in tattoos are frequent, especially in red tattoos and in red colour mixtures. The reactions are chronic itching and swelling. Strong allergic reactions may cause deep wounds, and they may also cause general immunisation in the body.

Non-allergic reactions occur in black tattoos, usually due to overdosing black pigment. Neurosensory complications may occur in tattoos with no visible swelling, dominated by strong itching and pain, which may be disabling.

Reproduction toxic damage in the form of, for example, abortion or deformities in the embryo caused by tattoos have not been observed.

Despite the fact that tattoo ink often contains potentially cancer-causing substances and thus presents a possible risk for the induction of cancer in tattoos and in the inner organs, such a risk has not been confirmed, neither clinically nor epidemiologically.

There is a risk of a number of psychosocial reactions that result from tattoos, including feeling embarrassment, loss of self-esteem and stigmatisation because of having a tattoo. There may be a connection between tattoos and psychosocial problems. Today, tattoos are prevalent in all levels of society in Denmark, but the incidence of tattoos is higher among people with mental disorders than in the general public. However it is not possible to come to a conclusion about any causal connection.

INTRODUCTION

This chapter focuses on clinical complications caused by tattoos, while the milder types of

discomfort resulting from tattoos are discussed in Chapter 6. Clinical complications show great variation with regard to the period of time, geographical area and tattooing practice, including quality, safety and the composition of the tattoo ink or colour used (1-5).

The complications cannot be clarified based on data output from Danish and foreign hospitals' diagnosis records. This is because tattoos, whether they are normal, complicated or of another type (for example, radiation tattoo marks) are coded using the same international diagnosis number, L81.8E, Morbus Cutaneus Pigmentosus Alia. No diagnostic classification system has been developed that categorises and specifies complications in connection with tattoos. The serious clinical complications in connection with tattoos must, therefore, be considered as not being sufficiently reported in medical data records and the necessary epidemiologic tools for systematic gathering and analysis of data regarding tattoo-related diseases and complications does not exist.

Definition of clinical discomfort in connection with tattoos

Clinical complications in connection with tattoos are defined as serious adverse side effects in tattoos (or resulting from tattoos), which manifest themselves as objective pathological/clinical changes, as well as subjective symptoms to a degree that they have the nature of disease or disablement, and which typically make the tattooed person seek medical treatment.

Seen in relation to the prevalence of tattoos, the general impression (see Chapter 2) is that tattoo complications have increased concurrently with increasing frequency of tattoos, and that serious complications continue to impact relatively few people. There are many mechanisms behind the complications, and diagnosis and treatment are, therefore, differentiated and a new sub-specialty of dermatology. Life-threatening infections, which occur as a result of tattoos, are normally treated in medical wards.

Since time long past it has been known that infections in tattoos may be lethal or cause serious disabilities in the form of amputations of limbs. Deaths due to tattoos occur to this day. For example, a 23-year-old Italian woman died due to a bacterial infection with sepsis in 2013 two days after getting a small tattoo (6).

The complications are generally divided into infectious and non-infectious complications. The discussion below emphasises complications that are relevant to Danish and European conditions.

INFECTIOUS COMPLICATIONS

In cases of infectious complications caused by bacteria and other microorganisms, the source of infection may be the tattoo parlour, equipment such as lamps, the couch, the tattoo machine, tattoo needles and ink bottles, the tattooist, the tattooed person or the tattoo ink.

Each year, an unknown number of Danes are infected in connection with tattooing. The types of infection range from bacterial skin and soft tissue infections to serious infections caused by blood-borne viruses (hepatitis B, hepatitis C, HIV) and serious systemic disease with bacteria.

During tattooing, the needle pricks the person's skin thousands of times and thus tattooing may insert the person's own bacteria through the skin barrier and into the skin and subcutis. This probably happens often, but the bacteria we have in our own skin are almost always too 'peaceful' to lead to an infection.

If the tattooist is a carrier of Staphylococcus aureus with reservoirs in the nostrils or intestine, poor hand hygiene may cause infection in connection with tattooing.

The tattooist's tools may be a source of infection and result in cross-infection from person to person. Tools may be assumed to be the most frequent cause of blood-borne virus being transferred between customers. This risk increases in case of tattooing in other countries, where the number of people with chronic viral infections with blood-borne viruses is much higher than in Denmark. The problem is that lack of sterility of the needle may mean that blood residues or tissue fluids that contain a virus or bacteria are transferred from one person to the next.

Tattoo ink is manufactured without standardisation and without quality control. Furthermore, water that is added to the ink either in production or by the tattooist diluting the ink may be a common source of microbial contamination. In a Danish study of 58 different tattoo inks from 13 different manufacturers, there was bacteria growth from seven inks (10%) from seven manufacturers (7). Only six of the 13 manufacturers stated that their ink was sterile. Despite labelling products as being 'sterile', bacteria was found in the ink, and the 'sterile' label was, therefore, not reliable in the concrete case. The bacteria found were as indicated in the table below (see Table 7.1).

The results from the Danish study correspond to the results of a number of foreign studies, which have shown that to a large extent, both tattoo ink from suppliers and ink in tattoo parlours used for a number of customers contain human pathogenic bacteria with a risk that ink may be a source of infection in connection with tattooing (8). For example, the authorities in Italy found, in both new ink and ink that was already in use, contamination in up to 86% of the samples studied (9).

CLINICAL STATES OF INFECTION

Infectious complications from tattoos have been summarised by N. Kluger in two publications (10, 11). Based on the medical literature and experience at the Tattoo Clinic at Bispebjerg University Hospital, states of infection caused by tattoos include the following:

Superficial infections and bacteria
Superficial infections are primarily caused by staphylococci, where the former may be penicillin resistant and some may be resistant to all variations of penicillin (including methicillin-resistant Staphylococcus aureus (MRSA)). The infection appears as a running sore with puss that resembles impetigo (Photo 7.1).

→ TABEL 7.1

Bacteria was isolated in 58 purchased tattoo inks by culture from newly opened products received directly from suppliers or manufacturers, and bacteria in tattoo ink in several samples received from tattooists (7).

PRODUCT NAME	BACTERIA FOUND BY CULTIVATION	BACTERIA COLONIES PER ML
	TATTOO INK (NEW)	
LFG-GREEN, DYNAMIC COLOR CO. (FT. LAUDERDALE, FLORIDA, USA)	BACILLUS SPP. STAPHYLOCOCCUS SPP.	› 100
TRUE BLACKS, INTENZE (SOUTH OCHELLE PARK, NJ, USA)	AEROMONAS SOBRIAE ACIDOVORAX	› Approximately 650
MEDITERRANEAN BLUE, WEFA COLOR (LAHNSTEIN, GERMANY)	STREPTOCOCCUS SANGUINIS PSEUDOMONAS SPP.	› 500
LIGHTNING YELLOW, ETERNAL INK (BRIGHTON, MI, USA)	ACINETOBACTER SPP.	› 110
MIDNIGHT BLACK, VOODOO, HUCK SPAULDBING ENTERPRISES, INC. (VOORHEESVILLE, NY, USA)	DIETZIA MARIS BLASTOMONAS SPP.	› 140
BLACK INK, TALENS (APELDOM, HOLLAND)	ENTEROCOCCUS FAECIUM	› Approximately 500
	TATTOO INK FROM TATTOOIST (BROACHED)	
INDIAN INK (PRODUCT NAME NOT IDENTIFIED)	STREPTOCOCCUS SALIVARIUS STREPTOCOCCUS SANGUINIS ACINETOBACTER SPP. ACTINOMYCES SPP.	› Approximately 500

→ PHOTO 7.1
Superficial infection in a new tattoo.

→ PHOTO 7.2A
Infection med staphylococci on the back of the lower leg. The infection was treated with antibiotics given intravenously.

Deep/serious bacterial infections
Deep bacterial infections may appear as erysipelas, abscesses and diffuse deep inflammation in the deep layers of the skin (pyodermas or phlegmons) (Photos 7.2A, 7.2B and 7.2C). Causative bacteria are are, as is the case with superficial infections, staphylococci, possibly MRSA and streptococci, rarer Pseudomonas, corynebacteria and Klebsiella. Deep and aggressive infections, which are extremely rare, with 'flesh-eating bacteria' may require an acute operation to remove the infected tissue, possibly by amputation (12).

Systemic infections
Systemic and life-threatening infections with bacteria introduced by tattooing occur when the bacteria of the infection goes into the blood (Photo 7.3). The person has a high fever and signs of blood poisoning (sepsis) with the risk of multi-organ failure and death. Bacteria in the bloodstream may, in rare cases, for example, infect the cardiac valves and damage them, resulting in heart failure. They may also cause osteomyelitis (13). The Danish Heart Association recommends that especially heart patients avoid piercing and tattooing due to the risk of infection of the cardiac valves (14).

Infection with contaminating bacteria
Infection may be caused by contaminating bacteria from the surrounding environment. The contaminating bacteria may be coli bacteria and atypical mycobacteria, of which especially Mycobacterium chelonae, which is related to tuberculosis bacteria has drawn attention lately (15,

→ PHOTO 7.2B

Infection with staphylococci in the tattoo with swelling of the entire arm and constitutional symptoms. The source of the infection might have been water used to dilute black ink and shadowing. The infection was treated with intravenous antibiotics.

→ PHOTO 7.2C

Infected tattoo with swelling and the development of an abscess in the subcutis. The person was generally affected and was treated with antibiotics given intravenously.

16). These infections are long-lasting and require a special diagnosis because they cannot be cured with ordinary antibiotics. The most common cause is contaminated water used to dilute ink in connection with shadow tattooing. The infections may appear as local outbreaks among the customers of a certain tattoo parlour. Mycobacterial infection has not been seen as an infection in Denmark and is probably exceptional compared to other causes of infection.

Virus infections

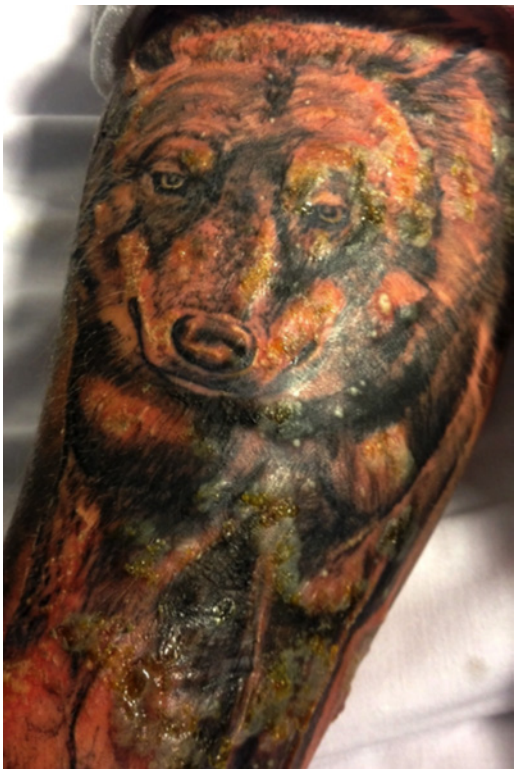
Especially in conditions such as amateur tattooing among prison inmates or among addicts who take drugs by injection, there is an increased risk of infection with hepatitis C and hepatitis B. In a systematic overview and meta-analysis of the medical literature published in 2010, it was concluded that tattooing is associated with an increased risk of contracting a hepatitis C infection with an odds ratio of 2.74 (95% CI: 2.38-3.15) based on a meta-analysis of a number of studies (17). This must be seen on the basis of the fact that 2.3% of adults in the United States are known to have antibodies against hepatitis C, and 55-84% of these have chronic infections. Only a few cases of transmitting HIV through tattooing have been described (18).

In Denmark, every year over 350,000 blood donations are screened for blood borne viruses; HIV, hepatitis B and hepatitis C viruses. From 2003-2012, 65 donors (in most cases first-time donors) where shown to be infected with hepatitis B virus. Among these, tattooing or piercing was indicated as a possible source of contamination with hepatitis B virus in 29 (45%) of the donors. A single case of a hepatitis C virus infection was also described. Most of these infections were probably from tattoos carried out outside Denmark. In recent years in Sweden, a number of cases of hepatitis B and hepatitis C virus infections transmitted by tattooing have been identified (19).

Local virus infections

Local virus infections can appear as warts (verruca vulgaris), water warts (mollucum contagiosum) and genital warts (condyloma acuminatum), which may have occurred through inoculation of virus from the tattooed person in connection with the many pricks of the tattooing needle. Cosmetic tattoos around

→ PHOTO 7.3
Severely infected tattoo with swelling of the arm and high fever. The general condition was significantly affected. The patient was hospitalised for a staphylococcus infection with sepsis, and was treated with intravenous antibiotics. The patient then recovered.



the mouth may provoke the outbreak of herpes simplex infection in people with previous cold sores.

Fungal infection

Fungal infections caused by different skin fungi, including Trichophyton rubrum and Epidermophyton floccosum are described in tattoos (10). Fungi are extremely unusual as contaminants in ink, and fungi infections are probably inoculated from the tattooed person. Fungal infections in tattoos are rare.

NON-INFECTIOUS COMPLICATIONS

By measuring indicators for the quality of life and itching using the Dermatologic Life Quality Index (DLQI) and for itching the Itch Severity Scale (ISS), a recently published Danish study shows that reactions in tattoos cause remarkably strong itching and, sometimes, pain. Itching often occurs at night, and there is a risk of it causing insomnia. Often it is not possible to treat or alleviate the itching effectively. The reduction in the quality of life is, even due to tattoos that cover a small area, the same size as the reduced quality of life observed in pruritic diseases such as psoriasis and eczema, which often cover an area that is much more extensive (20).

The non-infectious complications can be divided into allergic and non-allergic reaction types, which is a distinction of great significance for the choice of treatment, because allergies require radical removal of the pigment of the skin.

When is a tattoo reaction allergic?

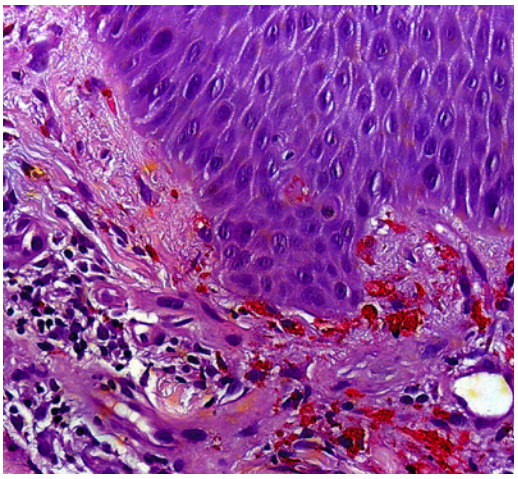
When assessing whether a reaction is allergic, the following is of significance:

- That the reaction is monomorphic; that is, consistent in one and only one colour and everywhere this colour is used in the tattoo
- That there is a latency period; that is, a sensitisation period, which may last for weeks, months and maybe years from the time the tattoo is made until the occurrence of the reaction
- That the reaction is chronic and constant in appearance and degree of discomfort, and usually is resistant to treatment with local steroids.

A further definitive sign of allergy is that an active reaction results in a concomitant reaction in an older tattoo with the same or nearly the same colour,

→ PHOTO 7.4

Histologic tissue section from skin with an allergic reaction to red tattoo pigment, which is localised in the corium against the interface to the cell-rich epidermis. The black nuclei in the corium represent lymphocytes.



→ PHOTO 7.5A

Black tattoo with papules and soreness. This is in contrast to the other parts of the same tattoo with no change of the surface pattern of the skin.

localized in another anatomic region and carried out independently of the problematic tattoo. With regard to whether pigment or other constituent substances in tattoo ink is the guilty allergen; that is, the actual cause of the allergy, as a rule it should be considered that tattoo ink is chemically impure. In addition, tattoo ink contains a number of unknown contaminating substances. Finally, the pigment is particulate and coated with an unknown ability to release chemical substances to the tissue. Cells and tissues may produce enzymatic and chemical split products of the original pigment with formation of entirely new chemicals inside the skin.

In a study with 90 patients with allergic reactions in their tattoos, allergy testing (patch testing) with standard allergens (European standard series) gave negative results. Allergy testing with the specific ink that had caused a reaction was also negative. Testing with a panel of textile colours, which included more easily dissolvable and bioavailable colorants also gave negative results (21). The study shows that allergens are not found directly in the tattoo ink product, but are generated in the skin over a long period of time. The process takes place by haptenation; that is, the chemical binding of two or more components that lead to an allergy-creating substance complex; here it is between an unknown colorant component or components from the ink and a tissue component or components, which might be tissue proteins. It is important to make clear that what you become allergic to is not a single known or well-defined chemical substance, which is found in or can be identified in and be prevented from being present in the commercial tattoo ink product in the near future.

The clinical appearance of chronic allergic reactions varies considerably. In the case of strong allergy, the reaction may be deeply ulcerating; that is, cause deep sore formation. In the case of moderate allergy, the reaction may be inflammation

→ PHOTO 7.5B

Black tattoo with many papules, which are most frequently localised at the 'lining' of the tattoo, where a surplus of ink may have been injected by the tattooist. Accompanied by inflammation and reddishness, which is also visible in the normal skin just outside the tattoo

→ PHOTO 7.5C

Raw punch biopsies from the same black tattoo (see Photos 7.5A and 7.5B) (the surface of the skin faces the right and the subcutis faces left). A great density of pigment is seen. Visible pigment formations can be seen with the naked eye, which have occurred in the corium as a clumping together of the nanoparticles in the original ink (nanoparticles are extremely small; that is, less than 100 nanometres in size and invisible to the eye even through an ordinary microscope). Due to the size, the aggregates act as foreign bodies in the skin, which therefore reacts. This results in clinical symptoms with itching and discomfort.

→ PHOTO 7.6A

Allergic reaction in red heart on the tattooed underarm.

with plateau-like swelling, reddening and sensitiveness of the tattoo. There may be a more or less strong secondary reaction in the epidermis in the form of scales or keratinisation with a skin surface dominated by condensed horny material. For a long time, clinicians have used the term 'lichenoid reaction', a designation that is connected to the visual appearance of the surface as being keratotic. In the case of stronger secondary reaction in the epidermis, there is dramatic change and massive keratinisation, which completely dominates the appearance, and covers or masks the allergic reaction in the underlying dermis like armour. The keratinisation may swell 6-8 mm above the level of the surrounding skin. In case of mild allergic reactions, there is only a mild or moderate degree of swelling in the tattoo with no or only light and barely visible keratinisation.

Microscopic studies of tattoo reactions

For a number of years, chronic tattoo complications, based on microscopy of skin biopsies, have been reported as lichenoid reactions, granulomatous reactions and the more seldom pseudolymphomatous reactions. The histopathology of tattoo reactions based on the pattern recognition that has traditionally been used in pathology has recently been reviewed in a review article (22). Used as a clinical diagnosis, however, the microscopic terms are not usable. The groups defined by histology are incomplete and overlap, and there is no correlation with any specific cause or trigger, any specific course of events or any specific clinical appearance except for granuloma correlated to sarcoidosis (23).

Clinical descriptive assessment of tattoo reactions

In the following, first the typical clinical complications, which were seen at the Tattoo Clinic at Bispebjerg University Hospital in clinical routine, will be reviewed. Then relevant potential side effects and more serious events will be discussed.

Papulonodular reactions

Papulonodular reactions are seen especially in black tattoos as isolated, small, possibly confluent nodosities, such as papules and nodules, in the tattoos, while other parts of the tattoo with the same pigment are not affected (Photos 7.5A, 7.5B and 7.5C). Histologically, there is inflammation; that is, infection-like changes with lymphocytic infiltration and, possibly, granuloma or foreign body reaction with giant cells. The histology typically shows large amounts of tattoo pigment in large aggregations; that is, clumping together of pigment particles. Aggregated black pigment may introduce the production of reactive oxygen species (ROS), which may result in inflammation (24). The reactions are not allergic and are often caused by excessive tattooing with the introduction of too much pigment. This pigment aggregates over time and forms larger conglomerations, which the skin, in the most pigment-dense places in the tattoo, regards as being a foreign body, reacts against it and attempts to eliminate it through the epidermis.

Plaque-like inflammation

Plaque-like inflammation is seen as a change of contour with elevation of the tattoo above the level of the surrounding skin, wherever the culprit colour is, and possibly with some scaling. This pattern is typically seen in tattoos with red colour or red nuances (Photos 7.6A and 7.6B), occasionally in blue/green and rarely or never in yellow. Plaque-like inflammation is hardly ever observed in black tattoos. The typical histology is as stated under the histologic assessment of interface dermatitis (see above). The reactions are often allergic based on the criteria stated above. Ulcerating reactions

Ulcerating reactions, that is, sore-forming reactions from the start cause strong inflammation in the dermis and necrosis (that is, cell death) followed by ulceration of the skin in all areas where the triggering pigment, typically red, is tattooed into the skin.

→ PHOTO 7.6B

Allergic reaction in a red tattoo with uniform reaction everywhere in the tattoo. Places with green pigment are normal and without reaction.

→ PHOTO 7.7

Tattoo reaction on the lower leg with severe allergic reaction in the red colours that is nearly ulcerating.

The sore formation goes down into the subcutis. Such manifestations are considered as being an expression of a strong allergic reaction. Tattoo products on the market have not been found to be directly caustic. Histologically the peripheral zone shows severe dermal inflammation, possibly as interface dermatitis (see above) and inflammation as part of the necrosis, which is followed be the rejection of dead tissue resulting in an ulcer, that is, a deep sore (Photos 7.8, 7.9A, 7.9B and 7.10).

→ PHOTO 7.8

Strong allergic reaction in a red tattoo, originally a red heart, with sore, dead tissue (necrosis) and loss of tissue going down into the subcutis.

→ PHOTO 7.9A

Strong allergic reaction with sore and loss of tissue going down into the subcutis

→ PHOTO 7.9B

The same patient as illustrated in Photo 7.9A. The allergic reaction in the tattoo has released an autoimmune reaction with similar sore formation in the normal non-tattooed skin.

→ PHOTO 7.10

Strong allergic reaction in a large tattoo, which originally covered most of the left leg. The patient developed a strong allergic reaction that resulted in amputations a number of times. Despite the amputations, there is still an active reaction in the thigh. There is also an autoimmune reaction throughout the patient's skin. The condition was supposed to be due to allergy to pigments or, hypothetically, due to adverse effects of pigment nanoparticles circulated in the patient with the blood.

Inflammatory reactions with hyperkeratosis
Inflammatory reactions with hyperkeratosis, that is, markedly increased thickness and elevation of the epidermis due to keratinisation is most often seen in tattoos with red colour (Photos 7.11 and 7.12). The histology shows interface dermatitis (see above), but with an especially strong proliferative reaction in the epidermis with lively new formation of epidermis cells, which multiplies the thickness of the epidermis many. A special variation has an irregular surface with 'notches' of epidermal inclusions, that is, ligated material of the epidermis and keratinised material that forms deep cyst or fist-like formations. This may be comparable to pseudoepitheliomatous hyperplasia as a descriptive microscopic diagnosis (25).

Urticarial or urticarial-like reactions
Urticarial or urticarial-like reactions, that is, 'wheal-and-flare' reactions or hives with a variable course and spontaneous healing or an intermittent course and chronic course may be seen with or without any special external triggering condition. Examples of triggering factors may be heat, stress, activity and sunshine. Reactions may exceptionally be acute, dramatic and anaphylactic, triggered by painful physical stimuli such as laser treatment and intradermal injection of corticoid.

→ PHOTO 7.11
Allergic reaction in a red tattoo with a hyperkeratotic reaction with strong keratinisation and multiplication of the thickness of the epidermis, which swells millimetres over the level of the surrounding skin.

→ PHOTO 7.12
Strong allergic reaction in the red part of the tattoo with dramatic hyperkeratosis, that is, thickening and keratinisation of the epidermis. The yellow, black and blue parts of the tattoo are normal and the reaction is selectively present in the red colour. In one area, the thickening has been so massive that the keratinisation has fallen off and has left a sore.

Reactions triggered by sunshine and light
Sunshine and light-induced reactions, also called photochemical reactions or photosensitivity (see also Chapter 5) may be severe and range from

minor episodes to more long-lasting thickening or papule formation, that is, small nodule-shaped thickening in the tattoo. The condition may begin a few seconds after exposure to the sun and be painful, but also be more long-lasting with a course of weeks to months, and return during a certain season of the year. This occurs most often in black and other dark tattoos.

Complications in the lymph tracts and the lymphatic system

It is not uncommon for the pigment of doubtful quality and excess colour, which has an easier dissolvability, to seep into the surrounding skin and give it a weak tint of colour or cause a slight lymphoedema, that is, a pillow-shaped swelling of the skin. Pigment particles are often transported by the lymph to the regional lymph nodes, which may be visibly pigmented and, possibly, enlarged. No cases of cancer of the lymph nodes in the regional lymph nodes related to tattoos have been reported, even though the dark-coloured lymph nodes, which were found to contain tattoo pigment are often routinely removed and microscoped in connection with sentinel node surgery of malignant melanomas (malignant birthmarks) in the skin (26, 27).

A single case of pseudolymphoma in a red tattoo has been described. The change apparently healed spontaneously and was, therefore, not malignant (28).

There are no reports in medical literature about lymphomatous cancer, that is, malignant lymphoma and leukaemia caused by tattoos. This is remarkable, because the lymph node is the most important first pass organ with regard to tattoo pigments, that is, the organ to which the substances in the tattoo pigment arrive first and in the most concentrated form, and in contrast to the dermis, contain many proliferating cells, which may potentially be exposed to a carcinogen, that is, a cancer-causing substance from the tattoo ink.

Neurosensory tattoo reactions

Neurosensory tattoo reactions are a complication that has not been noticed previously. Some people get severe pain in their tattoos or in the radial nerve segment, which is the large area of skin that the tattoo is on, and which becomes supplied by major nerves that comes from the spinal cord. The pain may be severe and disabling, even though the tattoo looks clinically normal and has modest or no histological changes, possibly with slight lymphocyte infiltration explained by scratching.

Cancer

Cancer in tattoos, that is, in the directly tattooed skin and in the areas of the tattoo that are not tattooed and have no tattoo pigment, were assessed considering the tattoo ink's potentially carcinogenic substances according to toxicological register data, which is primarily based on laboratory studies (see Chapter 8). The common forms of skin cancer are basocellular carcinomas, spinocellular carcinomas (both of which are skin cancers primarily caused by the sun) and malignant melanomas (malignant moles), as well as keratoacanthomas (keratinisation tumours), the latter of which is, however, clinically benign and self-limiting. Skin cancer as a complication in connection with tattoos was much debated. As far as is known, in Denmark no case has been observed where skin cancer has been caused by tattoos with an appearance that would lead to suspicion that the cancer was introduced by tattoo ink. A hypothesis is that dark tattoos, due to absorption of sunlight, may function as a physical sun filter in the skin itself, where the tattoo pigment absorbs the light, which then cannot be reflected back to the epidermis and cause the development of cancer.

This is currently being studied in a photocarcinogenicity study with mice (29). The fact that black tattoos in mice actually were shown to provide protection against skin cancer when exposed to sunlight, presumably for optical reasons due to reduced backscattered light including UV from the dermis, adds a new dimension to the discussion about carcinogenic substances in tattoo ink. The tattoo ink ingredients and risk of cancer associated with tattoos have previously been assessed based only on data regarding the regarding the potential or hypothetical risk of cancer from register data on single chemical constituent substances in tattoo ink independent of the solid fact that the vast majority of skin cancer cases are primarily induced by the UVB radiation in sunlight and not by chemical carcinogens. The interference of tattoos with the exposure of epidermis cells to UV light is, therefore, important and may be more significant than a possible content of a potentially cancer-causing substance in the tattoo ink. Potential chemical carcinogens that are, for the most part, in free form and occur as contamination during manufacturing are, furthermore, assumed to be quickly eliminated from the skin and organism, because the injection into the skin takes place as a single dose exposure without depot effect of soluble ingredients.

→ PHOTO 7.13

Skin cancer (basocellular carcinoma) in a tattoo. The tumour occurred in the skin outside of the tattoo and it grew from outside of it and later covered it. The case could be misinterpreted to be skin cancer caused by tattoo pigment, which clearly is not the case.

In a recently published literature review of the medical literature going back for decades, only 50 reports were found on skin cancer in tattoos, including malignant melanomas (malignant moles) basal cell carcinomas and spinocellular carcinomas (30). The authors conclude that the registered cases are probably coincidental, because skin cancer occurs extremely frequently in the population. Tattoos are not supposed to interfere with the spontaneous cell proliferation in the basal cell layer of the epidermis, physiological renewal of the epidermis and the development of typically sun-induced cancer in the normal epidermis because the tattoo pigment is deposited in the dermis underneath the basement membrane, hindering epidermal escape of the pigment and direct exposure of the basal cells and the epidermis (Photo 7.13).

Cancer in organs other than the skin as a result of tattoos has not been documented in medical literature through reports of isolated cases or systematically organised studies of groups.

Tattoos probably comprise the largest exposure of the population to substances that might potentially cause skin cancer. One explanation for the apparent lack of neoplastic effect of the potentially carcinogenic substances on the development of cancer in connection with tattoos may be that as contamination substances of the polyaromatic hydrocarbon (PAH) and free primary aromatic amine (PAA) types, these are eliminated quickly (over a period of a few days or weeks) and do not,

therefore, have a long-lasting or chronic impact on mitotic cells. Because tattoo pigments are very robust and not easily soluble, and for this reason are permanent in the tissue, any hypothetical segregation of PAA over time from azo colorants in pigments in the tissue may easily be so small and insignificant that they do not comprise a risk of cancer.

Overall, no connection between skin cancer, tattoos and tattoo pigments has been identified, even though tattoo ink quite often contains potentially cancer-causing substances in the form of impurities from the manufacturing of ink. There are no reports of cancer occurring in the regional lymph nodes, even though, as first pass organs, they are frequently exposed to tattoo pigment. Neither are there any reports of cancer of the inner organs related to tattoos. Finally, there are no reports of tattooed people who have large areas of skin tattooed who have contracted illnesses in the skin or inner organs, including cancer, which could be related to these people's very large tattoos. The lack of reports on the connection between tattoos and skin cancer does not in itself preclude that there may be a connection between skin cancer and other cancers, but considering that many millions of people over decades and centuries have been tattooed with ink and colours that contain potentially cancer-causing substances, especially PAH in soot and black pigment,– based on current knowledge there is no clinical evidence of significant risk of cancer caused by tattoo pigment and tattoos.

Other diseases or clinically relevant risks

Patients who have the disease sarcoidosis, which specifically attacks the lungs with the formation of nodules in the form of granulomas, have an individual disposition to get granulomas in many organs, including the skin. The nodules resemble tubercles in tuberculosis, but they are neither a sign of infection nor cancer. Within the spectrum of sarcoidosis, there are many internal and external conditions that may predispose or provoke the development of granuloma nodules in the tissue. Granuloma may, for example, be induced by vaccines containing aluminium being injected in the subcutis, where aluminium can be precipitated as particles with the size of tattoo pigment particles. Tattoo pigment is among the potential triggers of granuloma. This is particularly the case for black tattoos, where there is a special tendency for aggregation and thus the formation of foreign bodies is most pronounced. There is no evidence that tattoos may directly cause sarcoidosis in other organs, however, associated reactions in different organs, including the skin, as a manifestation of sarcoid alertness of the body may coexist.

On the whole, tattoos seem to live their own lives independently of any other skin disease that a person may have. Nevertheless, patients suffering from eczema have problems with the healing process after being tattooed. As described in an original publication on the Koebner reaction phenomenon back in 1876, in patients with psoriasis, in line with other physical stimuli, tattoos can cause psoriasis activity in the tattoo as what is called the Koebner phenomenon (31). Just as is the case with the Koebner phenomenon and psoriasis, tattoos can provoke the skin disease, lichen planus, previously also called lichen ruber, which is a very itchy inflammatory skin disease. Lichenoid tattoo reactions have certain similarities in the clinic and by histology to this disease.

Systemic or general clinical complications

Systemic or general clinical complications have been reported in the Internet-based study by Klügl et al on self-reported problems with tattoos. However, the data does not make it possible to draw conclusions about systemic events, which were few

in number, with any certainty (32). For a long time it has been known that allergic reactions in tattoos may cause general eczema in the skin, especially in the case of chrome allergy and mercury allergy, in which case tattoo removal may cause the problem (33) (see also Chapter 10). In old literature, such reactions are based on the use of chromium salts and mercuric sulphides, which were used as tattoo pigments in the past. Today, nickel salts are only in tattoo ink as industrial contamination, which is often in metallic form. Nickel contamination in modern ink can, in people who are already strongly allergic to nickel, induce widespread allergic contact dermatitis shortly after the tattoo is made, as discussed previously in this chapter. This parallels old observations with mercury allergy and tattooing.

The extent to which nanoparticulate pigment particles or fragments of them may reach other organs and thereby cause clinical symptoms from them has not been studied and is unknown. The effect of nanoparticles on health is described by the EU in a report (34). Circulating particles of the blood are often cleared by the Kupfer cells of the liver, which might also account for circulating tattoo pigments.

Reproduction toxic damage

Reproductive toxic damage in the form of abortion, deformities and malformations resulting from tattoos of fertile women before, up to or during pregnancy has not been shown. On the other hand, this has not been studied systematically either. This is despite the fact that women, apparently with no reservations with regard to pregnancy or the desire to become pregnant have, for generations and continue to have in the present time, had tattoos made with black tattoo pigment with a known content of a number of potentially cancer-causing substances, especially PAH and PAA (see Chapter 8). However, evaluations have not ruled out that tattoos and tattoo ink may have such an unfortunate complication.

Psychosocial and mental complications

There is a risk of a number of psychosocial reactions resulting from tattoos. This includes, for example, the feeling of shame when the tattooed person perceives that other people do not react just as positively to the tattoo as the person in question had expected. Some tattooed people experience a loss of self-esteem and stigmatisation because they have a tattoo. Some people regret the tattoo because they psychologically and socially have developed since they had it made. A number of people hide their tattoo with clothing.

A large number of studies indicate that there is a connection between tattoos and psychological difficulties in the form of psychiatric disorders, attempts to commit suicide, criminality and substance and alcohol abuse (see Chapter 3). However, it is not possible to conclude that the psychosocial problems are a consequence of tattoos. The connection between tattoos and the implied psychosocial problems may also be related to the fact that people with, for example, mental problems or people who are involved in criminality are more inclined to get tattoos than other people. Finally, it is a problem that most studies were made before tattoos became so prevalent, as described previously (see Chapter 1 and Chapter 3). Given that so many people from different groups have tattoos made today, tattoos have become mainstream (particularly among young people) and are, therefore, no longer automatically a sign of belonging to a dubious subculture.

One of the findings that are certain is that the incidence of tattoos is higher among people with mental disorders than in the general public. Knowledge about the relation between tattoos and

mental disorders is both from studies of tattooed people who have not had contact with psychiatric services and from studies of psychiatric patients. An increased incidence of different mental disorders (especially personality disorders) is found in people with tattoos, and a higher incidence of tattooed people is found among psychiatric patients than in the general population (35). Both types of studies also found that among people with tattoos there is an overrepresentation of people with alcohol and substance abuse, impulsiveness and risky behaviour. More people with self-inflicted injuries are also seen. An older study shows that a higher number of hospitalised psychiatric patients with tattoos than non-tattooed patients have had chaotic upbringings (36). They have more often been in children's homes, have shorter educations and moved away from home earlier. Bulimia seems to occur more frequently in young women with tattoos than among those without tattoos (37). The existence of a tattoo is reported to be connected with an increased risk of suicide or death by accident (38).

Among prison inmates and people in criminal environments, the occurrence of tattoos is much greater than in the general population, which probably is due both to the fact that tattooed individuals have a greater risk of being involved in criminality and that tattoos are part of the criminal subculture, where tattoos may be used to indicate affiliation with, for example, a certain gang (39, 40) (see also Chapter 4).

Again, it must be emphasised that the results of these studies cannot be generalised and uncritically extrapolated to the situation today.

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8

TATTOO INK

THIS CHAPTER REVIEWS THE HEALTH PROBLEMS THAT MAY BE CONNECTED WITH CHEMICAL CONSTITUENT SUBSTANCES IN TATTOO INK. THE DECOMPOSITION OF TATTOO INK IN THE BODY IS ALSO DESCRIBED.

SUMMARY

Tattoo ink is an ordinary industrial product, which contains one or more pigments and other ingredients in the form of adjuvants (for example, binding agents, additives and solvents). Finished tattoo ink may also contain chemical and microbial impurities. A recent Danish study found pathogenic bacteria in 10% of the tattoo ink that was studied.

The most frequently found chemical impurities in tattoo ink are polyaromatic hydrocarbons (PAH), primary aromatic amines (PAA) and metals, which may also include heavy metals; that is, substances, which, based on the register data, may be harmful.

As a rule, tattoos involve a one-time dosage, where soluble substances are assumed to be distributed to the bloodstream and converted quickly, while poorly soluble substances and particles can be deposited in the skin, in regional lymph nodes and, possibly, in other organs over time. The permanent colour of tattoos, which is seen in the skin, is due to tissue deposits of pigment particles, which are especially robust, for decomposing in the tissue.

Being very composite, ink for tattoos cannot be characterised toxicologically based on a single and known biokinetic model. Photochemical decomposition of pigment may result in new chemical decomposition products. The critical effects of ingredients in ink comprise potential risks, such as triggering allergy, cancer-causing effects, reproductive toxicological damages and toxic health effects of heavy metal.

The risk assessment of substances in ink presupposes valid knowledge about the quantitative exposure. This knowledge does not exist, even for the most commonly used ingredients and contaminations in tattoo ink. Therefore, it is concluded that regardless of the fact that tattoo ink, according to register data, contains potentially dangerous substances, that traditional toxicological risk assessment of chemical substituent substances cannot currently be introduced as a general method for assessing the health risks without there being a validation of the application of the methods with regard to tattoo ink. Regarding allergic sensitisation, it must also be noted that the allergen that triggers the quite frequent allergic reactions to the red colour is a hapten formed inside the skin over time. This means that the allergen itself is not present in the ink product and cannot, therefore, currently be characterised, isolated, measured and excluded from ink.

INTRODUCTION

Tattoo ink is a fluid product that contains one or more pigments and other ingredients in the form

of adjuvants, such as binding agents, additives and solvents. The finished tattoo colours may also contain chemical and microbial impurities, which may come from the raw materials and/or the manufacturing of tattoo colours.

In Denmark, approximately 500-1,000 differing kinds of tattoo ink with a broad selection of colours from different manufacturers and suppliers are in use.

This chapter first describes the manufacturing of tattoo colours, and then it goes into more depth about the chemical composition, focusing on which chemical substances there are in specific tattoo colours.

MANUFACTURING AND SALE OF TATTOO INK

The United States and England are traditionally the major manufacturing countries, but tattoo ink is also manufactured in many other countries, including China and other Asian countries.

There are no internationally or nationally recognised standards or the use of good manufacturing practice (GMP) for tattoo ink, as is the case with medicines and cosmetic products. Tattoo ink may, therefore, be regarded as a perfectly normal industrial product in the same way as paint, leather colouring and other types of colour for general use.

In practice, there are no requirements for manufacturers that have been adopted and function with regard to documentation of the raw materials used and their actual chemical composition and degree of purity, including the existence of any chemical

About tattoo ink, pigments and colorants.

Tattoo ink is a commercial product used to create a permanent change of colour in the skin in a colour that is wanted. During tattooing it is injected into the corium.

A colour is the subjective experience that is the visible colour or the cover determined by measurement, for example, using spectrophotometry.

A tattoo pigment is a particle of the size of a nanoparticle or microparticle, which in normal illumination gives off a certain colour and is typically robust with regard to physical, chemical and biological decomposition, and therefore is permanent as a colorant when injected into the skin. Chemical surface treatment of the particle (coating) may affect the particle's ability to decompose under biological conditions and increase the robustness.

A colorant is a chemically well-characterised substance, which in normal illumination appears coloured, and which does not have the same high degree of robustness that pigments have.

impurities that occur during the manufacturing of tattoo ink. The major pigment providers, which may have detailed product data sheets about raw materials delivered for specific uses, as is the case with foodstuffs, typically do not sell pigments for use in tattoo products in order to avoid incurring product liability. Therefore, manufacturers must often use small suppliers, and often they will not be able to obtain sufficient information from the suppliers about the raw materials that are used.

In the United States, the manufacturing and sale of tattoo ink is regulated by the Food and Drug Administration (FDA) and it is included as a category in the group of cosmetic products. Mercuric salts, for example, cinnabar (mercuric sulphide – a classic red colorant) was previously used to a great extent in tattoo colours. In the United States, since 1976 a limit value for the concentration of mercury in tattoo ink has been 2 ppm, because at an early stage mercury allergy was known to be a cause of allergic reactions after tattooing. Also the content of arsenic and lead were subjected to requirements. But other than this, there are few or no rules. The FDA has pragmatically chosen to take a position on the problems that arise. A large part of the control of the tattoo area in the United States is the responsibility of the individual states, each of which has its own guidelines.

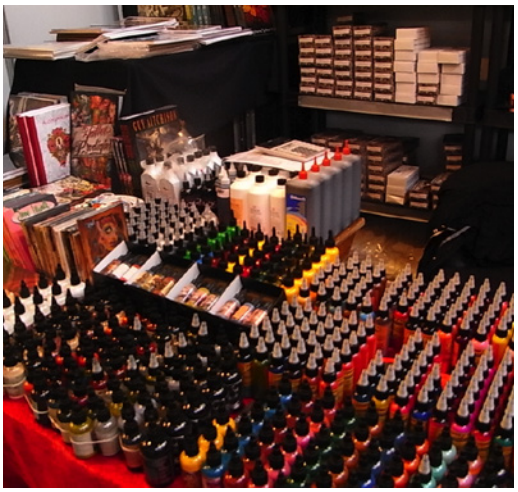
Danish tattooists, especially amateur tattooists often buy low-cost ink from Asia, known as 'China ink'. The extent of these purchases, which often take place on the Internet, is probably significant. There is no knowledge about the conditions under which 'China ink' is manufactured. There is little, no or misleading product information.

INFORMATIVE LABELLING OF TATTOO INK

On the whole, the lack of and/or incorrect informative labelling of tattoo ink packaging is a big problem in the industry, also in the case of products from large and established manufacturers.

→ PHOTO 8.1

The selection of tattoo ink from international manufacturers is very large and comprises hundreds of products. Photo from a tattoo festival in Copenhagen in 2012.



→ PHOTO 8.2

An ink product from England, which was delivered as powder for the tattooists to mix with suitable liquids. The manufacturer accepts no product liability at the same time as it recommends using the product for tattoos.

Høgsberg et al, in a study of 58 commonly used tattoo ink supplied by established manufacturers, found that the labels were extremely inadequate (1). This was the case with regard to indicating the main pigment and its CI number, the indication of other ingredients (including preservatives) and the indication of the dates of manufacturing and expiry. In ink, which according to the label was sterile, disease-causing (human pathogenic) bacteria was found. Ten per cent of the new ink that was studied contained human pathogenic bacteria. There were also big problems with the packaging, where the physical sealing of the content was defective in 28% of the products received. After requesting the supplier and manufacturer to send product data sheets, it turned out that they were either full of omissions or were not sent. None of the manufactures could explain the ink's chemical content in detail.

Chemical constituent substances

Tattoo ink is a product that is injected into the skin, and therefore the body, which is in a class of its own; that is, it is different from cosmetic products and medications.

As mentioned, tattoo ink contains one or more colorants; that is, pigments and other ingredients in the form of binding agents, additives and solvents. Finished tattoo ink may also contain chemical and microbial impurities. A current overview of the composition of tattoo ink is provided by de Cuyper & D'hollander (2). In 2012, the Canadian authority that is responsible for the regulation of tattoo ink published a detailed overview of aromatic azo and benzidine-based substances, their chemical decomposition and their potential health-damaging effects (3). There is detailed information about pigments, including carbon black, their characteristics in an industrial context, chemically and physically, as well as their production in 'Paint and Coating Testing Manual' published by the American Society for Testing and Materials (4).

Common ingredients

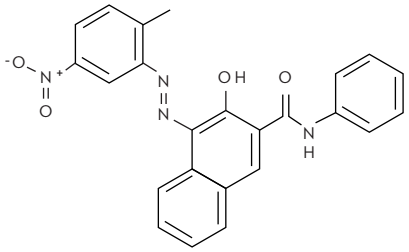
Tattoo ink is a suspension of pigment particles in an aqueous medium, often with the addition of isopropanol. The pigments that give the wanted colour are coloured particles, which ideally are not soluble in tissue fluids, water or common lipophilic media. The particles generally have a size of up to approximately 800 nanometres. However, the size of the black pigments, which are the smallest, is generally less than 100 nanometres and they are, therefore, nanoparticles (5). The pigment content in the product varies a lot and is often within the interval of 10-30%. Some ink contains more pigments.

Chemically, the pigments may be divided into inorganic and organic substances, which are described in Chapter 5. Carbon black, azo substances and phthalocyanines are currently the dominating organic colorants in tattoo colour – azo colours in, for example, red, yellow and green colours and phthalocyanines in, for example, blue, green and purple colours.

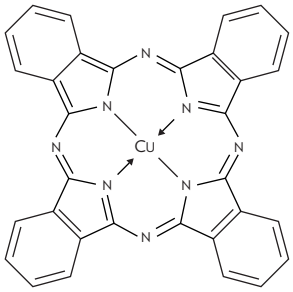
Azo colorants is a generic term for a group of organic, synthetic colorants that all contain the characteristic 'azo group' with two nitrogen atoms in the centre of the molecular structure. An example of a red azo colorant is pigment red 22 (Figure 8.1a), which has been used in studies of the decomposition of pigments injected into the skin. In addition to use in tattoo colours, azo colorants have an enormous prevalence because they are used in, among other things, enamel paint, leather colours and textile colours, and they are also used in industrially processed foodstuffs.

→ FIGURE 8.1A-F

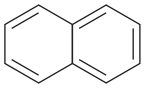
A PIGMENT RED 22



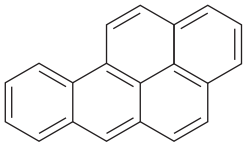
B COPPER PHTHALOCYANINE



C NAPHTHALENE

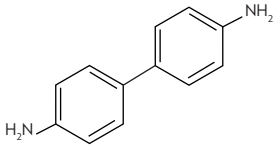


D BENZO[A]PYRENE



E ANILINE

F BENZIDINE



Phthalocyanines is a generic term for a group of organic, synthetic colorants, which may form complexes with most of the elements in the periodic table of elements. An example of a phthalocyanine is copper phthalocyanine (Figure 8.1b).

Tattoo ink may have inorganic pigments added to get lighter colour nuances (for example, titanium dioxide, zinc oxide or barium sulphate) or darker nuances (for example, carbon black).

In addition to solvents, tattoo ink usually also contains other adjuvants, for example binding agents (often barium sulphate), different additives (substances that are loosely bound to the pigment to modify the pigment's properties) and preservatives. Antioxidants may also be added to prevent oxidisation and the colour becoming pale. Glycerine and the plant extract witch hazel may be added to achieve suitable usage properties, and aluminium in the form of aluminium silicate or magnesium-aluminium-silicate to affect the ability to flow (thixotropic properties). Chemical coating of the pigments may make them more robust with regard to the physical stability and prevention of aggregation of the tattoo colour. Preservatives may be

added because tattoo ink, as is the case with other aqueous products, might be exposed to microbial growth, especially in warm storage conditions (in practice, ink is not stored in refrigerators) or by the tattooists repeated use of the same ink.

Chemical impurities

In addition to the ordinary and intended ingredients described above, the finished tattoo colour may contain chemical impurities, which may come from the raw materials and/or from the manufacturing of tattoo colours.

The most frequently found chemical impurities are polyaromatic hydrocarbons (PAHs) and primary aromatic amines (PAAs), and sometimes metals, including heavy metals.

PAH is a generic term for polyaromatic combinations, which consist of condensed ring systems (benzene rings), for example, the simplest structure of PAH in the form of naphthalene (Figure 8.1c) and the more complex benzo[a]pyrene (BaP) (Figure 8.1d). PAH is especially formed by the combustion of organic material, for example, fossil oil, coal tar and wood. PAH is found throughout the environment from car exhaust fumes and tobacco smoke. PAH can also be consumed with food by eating grilled or smoked food. Black pigment, that is, carbon black, is produced by incomplete combustion of carbon and may, therefore, include PAH as a chemical impurity.

PAA is a generic term for aromatic amines, where the primary amino group (NH_2) is connected to a benzene ring with the simplest PAA, aniline, (Figure 8.1e) and the more complex benzidine (Figure 8.1f) as examples. Azo colorants may release PAA through chemical or enzymatic decomposition.

Heavy metals are metals with a high density (often indicated as > 5 g/cm3), such as lead, mercury, cadmium and chromium. Salts of the latter three heavy metals were previously used as pigments in red, yellow and blue/green tattoo colours until the organic pigments took over the market 30-40 years ago because the metals mentioned, particularly mercury and cadmium salts, were associated with allergic reactions. Heavy metals are also expelled from the body slowly, or not at all, depending on their chemical form, application and volume. The definition of which metals are designated as 'heavy metals' is not unambiguous.

Chemical analyses

Tattoo ink contains known and unknown soluble and poorly soluble substances. This is of great significance when identifying and analysing the chemical constituent substances in ink. As a rule, with many methods of analysis and with few exceptions, it is only possible to measure chemical substances that can be put into a soluble molecular form. Analysis of tattoo ink using chemical analysis has, therefore, a built-in and significant blind spot, where substances of significance may be overlooked, depending on the analysis methods chosen.

The focus chosen for chemical analyses of tattoo ink has, as a starting point, been on the health-damaging effects of substances based on toxicological studies of chemically pure individual substances (studies on cell cultures, in animal studies or other forms of experimental tests) combined with human data of every available kind, especially commercial exposure of industrial workers to substances that have caused illness. The tattoo area has only been clarified sporadically with regard to potentially health-damaging substances. Diseases caused by tattoos carried out using contemporary organic pigments have not been studied in detail until recently (see Chapters 6 and 7). Therefore,

major and systematic epidemiological studies with regard to tattoos, which can be used to base a choice of focus areas for chemical analyses of tattoo ink, have not been carried out. The current clinical knowledge indicates that allergic reactions in the skin are the most significant risk that is related to chemical raw substances in tattoo ink. But the allergen that triggers allergic reactions, especially in red tattoos, is created inside the skin after certain period of time. The allergen is not found directly in the ink product and is not a simple PAA, which has occurred in the ink as a chemical decomposition product. The development of cancer of the skin or in the regional lymph nodes has not appeared as a problem related to tattooing with a proven relationship to chemical substances in tattoo colour (see also Chapter 7). The results of chemical analyses are always narrowly related to the choice of focus and choice of analytic method. Therefore, in the studies that are referred to below, only that part of the chemical content of the ink is characterised, as the choice of analysis methods and objects in the studies determine.

Analyses of chemical constituent substances in tattoo ink have primarily concentrated on the chemical impurities, that is, PAA, PAH and metals (especially heavy metals) studied in accordance with Council of Europe Resolution ResAP (2008)1 (6).

The Danish analysis report

A Danish analysis report (7) comprising 65 tattoo colours from ten different colour series, all of which were purchased from European suppliers. In connection with ordering the colours, safety data sheets were requested and data sheets were also searched for on the Internet. It was not possible to obtain data sheets for 19 of the 65 colours. This is remarkable, because for ten out of the 46 colours, that is, for approximately one-fourth of the colours for which it was possible to obtain data sheets, there was no consistency between the pigments that were indicated on the packaging and the pigments that were stated in the safety data sheet.

A total of 61 colours were analysed for the content of 66 different elements, including the 13 metals that are included in the Council of Europe's resolution (Table 3 in the resolution) (6) of recommended maximum allowable concentrations of impurities in products for tattooing. The following metals were found in higher concentrations than the Council of Europe's recommendations: nickel (all 61 colours), chromium (57 colours), copper (two colours), barium (eight colours), lead (four colours), cadmium (one colour) and zinc (one colour). In addition to the expected content of copper in the tattoo ink, which contains phthalocyanines (for example, blue, green and purple colours), and titanium in the tattoo colours that contain titanium dioxide (for example, white colour), it was not possible to show a connection between the colour of the tattoo ink and the content of specific elements. The Council of Europe's resolution recommends that if the product contains nickel, this must be stated on a label on the product, which is not the case for any of the tattoo colours studied. Nickel, copper, barium, lead and cadmium, as well as aluminium and titanium were selected for the health-related assessment that is described below.

Nineteen colours were analysed for the content of 16 different PAHs. In the Council of Europe's resolution (Table 3 in the resolution), a recommended maximum value for PAH and for benzo[a]pyrene is stated. The recommended maximum value for PAH is a total value, and it is not specified which PAH structures this total value covers. The concentration of the total PAH was higher than the Council of Europe's recommendation in 14 of the colours with the highest concentrations of black

colour. The concentration of benzo[a]pyrene was higher than the Council of Europe's recommendation in a single black colour. All 16 PAHs were selected for the health-related assessment, which is described below.

Nineteen colours were analysed for the content of 23 different PAAs segregated from azo colorants after chemical processing of the tattoo colours. Twenty-four colours were analysed for the content of free PAAs; that is, PAAs that come from a source other than azo colorants, and 30 colours were analysed for content of p-phenylenediamine (PPD), which is a PAA, which due to its allergy-causing properties is prohibited from being used in products that come into contact with the skin. These 23 PAAs contain 15 of the 20 aromatic amines that are stated in the Council of Europe's resolution (Table 1 in the resolution) of aromatic amines that should not be in tattoo colours or be released from azo colorants due to their cancer-causing, mutagen, reproductive toxicological and sensitising properties.

In up to two-thirds of the colours, one or more of the aromatic amines, which according to the resolution are unwanted, were found (Table 1). PAA content could not be connected to any specific colour and varied from product to product. These PAAs were selected for the health-related assessment, which is described below.

It is worth noting that the prohibited PPD was not found in any of the 30 colours that were analysed. The primary amine, PPD, is the most responsible for allergy caused by henna tattoos, where a tattoo design is painted on the surface of the skin without being injected.

Five black colours were analysed for content of carbon black. Carbon black was also selected for the health-related assessment, which is described below.

Six colours (three green, two purple and one blue) were analysed for content of phthalocyanines, which were found in all six colours. Phthalocyanines were also selected for the health-related assessment, which is described below.

The report also contained an analysis of ink from eight clinical cases of allergic reactions to tattoos. No connection could be determined between the content of chemical substances in the ink used, especially PAA and allergic sensitisation, purely clinically. It was concluded that the content of nickel, regardless of the fact that it was found in all of the ink, was not connected to known allergic manifestations in tattoos. The clinical cases illustrated that the red colour is most frequently involved in chronic tattoo reactions, as described in more detail in Chapter 7.

The Swedish report

A Swedish report comprised 31 tattoo inks that were studied for content of 20 aromatic amines, a further seven substances classified as carcinogens, 14 metals and 16 different PAHs (8). Of the 31 inks that were studied, only five were without critical comments with regard to constituent substances. Ten in 31 inks contained aromatic amines characterised as PAAs. Analysis for metals showed, among other things, content of barium, chromium and nickel, while cadmium, lead, mercury, selenate, antimony and chromium VI were not found in any of the inks. PAH was found in six of the inks, of which four exceeded the recommendation of the Council of Europe. A single black ink had PAH content (12 different ones), which in all was 540 times higher than the Council of Europe's recommendation, and a content of benzo[a]pyrene, which was 480 times

higher than the recommendation of the Council of Europe.

The studies on the content of chemical substances in tattoo ink that are referred to are not directly comparable because different ink and different chemical substances were selected for analyses in the different studies. However, they all indicate that the content of chemical substances in tattoo colours very often exceeds what is recommended by the Council of Europe's resolution (6) with regard to PAH, PAA and a number of metals.

The studies, which are referred to above, are designed based on register data on potentially dangerous substances and on the substances that the resolution has focused on. Data has not been critically compared to clinical data except for in the eight cases mentioned, which are included in the Danish Environmental Protection Agency's report (7). Reference to human health data is crucial to a final conclusion about the relevance of the findings in a health-related context. The studies have not addressed the question of free and biologically accessible chemical substances with regard to chemical substances bound in pigment or as metal.

Other studies of chemical constituent substances
There are a number of studies from different countries on chemical constituent substances in tattoo ink.

Snowden et al found in an early study with 18 patients with reactions in red tattoos and found that until 1988, only one had a positive allergy test for mercury (9).

Lehmann & Pierchalla, in an early publication also from 1988 on chemical analysis of nine commercial tattoo inks found that traditional colorants consisting of simple inorganic substances, especially mercuric salts and cadmium salts, had been replaced by newer synthetic pigments (10).

In a current assessment of the health risks in the population, it must be taken into account that exposure to pigments etc. from tattoos in the last 30 years has primarily consisted of the new organic pigments and simple combinations of inorganic substances such as iron and titanium, while metals such as mercury, cadmium and lead are, in practice, no longer used.

In a number of recent studies, varying contents of the metals aluminium titanium, copper, iron and barium have been found in tattoo ink (11, 12). In the latest literature, which covers a large number of tattoo inks that have been studied, the main findings regarding the content of metals have been confirmed.

Studies of decomposition products of tattoo pigments
For information about photochemical substances formed in the skin from tattoo pigments that have been exposed to light in the form of sunlight and laser light, see the chapter on pigments, colour and light (Chapter 5).

For information about the formation of allergens by haptenation from unidentified raw materials in tattoo ink, see the chapter on clinical complications (Chapter 7).

Due to the lack of precise knowledge about chemical constituent substances in tattoo ink that causes allergic reactions, fingerprint measurement of chemical spectra using Raman spectroscopy has been introduced (14). By using Raman spectography, spectra of ink, pigments, ingredients and reference substances can be measured in both the ink

products and the skin itself, both noninvasively and based on biopsies. The method makes it possible to develop a library of spectra for problematic tattoo pigments and inks, which has caused allergic reactions or another form of unwanted reaction. The Raman method is used in many laboratories around the world, and libraries are already established for a large number of specific chemical ingredients and substances.

In vitro testing and animal studies

There is a large number of test methods for assessing the risks of chemical substances, especially medicinal substances, but these tests generally have not been developed, are not valid, or have not been validated for studying robust particulate substances such as pigments and finished products in the form of tattoo ink. In addition, strong colours of pigments and pigment substances may prevent the practical completion and interpretation of the tests. It requires comprehensive research and extensive development work to establish preclinical test methods, which can be used for screening tattoo pigments, ingredients and finished tattoo products. Test systems must be adapted to the special, extensive, unknown and probably varying dosimetry and biokinetics of pigments and pigment substances in realistic and relevant conditions and under physiologic tissue conditions in which cellular and enzymatic processes play an active role.

When considering possible animal models, the choice of species of animal is crucial. Human-relevant tattooing using a tattoo machine may, for physical and anatomic reasons, only be carried out in skin of a certain thickness and with a histological structure that is close to human skin. This technical prerequisite makes a priori studies of tattooing small animals uncertain in biokinetic studies, among others, and this means that, in principle, pigs are the most suitable study animals. Pigs also have a larger volume of distribution. In the research on tattoo ink, studies carried out on mice and rats have been published, but not on pigs.

The method-related hindrances and limitations mentioned also apply to register data based on in vitro experiments on nonparticulate and soluble chemical substances and soluble chemical substances extrapolated to tattooed human skin. Experimental skin pharmacology has developed artificial release models and skin penetration models, exemplified by Franz cell systems. In experimental surgery, special models were developed for the study of release of metals from compound impression materials and prosthesis materials simulating physiologic conditions, and with regard to detoxification of compound impression materials and prosthesis materials, detoxification models have been developed that simulate physiologic conditions.

Exposure assessments regarding tattoos are significantly hindered by the lack of data on the release of free and soluble chemical substances from pigment particles under physiologic conditions. This must be considered together with the fact that colouring the skin using tattoos is permanent, which indicates extraordinarily slow release of chemical substances and metabolites from the pigment. Thus, the models must be constructed to detect extremely small amounts of split chemicals and metabolites released from pigment particles over a long time, that is, years, referenced to clinical adverse effects that such minute amounts might eventually cause. The task is extremely difficult because of the required time span, and for a number of other reasons.

In a meeting 17 October 2014, the Council of Europe preliminarily adopted the working docu-

ment, 'Towards Toxicological Risk Assessment of Tattoo Chemicals and Inks', prepared by a group of experts established at the initiative of the Dutch authority, the National Institute for Public Health and the Environment. In the toxicological investigation, the group of experts makes a distinction between the ink ingredients that are soluble and those that are particulate or very poorly soluble. For former type of ingredients, known toxicological methods are applied to the extent that it is technically possible, including with regard to the fact that strong colouring of ingredients may render the test methods impossible to use for technical reasons. The consensus of the group of experts is that poorly soluble ingredients and particulate ingredients cannot be assessed based on a generally applicable analysis programme or standard algorithm, but must be evaluated case-by-case. The group points out that the large knowledge deficit prevents being able to establish a general toxicological investigative programme regarding tattoo ink. The group also points out the necessity of animal studies, particularly studies with mice and pigs.

THE PIGMENT'S ROUTE THROUGH THE SKIN AND THE BODY

Tattooing injects the ink with thousands of vertical needle pricks into the corium (dermis), which is 1-2 mm thick. During the days after tattooing, some of the tattoo colour will be rejected by the skin together with desquamated scabs and dead skin cells, or seep into the bandaging, while the remaining part will stay in the dermis (15).

Soluble substances in the ink and the vehicle in the form of water and isopropanol will probably distribute itself locally in the tissue and move into the bloodstream within a short period of time (see Figure 8.2).

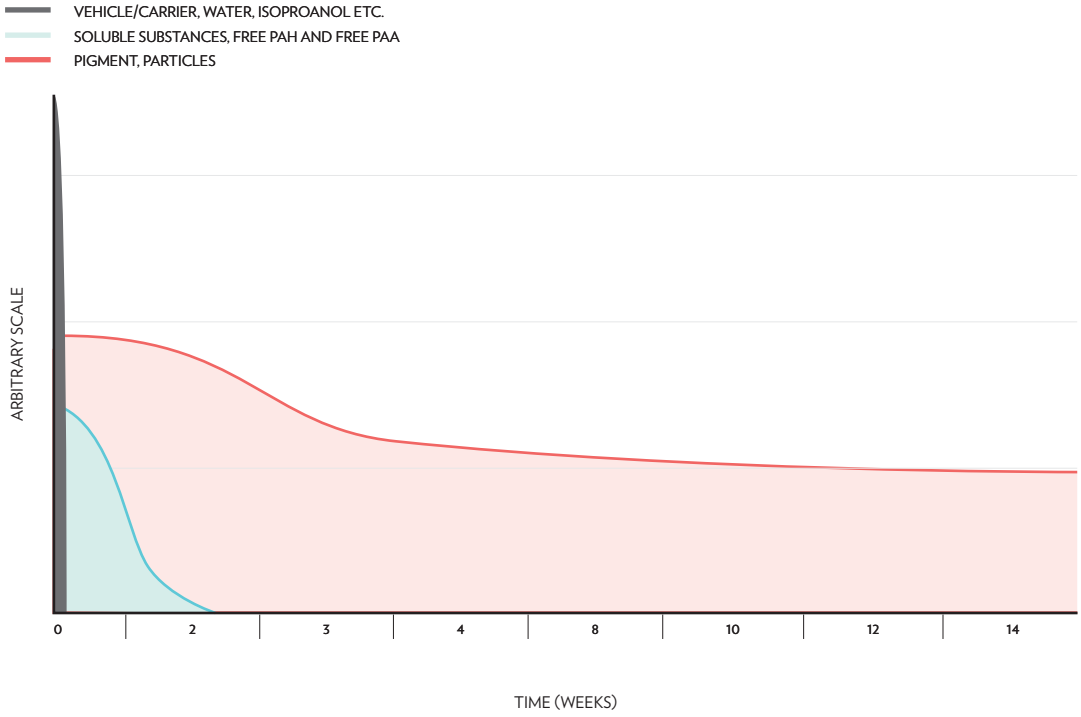
→ PHOTO 8.5

Practical execution of tattooing with the injection of ink into the skin introduced by thousands of needle pricks through the barrier of the skin.

The poorly soluble particles, such as the pigment particles will also move locally in the tissue and towards the vessels, especially the lymph vessels, so that the particles have a certain possibility to move out of the skin and through the lymph vessels to the regional lymph nodes in the armpits or groin. The lymph nodes, which have lots of cells, have a filtering and detoxicating function, which in a sense may be compared to the function of the liver with regard to foreign substances absorbed by the intestines (organ of first pass effect, here in the lymph node) (16). Chemical substances in the skin may undergo photochemical changes in situ (see Chapter 5), before the substance is distributed regionally or systemically. As mentioned, the regional lymph nodes, with regard to tattoo pigments, are the most important first pass organ before the route to the bloodstream, while the soluble substances can go directly into systemic circulation. In studies with mice, nanoparticles can, in addition to being in the tattooed skin and the regional lymph nodes, be shown in organs such as the liver and the spleen as soon as 24 hours later (17). There is a lack of studies with more advanced species, such

→ FIGURE 8.2

Hypothetical illustration of the distribution and elimination of tattoo ink after injection into the skin. Inert carriers (water and isopropyl alcohol) are eliminated from the skin in the course of minutes or a few hours, free chemical substances in the course of hours or a few days, pigment particles are redistributed in the tissue and are distributed to, among other places, lymph nodes in the course of days or a few weeks, but most of the pigment particles are permanently deposited into the corium for years with very little elimination. This provides permanent colouring of the skin and determines the tattoo's visible colour.



as pigs. The conditions during human exposure are unknown and are a very great research challenge.

Based on the formulation of the ink, as described above, and seen in light of the possible absorption, distribution, metabolism and excretion, the ingredients may be divided into being easily accessible, possibly accessible and inaccessible. Every single constituent substance in the ingredients of ink will have its own biokentic profile.

The tattoo pigments that are intended to remain in the skin permanently, must not, of course primarily belong to the accessible group. A type of pigment or fraction of the pigment may, however, prove to be accessible in the long run. Transformation of pigments may also form chemical substances that are easily accessible and quickly metabolised and eliminated, for example, PAA. The metabolism and excretion of the pigments after tattooing and under the physiological tissue conditions are unknown, neither for specific model pigments nor for the many pigments that are used in tattoo ink. Lack of knowledge about the human dosimetry and biokinetics of tattoo pigments, other ingredients and chemical impurities in tattoo ink are, as

described in the following, are the key obstacles to being able to carry out a valid risk assessment of tattoo colours.

HEALTH RISK ASSESSMENT

In a health risk assessment, an assessment is made of any health risks that may be connected to the chemical substances (colorants as well as adjuvants and impurities) in tattoo colours after tattooing. In other words: An assessment is made of the extent to which a given chemical substance that has been deposited in the skin by tattooing may result in a health risk in the tattooed person.

This section describes the results of the health risk assessment of selected chemical substances in tattoo colours in the expert report initiated by the Danish Environmental Protection Agency (7). The principles for the health risk assessment are described in detail in the report itself.

As previously mentioned in this chapter, eight metals (aluminium, barium, lead, cadmium, chromium, copper, nickel and titanium), 16 PAHs, ten PAA, carbon black and phthalocyanines were chosen for the health risk assessment.

Hazard assessment
The hazard assessment, that is, the critical effects of the selected substances was, in part, based on the classification of substances by the EU in accordance with Annex I of Directive 67/548/EEC (18) and the classification of the carcinogenic effect according to the International Agency for Research on Cancer (IARC), and in part on the critical effects that are identified in selected national and international expert assessments.

Carcinogenic effect
For PAH and PAA, the carcinogenic effect was assessed as being the critical effect with regard to tattooing. Because damage to the genes is the fundamental mode of action for the development of cancer after exposure to PAH and PAA, it is assumed that there is no lowest threshold (dosage) for the cancer-causing effect. Therefore, a derived no effect level (DNEL) for the substances in these two groups cannot be determined. A derived minimal effect level (DMEL) has been indicated in the expert assessments for a single PAH (benzo[a]pyrene) and for two PAA (aniline and o-anisidine). It was not possible to indicate or determine a DMEL for the other substances.

Cadmium, chromium VI and nickel have been classified by the EU as having carcinogenic effects and the IARC has classified them as being in group 1, 'carcinogenic to humans'. Because the development of cancer is only seen in the respiratory tract after inhaling the substances, the carcinogenic effect of these three substances has been assessed as not having a critical effect with regard to tattooing.

The IARC has classified lead as being in group 2A 'probably carcinogenic to humans', but the EU has not classified it as having a carcinogenic effect. The fundamental mode of action has not been fully clarified and tumours have only been seen due to very high dosages. On this basis, the carcinogenic effect of lead was not assessed as having a critical effect with regard to tattoos.
The report concluded (7) that there is a general lack of knowledge about the development of cancer due to tattoos. It has been shown that pigments in tattoo colours can be transported from the tattooed skin area to the regional lymph nodes, where tumours may occur. The extent to which the development of tumours in lymph nodes is related

to the pigment's intrinsic properties or is the result of depositing a particulate foreign substance in the lymph node cannot be assessed on the basis of current knowledge. A connection between the development of skin cancer and tattoos has not been proven or made probable.

Sensitisation

For a number of the selected substances (aluminium, chromium, nickel, aniline, p-chloraniline, 3,3'-dichlorbenzidine and 4-methyl-m-phenylenediamine), sensitisation was assessed as having a possibly critical effect with regard to tattoos. The substances mentioned above, with the exception of aluminium, are classified by the EU as being able to result in hypersensitivity upon contact with the skin.

Aluminium can trigger reactions in the skin, such as inflammation and granulomatous reaction, but it is still not clear whether these reactions are truly due to allergy or are of a different nature resulting from the special physicochemical reactions, which can take place around aluminium particles, or deposits in the tissue.

For the substances mentioned above, it was not possible to determine a DNEL based on sensitisation as a possible critical effect.

There is a general lack of knowledge about the development of sensitisation as a result of tattoos. There is some uncertainty regarding how allergic reactions with regard to tattoos appear clinically, and how the occurrence of an allergic trigger mechanism can be documented. This is because the current tests for contact allergy are neither suitable for testing particulate provocations in the form of tattoo colorants nor have they been developed or validated for this purpose.

Thus, on the basis of current knowledge, it is not possible to assess the extent to which the development of sensitisation resulting from skin contact with the substances mentioned above actually comprises a critical effect with regard to tattoos.

Other critical effects

For barium, the critical effect with regard to tattoos was assessed as being effects on the cardiovascular system, for lead it was effects on the nervous system in children and unborn children, for cadmium it was effects on the bones and kidneys and for phthalocyanines, it was effects on the red blood corpuscles.

A DNEL was determined for barium, cadmium and phthalocyanines, while no DNEL can be determined for lead because a lowest threshold for the critical effect of lead is not known.

Certain copper salts may cause irritation of the skin. It has been assessed that irritation of the skin is probably not a critical effect of copper with regard to tattoos.

Titanium dioxide often occurs in the form of nanoparticles in tattoo ink. On the basis of available data, it was not possible to assess any health-critical effects of titanium dioxide as nanoparticles.

Carbon black, which is from sources of carbon, may contain different carcinogens (for example, PAH) in various amounts. The critical effect of PAH in tattoo colours is the development of cancer. Carbon black often occurs in the form of nanoparticles in tattoo colours. On the basis of available data, it was not possible to assess any health-critical effects of carbon black as nanoparticles (7).

Conclusion on hazard assessment

The analysis report has shown that for most of the selected substances/groups of substances, it was not possible to determine the DNEL/DMEL for the critical effect or effects, most often the carcinogenic effect and or sensitisation from contact with the skin. Possible clinical effects with regard to tattoos for a few of the selected substances/substance groups could not be identified.

Exposure assessment

In principle, it is the concentration of the substance that is found in the analysis of the tattoo ink that is the basis for an assessment of the exposure to a chemical substance in that ink. In order to be able to express the exposure as a systemic dosage (in the unit mg/kg body weight per day) for characterisation of the risk, it is therefore absolutely decisive to know how much of the substance there is in the tattoo ink, which is deposited in the skin by tattooing, and how much of the substance that is subsequently transported from the tattooed area to the body's tissue and organs through the bloodstream and/or the lymph system.

In a study with the azo colorant pigment red 22, it was found that the amount of pigment deposited in the skin (of mice) varied from 0.60 to 9.42 mg/cm2 (mean value 2.53 mg/cm2), depending on the tattooing technique. Based on this mean value and an average tattooed area (430 cm2) the average amount of pigment deposited in the skin was calculated as being 1,088 mg. For the group of people with tattoos that cover a large area (1,090 cm2), and the highest dosage (9.42 mg/cm2), the amount of pigment deposited in the skin was calculated as being 10,268 mg. However, there is a great variation in the amount of pigment deposited in the skin, depending on the tattooing technique, just as there also is a big difference between the tattooed areas from person to person.

In the first weeks after tattooing, the pigments will, as described previously, be able to move locally in the skin. Some of the deposited pigment is decomposed locally in the skin to other chemical substances by, among other things, the effects of light (see Chapter 5), and some will enter into the lymph vessels and the bloodstream, with the result that the pigments can be absorbed in the body and be distributed to the body's tissues and organs. The kinetics of the azo colorant pigment red 22 has also been studied in mice (19, 20). It was found that 42 days after tattooing, the amount of pigment in the skin had been reduced to 32% of the initial dosage. However, there is no knowledge about how big a part of the initial dosage was absorbed in the body and how much of it was decomposed in the skin locally. Also, the structure of mouse skin is very different from the structure of human skin, which means that the decomposition of pigment red 22 in human skin may be quite different from in mouse skin. It is difficult to tattoo mouse skin, which is thin, which means that some of the tattoo ink is easily deposited in the underlying tissue or in the musculature. The studies mentioned did not include checks of whether the skin tests represented purely dermal tattoos without the pigment being deposited in deeper structures. Neither did the studies take into account that there will be differences between individuals among tattooists with regard to how much and how deeply tattoo ink is deposited, just as the differences between tattoo needles and their traumatic effect on the tissue may play a role.

The pigments in the analysed tattoo colours belong to different chemical groups (phthalocyanines, azo colorants and inorganic pigment, titanium dioxide and carbon black), and they are very different both chemically and structurally. Extrapolation of the results from a single study of only one pigment (pigment red 22), selected

among a hundred in use, to pigments in general was assessed as being subject to great uncertainty because the amount of pigment deposited in the skin and the subsequent absorption, distribution, transformation and discharge of different pigments will, of course, vary as a result of the chemical and structural differences between the pigments.

The pigments are generally poorly soluble or insoluble in water, and therefore probably also in biological fluids, such as blood or lymph. The very low solubility means that pigments, when deposited in the skin, will behave significantly differently from substances that are completely or partially soluble in biological fluids. Also, pigments in tattoo colours are often coated in order to, among other things, prevent dissolution and decomposition in the skin. Therefore, both solubility and the coating of pigments have great significance for any absorption of pigments after depositing in the skin and subsequent distribution to the body's tissues and organs. The solubility and coating of pigments also has great significance for any release of decomposition products and chemical impurities in the pigments after depositing in the skin. There is a lack of general knowledge with regard to these aspects. Extrapolation of knowledge about substances that are soluble completely or partially in biological fluids to pigments in general was assessed as being subject to very great uncertainty.

Pigments may occur in tattoo ink products as particles with a particle size that is less than 100 nanometres, that is, as nanoparticles. It has been described that nanoparticles injected in the subcutis may be distributed to organs in the body (the liver, the kidneys, the spleen), while larger particles do not move from the subcutis into the bloodstream. The absorption of nanoparticles and distribution in the body is, therefore, different than for dissolved substances and larger particles. The tattoo colour's content of nanoparticles thus results in a great degree of uncertainty about which organs are exposed other than the skin and the lymph nodes, which drain the tattooed area.

Most of the PAA, PAH and elements that were found in the analysed tattoo ink are not directly used in the inks as such, but occur due to chemical contamination or breakdown of pigments (for example, PAA from azo colorants or copper from phthalocyanines) or occur as chemical impurities (for example, PAH in carbon black).

Therefore, with regard to the health risk assessment, it was assessed that the analysis programme used would not be able to identify which pigments, adjuvants and chemical impurities actually occurring in the analysed tattoo ink products that a tattooed person could be exposed to, implicating a threat to health.

The analysis report has, therefore, shown that there are a number of limitations and a lack of knowledge with regard to being able to assess the deposited amount of a pigment or pigments in the skin, and subsequent absorption of a pigment or pigments from the tattooed area of the skin and distribution to the body's tissues and organs (7). The same conditions exist with regard to adjuvants and chemical impurities. Therefore, it was not possible to carry out a valid quantitative exposure assessment based on the available knowledge; that is, it was not possible to calculate a systemic exposure for the selected chemical substances in the tattoo colours that were analysed.

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9

REGULATORY CONDITIONS FOR TATTOOING AND TATTOO PIGMENTS

THIS CHAPTER REVIEWS THE APPLICABLE LEGISLATION ON TATTOOS AND TATTOO COLOURS IN DENMARK AND THE EU.

SUMMARY

The regulation of tattoo colours in the EU and Denmark is covered by general legislation regarding product safety. With a resolution from 2008 (ResAP (2008)1), the Council of Europe has prepared a proposal for specific regulation of tattoo ink, which the countries themselves may decide to follow. Based on the Council of Europe's resolution, a number of EU countries have prepared their own nationally adapted rules regarding tattoo colours. Due to uncertainty regarding the validity and value as an instrument of regulation and European diversity among countries, the resolution has not been able to improve the actual safety for tattooed people.

In Denmark, as a follow-up to the tattoo act of 1966, in 2013 a new act introduced a volunteer programme for industry administration by tattooists under the supervision of the Danish Health and Medicines Authority. The tattoo industry has rejected the programme, rendering both the legislation and the resulting statutory order without practical significance. The Danish Environmental Protection Agency has prepared guidelines, which in part contain requirements for constituent substances in tattoo colours, and in part requirements for the preparation of safety assessments of the products. The guidelines emphasise that specifications for a toxicological safety assessment should be prepared. The requirements in the guidelines are extensive, and they are difficult or impossible to comply with in practice.

The guidelines are controversial with regard to the EU, which has recently rejected the notification of a Danish statutory order with similar content. The Council of Europe's resolution and the Danish guidelines mention a number of substances, which are regulated as a negative list. The list is extensive and the analysis methods are generally neither described nor outlined when exceptionally indicated, validated for use in analyses of tattoo ink. In reality, tattooing and tattoo ink in Denmark continue to be without any control of any significance by the authorities.

With the desire to have joint, specific legislation regarding tattoo colours within the EU, in March 2014, the Health and Consumer Protection Directorate General (DG SANCO) decided to investigate the possibility of preparing a joint European standard for tattoo ink safety, with reference to the EU directive on consumer products. At the same time, the EU has delegated the task of preparing joint guidelines for hygienic tattooing to the German Institute for Standardization [Deutsches Institut für Normung] (DIN) in cooperation with European standardisation institutes, including Dansk Standard [Danish Standards].

INTRODUCTION

Legislation on and the authorities' regulation of tattooing in Denmark, Europe and internationally has occurred late with regard to the prevalence of tattoos in recent years and has been characterised

as being 'minimal solutions' that are determined locally. The solutions are very different and comprise a patchwork of inconsistencies with large gaps. An example of the inconsistencies is the paradox that the Danish Practice of Medicine Act [Lægeloven], now incorporated into the Danish Health Act [Sundhedsloven], states that only authorised healthcare professionals may carry out operations, including perforation of the skin and injections. At the same time, it is perfectly acceptable for anyone, without any education, to inject tattoo colour into the skin, colour that has to a large extent unknown contents, and which in no way complies with the requirements that there are for injecting medicine, including the requirement for sterility.

LEGISLATION IN DENMARK

In Denmark tattoos of any kind were allowed until 1966, when the first act on tattoos in Denmark determined that only people who are 18 years of age or older could be tattooed (1). At the same time it was prohibited to tattoo the face, on the neck and on the hands. The law was signed by King Frederik IX. The Danish law was made on the basis of medical publications in The Journal of the Danish Medical Association [Ugeskrift for Læger] by the plastic surgeons Michael Pers and Torben von Herbst and by the physician Torben Hvam later the same year on the tattooing of minors (2) and the frequency of tattoos among criminals (3), of which nearly half were tattooed. The law did not include any provisions on controlling the tattoo industry or the tattoo ink used. There are no rules about hygiene or preventive measures to limit the risks that were known at the time for limiting the transfer of infections, including hepatitis and (rarely) syphilis.

The Act of 1966 was supplemented by a new act on tattooing that was adopted by the Danish Parliament on 1 May 2013 (4). This law implemented an offer to the tattooists to be registered voluntarily through the tattooists' industry associations, as a kind of quality control of the ink use, and a requirement that ink must be sterile. The main elements in the applicable law are:

The tattooists could call themselves registered tattooists through one of the industry-administered registration programmes carried out by their own associations that shall be formally approved by the Danish Health and Medicines Authority.
The associations take care of education and the determination of rules as a prerequisite for the tattooists being registered.

The associations are responsible for handling of and resolution of any complaints by the customers.
It is allowed for anyone to tattoo others, regardless of whether or not a tattooist is registered.

The Danish Ministry of the Environment determines rules for the control of tattoo ink.

It is the responsibility of the Danish Health and Medicines Authority to, after payment of a fee, maintain a register of approved industry associations and to carry out the approval of their articles of association. The Danish Health and Medicines Authority is not obligated to supervise tattoo parlours and ensure their suitability for this purpose.

The Danish Health and Medicines Authority is not obligated to supervise the general safety regarding tattooing, for example through the establishment of a notification arrangement for a data register of unintended events and medical complications in connection with tattooing.

REGULATION OF TATTOO INK

In Denmark, tattoo colours are covered by the law on chemical substances and products (5) and the product safety law (6). None of the laws mentioned above specifically address tattoo colours.

In 2013, the Danish Environmental Protection Agency, after having completed the consultation and confirmation process in the Danish Ministry of Health, presented a proposal for a new statutory order on the control of tattoo ink. The order is a revised implementation of the Council of Europe's resolution, (ResAP) (7), (see the review below). However, the order did not go into force because the EU has raised an objection in principle with reference to decision C-358/11 of March 2013 by the Court of Justice of the European Union, known as the Lapin decision. The matter of principle is the extent to which individual countries in the EU may introduce national limitations on chemical substances in situations that concern the entire EU, and where a national regulation may conflict with general EU regulations, in this case the regulation of chemical substances according to the European Parliament's, and the Council of Europe's, as well as the European Union's regulation (EC) no. 1272/2008 (the REACH regulation) (8). A consequence of the decision and the rejection of the notification of the Danish statutory order is that rules regarding tattoo ink must be harmonised and formalised under the EU without there being national leeway for independent regulation. In July 2014, the Danish Environmental Protection Agency announced that the order on tattoo colour had been given up and instead, the agency has prepared guidelines (9), which do not require EU notification. This may take place without circumventing the EU's decision.

The guidelines are divided into two sections; one is a description of the requirements for constituent substances and the other is a product safety assessment. A special section regards the regulation of what are called CMR substances, that is, substances that are classified for carcinogenic effect (C), mutagenic effects that may damage genetic material (M) and/or reproduction toxic effects that may damage fertility and/or an unborn child (R). Thus, a prohibition has been made against the import, sale and use of tattoo colours that contain components which, according to applicable legislation must be classified as being carcinogenic (C), mutagenic (M) and/or reproduction toxic (R) in category 1A, 1B or 2 in accordance with REACH (8). Colorants known as azo colorants are mentioned separately in section 3(2) because it is assumed that certain azo colorants can be decomposed to health-damaging primary aromatic amines (PAA).

The main emphasis of the guidelines is on the preparation of the safety assessment and the safety report. The safety report must establish that the tattoo colour does not present a risk to human health when tattooing. This is ensured by using information about the tattoo products' safety and also a safety assessment of the information. Thus, there must be a thorough toxicological account regarding all of the constituent substances in the product, including impurities. Exposure risks regarding the product, as well as substances and mixes, including impurities, must also be stated. Then the information must be included in a thorough report about the safety of the colour.

Due to the results from different studies of tattoo colour, it is a requirement that the tattoo products must be sterile in unopened state, that is, they must comply with the requirements for sterility that are stated in the European Pharmacopoeia (Ph. Eur), section 3(4) (10).

EUROPEAN UNION LEGISLATION

There are no specific provisions for the regulation of tattoo colour and tattoos in Europe. After the Lapin decision, as described above, the area of regulation of tattoo ink is a EU–matter, but it is not necessarily covered by REACH (8), which, as a starting point, deals with the occupational risk of handling large volumes of chemically pure individual substances, that is, in volumes of more than one tonne. REACH goes into force unless a specific area is not already covered by a special rule. Tattoo ink, which has a composite chemical content and is intended for a specific use, may be regarded as a consumer product and regulated by the EU as such, without being in conflict with REACH, which has a different scope. This will be discussed in more detail below.

The EU has previously addressed the tattoo area, which goes beyond regulating ink. A EU report from 2003 (11) resulted in the conclusion that there is a lack of research-based knowledge about tattoos. The deficit of knowledge especially affects the questions about the extent to which tattoo ink triggers allergy and phototoxicity, and whether the chemical substances in ink are carcinogenic, mutagenic and/or reproduction toxic to an extent that is clinically relevant. But the report also points out that there is a lack of clinical an epidemiological knowledge as a rationale for regulation. A large number of countries in Europe have already adopted national legislative measures regarding different risk elements of tattoos; provisions that are chaotic and that have very different levels of ambition. Other countries have no provisions.

The Council of Europe's resolution

The Council of Europe may propose provisions to for the individual countries to consider without them being obligated to implement provisions nationally. This is in contrast to directives adopted by the EU. In 2003, the Council of Europe put forward a resolution regarding tattoo ink. The resolution was updated in 2008 (7).

The resolution only deals with the control of tattoo ink and not tattooing, tattooists and practices. In contains negative lists and states the limit values based on register information and in vitro information. Twenty aromatic amines are on the negative list due to their potential carcinogenic, mutagenic, reproductive toxic and sensitising properties. Limit values are stated for 27 PAHs due to potential carcinogenic, mutagenic and reproductive toxic properties. The resolution does not state provisions for expiry dates or how such dates would be able to be determined, should they exist. Regarding the specification of analysis methods to determine the absence of critical substances or to assess whether limit values are complied with, the resolution refers to analysis methods that are used for the determination of textile colours without taking the particulate properties and very poor solubility of tattoo colours into special consideration. With regard to metals, methods that measure total volumes of metal in the products are referred to, regardless of whether the metals are found in soluble form, are particulate or insoluble.

Implementation of the resolution

A number of European countries, including Sweden, the Netherlands, Germany, France, Switzerland and Italy have implemented adapted versions of the Council of Europe's resolution; each country with its own version. However, formal national implementation in a country does not necessarily mean that the resolution is used in practice. For example, Italy has a general legal provision that the resolutions of the Council of Europe are implemented in the country, but in the area of tattoos, it is left up to the regions themselves to determine

which rules they want to implement. In Italy there is a broad range of variations in the implementation, including a number of regions that have no rules at all. The Council of Europe's resolutions have generally not been implemented in Eastern European countries, in large countries such as Spain and Greece, and in a number of small countries.

Thus, the total picture of control of tattoo ink in Europe is inconsistent. Manufacturers of tattoo ink operate internationally and the ink is often bought on the Internet. The local high requirements for documentation of ink safety taken together with the current practice and lack of consistency in ink regulation in Europe, puts manufacturers in a situation where it is impossible for them to comply with quality requirements for tattoo ink as, for example, formulated in the Council of Europe's resolution.

DISCUSSION OF THE REGULATORY CONDITIONS

The Danish law on voluntary industry-administered registration programmes for tattooists (4) was adopted despite criticism during consultation from the Danish tattoo guild [Dansk Tatovør Laug], the independent tattooists [De Uafhængige Tatovører] and the Tattoo Clinic at Bispebjerg University Hospital. It was decided to assess the extent to which the law works after two or four years. The leading industry association, the Danish tattoo guild [Dansk Tatovør Laug] and the independent tattooists [De Uafhængige Tatovører] did not want to participate in an industry-administered program and take on the obligations, responsibilities and limitations connected with doing so. The Danish Health and Medicines Authority prepared the law through a statutory order that went into effect on 17 January 2014 (12). However, because the industry associations chose not to agree to the programme, the order has no significance in practice.

It has been assessed that the requirements in the Danish Environmental Protection Agency's recommendations (9) regarding certain manufacturers will be to extensive and difficult to comply with. As a consequence, the Danish market may be avoided by these manufacturers, which may open opportunities for more dubious manufacturers and products. When looking at the experience with the Council of Europe's resolution (7), there are examples of practice in which tattoo colours are marketed as being in compliance with the resolution only on the basis of a chemical analysis report. This means that the safety report, which is an important part of the risk assessment, is lacking. This results in a risk that there is a general practice where only laboratory data is the basis for acceptance of the products.

Due to their health-damaging properties, the guidelines regulate a number of PAAs, because it is well known from the literature that certain azo colorants, including tattoo colours, may form these amines through a chemical process. However, it has not been shown whether azo colorants may cause the formation of primary aromatic amines in the skin. Photochemical and enzymatic reactions are listed as possible chemical reaction types that determine the metabolic transformation of azo colorants in the skin in physiological conditions. These reaction types are difficult to replicate in laboratory conditions.

The resolution's indication of analysis methods is both uncertain and insufficient. None of the methods mentioned have been validated for analysis of tattoo pigments and ingredients. The resolution has proven to be difficult to implement because of the lack of precision of the analysis techniques and test methods, but also because of the extensive requirements that the manufacturers are not currently able to comply with. Another weakness

is that it has not been possible to relate the critical constituent substances to the tattoo complications that are observed in the clinic. The analysis of the substances can, therefore, be of no importance or actually misleading with regard to the clinical and epidemiological reality. There is a lack of knowledge about the release of tattoo ink's chemical substances in the skin and systemically in people who are tattooed. The knowledge about the substances' biokinetics from animal experiments has only been studied in some mouse studies, which cannot provide the basis for conclusions about exposure in human situations. Finally, the resolution is of limited significance because the tattoo ink that is in the market is manufactured based on a large number of pigments, chemical variations and decomposition substances. Chemical quality assurance of tattoo ink is, therefore, very complex and difficult due to the large number of constituent substances and their possibilities for chemical and toxicological effect and interference.

The Council of Europe's resolution has not succeeded in solving the problem of the microbial safety of tattoo ink. In this area, there is a great deal of basic knowledge and clarity about unwanted microbial agents, the reasons for complications and their manifestation in the form of systemic infection and danger to the tattooed person. The resolution does not provide any sterilisation method for tattoo ink. Medicine that is injected into or under the skin and used after opening is subject to strict restrictions, as is the use of the same medicine for a number of people. The latest version of the Council of Europe's resolution from 2008 allows the possible use of preservatives without providing any details about the type and limits on the volumes added (7). It is accepted that opened ink is used for a long time and for a number of customers. There are examples of the use of large volumes of parabens and methylisothiazolinone in ink. Both substances are known to be sensitizers. For the same reason, their use is restricted or is being phased out of cosmetic products.

There is no positive list for ingredients that manufacturers of tattoo ink can comply with in the same way as is done for cosmetic products. There is no information about the extent to which any authority in Europe is preparing such a list. The difficulty of preparing a positive list particularly concerns the organic pigments, which now dominate the market, in contrast to certain inorganic pigments such as iron oxides, which come in a broad range of colours, and possibly can be assessed toxicologically and be 'acquitted' for use in tattoos. There is comprehensive basic knowledge about carbon and carbon black, and their PAH content, and it is realistic that toxicologically acceptable forms can be identified. The preparation of a positive list of tattoo pigments will provide the manufacturers with a real possibility to produce ink that is safer. They do not have this possibility today, where the manufacturers are responsible for the safety of the products. In some of the countries that follow the Council of Europe's resolution, there are requirements that the manufacturers include safety documentation in their product information, including a formal toxicological risk assessment; a requirement that i reality is not possible to fulfil with the current lack of knowledge.

By exclusively focusing on negative lists as product information, the focus is removed from actual constituent substances, which may create precedence for a practice in which the consumer may get the impression that the product has been approved in accordance with the Council of Europe's resolution, based solely on a chemical analysis with regard to the prohibited constituent substances.

EU's decision to define tattoo ink as a consumer product is probably due to the acknowledgement that, in part, the tattoo industry has very little structure, and in part that many private people (including amateur tattooists) themselves buy equipment and ink, and attempt to make tattoos, and by doing so become ordinary consumers of products.

Control of tattoo ink at European level now has a new dimension. On 4 April 2014, through the Health and Consumer Protection Directorate General (DG SANCO), due to pressure from several member countries and because tattoo ink safety is subject to article 13 (13) of the General Product Safety Directive (GPSD), the union will start to regulate tattoo ink. This is to primarily take place through annually updated guidelines and the European RAPEX system for reporting consumer products that may present risks to the users. As a starting point, the EU will make use of the Council of Europe's resolution. The unsolved problems related to the resolution are discussed above.

It is possible that DG SANCO will also take a position on other products, such as tattoo needles, tattoo machines and tattoo utensils. The safety of these is an area that has been neglected. Needles may be non-sterile even though they are stated to be 'sterile' and needles might release metal such as nickel and chromium. Tattoo needles and machines have certainly never been CE approved or labelled. The technical quality of tattoo machines may be poor and vary regarding function and ink dosage. Tattoo machines, as non-enclosed machines, typically cannot be sterilised or be made safe against infections by cleaning with alcohol gel. There is an alternative in the form of motor-driven enclosed machines. In principle, and regarded without considering what is actually realistic, tattoo needles and machines are in the same category as medico-technical equipment, which is subject to strict regulatory control at EU level.

At the same time as the initiative by DG SANCO, the EU has delegated the preparation of proposals for European guidelines on hygienic tattooing to the German Institute for Standardization [Deutsches Institut für Normung] (DIN) in cooperation with standardisation institutions in other European countries. Dansk Standard [Danish Standards] is also involved in this work.

The EU wants to create joint rules to be implemented in all member countries and replace the national rules. Joint European rules will make it possible for the manufacturers to realistically comply with them.

PROPOSAL FOR A EUROPEAN REGULATORY PLATFORM

The basic regulatory idea in the Council of Europe's resolution (7) is well known, but as an attempt to open the discussion, a framework proposal for a joint regulatory platform that could apply to the European market is outlined in the following. The central idea of the registration programme is the identification and quantification of tattoo products' constituent substances (positive list) rather than a regulation of unwanted substances through the use of negative lists.

The proposal below for a joint regulatory platform must be seen as inspiration for the continued debate about requirements for the safety of tattoo colours. In this regard, it is important that all problems be included and evaluated before determining final requirements.

Toxicological profile

The idea is that every single tattoo product should be reported to a European database, which is maintained by a joint European authority. The system is known from the reporting of cosmetic products to the CPNP database. The database must be updated on an ongoing basis with toxicological profiles for the individual constituent substances, including different colour pigments. The toxicological profile is structured according to a template that is agreed to beforehand. The idea is that the authorities assess the reported constituent substances on an ongoing basis. Concurrently with the constituent substances being assessed in this manner and then approved, the assessment must subsequently be entered in the database as approved toxicological reference material for coming reports of similar constituent substances. Until there is an approved toxicological profile for a specific constituent substance, it is the manufacturer's responsibility to provide the necessary data in connection with the report. It must be possible to search in the database for available toxicological profiles and refer to them in the report.

Because a number of constituent substances in tattoo products are already considered to be unwanted for safety reasons, the product database may contain a 'negative template', which makes it impossible to report precisely these constituent substances. The list can be revised on an ongoing basis.

Chemical profile

The basic chemical documentation for the report must be a chemical profile, the structure of which is known from certificates for finished products, as are used for, for example, medicines, vitamins, products that contain minerals and dietary supplements. The chemical profile must contain a number of specifications and requirements for the various constituent substances in the product. An example can be seen at www.vidensraad.dk

For each constituent substance, the method for identification and quantification must be stated, as well as the analysis method and specifications. By focusing on colour pigments, including the substances' concentration and purity, the focus is on the main causes of uncertain product safety, that is, impurities of various kinds. Thus, when reporting, the manufacturer must present documentation of the content and concentration of each individual colour pigment in the tattoo product. The system requires adoption and development of a generally usable quantitative analysis method for this purpose, so that information regarding impurities in the colour pigments is also provided. For more inspiration see (14).

The colour pigments are identified by using their Colour Index (CI) numbers. The photostability of the colour pigments should also be part of the chemical profile. After the colour pigments, the product's other constituent substances should be focused on. There may be various solvents, stabilisers, preservatives, pH-regulating substances etc. In a way that is similar to the colour pigments, suitable and acceptable analysis methods must be identified, which must also be stated in the certificate.

Considering that control of ingredients in tattoo ink is difficult and that in practice the Council of Europe's resolution has not proven to be usable as an instrument for the regulation of ink, the above at least introduces consideration of introducing a registration programme for tattoo ink so that the authorities can have an overview of the ink market. This will also result in manufacturers and suppliers of ink being identified and be legal parties, which can be made liable for their products. Such a pro-

gramme has been practiced for years in the area of cosmetics, where it has had a significant 'educative' effect and ensured a reasonable legal status.

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10

REMOVAL OF TATTOOS

TATTOOS CAN BE LIFE THREATENING, AND THEY CAN BE REGRETTED. BUT THEY ARE VERY DIFFICULT TO GET RID OF. HOWEVER, IN CASE OF DISEASE IN A TATTOO, THE COLOUR MUST BE REMOVED EFFECTIVELY.

SUMMARY

There are two scenarios for the removal of tattoos. One is when the tattooed person regrets the tattoo. The other is removal due to medical complications in the tattoo, which are most frequently an allergic reaction.

In case of regret, lasers, or intense pulsed light (IPL) and various forms of caustic methods are freely available on the market. In Denmark, the market for tattoo removal is completely without rules or control, even though the methods may result in significant personal injury. New methods, such as acid burning using high concentrations of lactic acid are used uncritically.

Removal due to medical complications is the responsibility of the healthcare system. In some cases, especially in case of non-allergenic reactions, usually in black tattoos, medical lasers are used. Lasers are selective with regard to tattoo pigment and release high levels of energy and heat in the pigment in the skin, with the risk of damaging the surrounding tissue, followed by scar formation. Organic pigments and black in the form of carbon black are, in principle, suitable for removal using a laser, while inorganic pigments such as iron oxides and titanium dioxide may unintentionally cause dark coloration. It requires medical expertise and special insight into tattoos to use lasers to remove tattoos.

For frequent and more severe complications in the form of allergic reactions, which are often found in red tattoos, laser treatment is relatively contra-indicated. The treatment of first choice is surgical in the form of dermatome shaving, which has proven to be effective, acceptable in terms of side effects and results a high degree of satisfaction among those who have received treatment. The removal of tattoos in case of complications is a specialist task in the healthcare system, and a treatment that to a large extent should be centralised.

INTRODUCTION

The idea of permanent tattoos is that they are to last for a lifetime. Therefore, tattoo pigments have been developed to be a very robust material, which ideally cannot be decomposed or removed. The removal of a tattoo in case of regret or for treatment reasons by completely eliminating the tattoo and re-establishing completely normal and undamaged skin as it was before is seldom possible. 'Removal' in connection with a regretted tattoo is a misrepresentation bordering on being misleading.

The wish to remove a tattoo has two lines of approach. One is that the tattooed person has regretted the tattoo and its design. Tattoos have become a sociocultural or cosmetic problem. This is the largest group. The other situation is when a

chronic medical type of complication has occurred in the tattoo, often accompanied by significant discomfort, for example, in the form of swelling and itching, which affects the quality of life. In the first case, the tattooed skin is structurally normal, while the skin in the other case is characterised by sickly inflammatory changes as part of an allergic reaction in the skin. The two situations give different prerequisites for which removal methods can be used. Cosmetic tattoo removal in case of regret is regarded as the tattooed person's own problem, while removal due to complications is regarded as being the responsibility of the healthcare system.

The removal methods will be described below. Lasers are most often used to remove ordinary tattoos due to regret, while surgical methods, particularly dermatome shaving is the most rational in case of medical complications in tattoos.

The reasons for wanting to have a tattoo removed vary. The general impression is that a third of the tattooed people are satisfied with their tattoos, a third regret having their tattoos over time, while the rest are indifferent. Only some of those who regret a tattoo want to have them removed. One of the considerations regarding removal is that treatment is expensive. In the YouGov study (1) based on telephone interviews of a representative group, 16% regretted their tattoo; 19% of the men and 13% of the women. This means that approximately 100,000 Danes regret their tattoos.

Previously, tattoos were removed using salabrasion, which is scrubbing the skin with salt and by dermabrasion, where upper layers of the skin are removed using a rotating grindstone. Chemical methods such as treatment with tannin and acid burning with silver nitrate have also been used. But the methods were not effective; they were painful and had many adverse side effects. Surgical removal by excision may be used for very small tattoos, but occasionally also for large tattoos, where skin transplantation is required. Surgical removal is radical, but always leaves a substantial scar, so surgical removal by excision is reserved for special cases.

The current practice is primarily to use medical lasers, which are potent lasers that are normally used for medical purposes by doctors. But also other types of instruments offered on the market, for example, intense pulsed light (IPL) equipment, which is not based on lasers but is simply a strong and burning light (such as light from a burning glass). Removal using a laser with the correct equipment is expensive and costs 10-20 times as much as the original price of the tattoo.

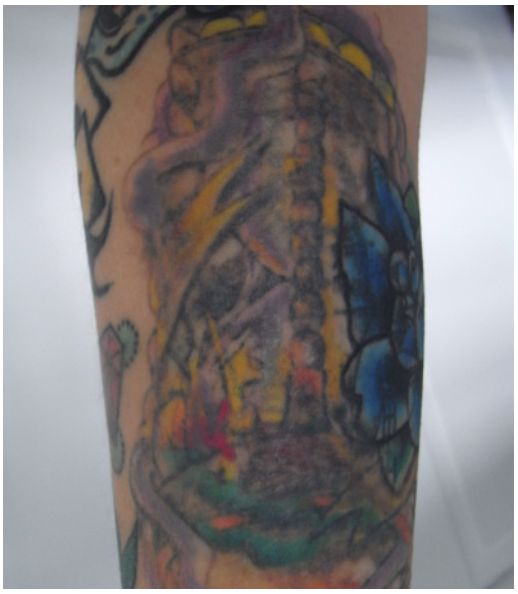
In Denmark, and in most EU countries, anyone can legally, and without any formal limitation, offer tattoo removal using lasers with any kind of equipment at all, including both expensive medical lasers and cheap laser systems and IPL equipment, which are totally unsuitable for this purpose. In many cases the result of removal using lasers is poor and there is a risk of scar formation and bleaching of the skin in the treated area.

REMOVAL USING LASERS

The ideal tattoo consists of strongly coloured, insoluble, non-poisonous and light-resistant pigment particles. But for the ideal removal of the same tattoo, the requirement at first is that the colour – what is visible – disappears without resulting in a scar or another injury. This requirement can be fulfilled to a certain extent by using powerful medical lasers. In order to avoid damaging the tissue, laser light is dosed as tiny pulses lasting nanoseconds. Tattoo removal, however, often only leads to a bleaching of or damage to the skin and in a num-

→ PHOTO 10.1A

Tattoo removal using a laser with incomplete results because the tattoo (on most of the arm) has only been bleached and erased in appearance, despite the use of own equipment in the form of a Q-switched laser. No attempt was made to remove the blue flower to the right and the tooth/jaw design towards the top of the figure.



→ PHOTO 10.1B

Skin punch biopsies from the same person shown in Photo 10.2A. The biopsy to the left was taken from a red tattoo from laser-treated skin. The biopsy to the right was taken from a red tattoo that has not been laser treated. It can be seen that the laser was not able to bleach or 'remove' red pigment deeper in the corium. In allergic reactions, pigment that remains in the deeper layers of the skin will mean that the reaction will most probably return. The fact that the colour in the outer part of the skin has been bleached does not mean that the pigment has been removed, because photochemical and physical processes may result in the pigment simply losing colour, regardless of whether it still remains in chemically changed or unchanged form. See also Photo 5.2.

ber of cases, the tattoo is not changed noticeably by laser treatment. (Photos 10.1A and 10.1B.)

The light from lasers operates at one specific wavelength – that has one colour. If the wavelength used by laser is absorbed by the pigment particles, there is the possibility of hitting them selectively. To a certain extent, the surrounding tissue will reflect or scatter the light. The rest of the radiation may be absorbed diffusely over a greater volume without heating or permanently damaging the tissue.

An exception from this is melanin in the epidermis. Melanin is the most important natural pigment in the skin and determines its normally brownish colour. Melanin absorbs throughout the entire visible spectrum, and photochemical decomposition also involving pigment cells (melanocytes) is unavoidable in laser treatment. Therefore, the tattoo will often be replaced and marked by a light, that is, depigmented area in the skin. But if a laser is used that operates in the infrared spectral area where the melanin does not absorb, this lightening with irreversible loss of pigment cells can be avoided (2, 3).

Among the lasers that are usable in practice, 510 nm, corresponding to green light, is the shortest available wavelength. Yellow and, in part, red pigments have their most powerful absorptions at lower wavelengths, so it is most often not possible to remove them using laser treatment. In contrast,

black pigments absorb over the entire spectrum, and to the extent that they are comprised of carbon particles, experience is positive regardless of which wavelength is used. It is even possible to use the infrared part of the spectrum and still successfully remove black, blue and green tattoos (4). Thus, black is the easiest pigment to remove.

Physical and chemical processes in the skin during laser treatment

The term selective thermophotolysis is often used to describe the mechanism of action when tattoos are removed with pulsating lasers (2, 5). This means that the particles become so hot as a result of the illumination that they break apart. If, for example, a laser pulse of 10 nanoseconds is used and the laser typically releases 10 J/cm2 per pulse, this corresponds to an effect of 10 million watts/cm2. That is enormous and things only go well because an attempt is made to use ultra-short pulse lengths of the same size as the time it takes for the particles to deliver heat to the surroundings. The maximum effect is achieved if it is possible to dose as much energy as possible to the particle before it starts to heat up the surroundings.

Small particles are faster at delivering the heat than large ones because they have a relatively large surface. Therefore, greater demands are placed on the laser's speed when very small nanoparticles are to be removed, which, for example, dominate in carbon black tattoos (6).

The layer of the pigment particle that is on top receives more light than those in the 'shadow'. Before the pigment particle can distribute the absorbed energy, it therefore explodes as a result of the tension that is created – if it can. Inorganic particles such as iron oxide and titanium white may, however, not fragment, because the chemical bonds between the atoms in the crystal are very strong. Clinically, this results in the practitioner not being able to remove tattoos with iron oxide and titanium oxide at all or incompletely. Instead, a darkening of the pigment may be seen.

Graphite particles (carbon black) in black tattoos are a special case in this connection. The laser treatment is often quite successful. It is possible to see that the black colour disappears. This is an elementary observation that means that the layer-divided graphite structure has been broken down. You can imagine this decomposition taking place gradually. The primary graphite fragments are hit by the laser light again with secondary fragmentation processes as a result. This decomposition continues until the product no longer absorbs visible light. The terminal products must be colourless.

Thus, there is both a chemical and a physical decomposition of the graphite particles. But bleaching does not mean that the material per se has disappeared. The products' identity and their future fate are not known. Quinones could be mentioned as likely products when removing carbon black tattoos.

In the literature on laser treatment, the term 'thermal relaxation time' of the pigment particle, which, to a certain degree, conceals that the time for cooling the particle is determined by the ability of the surroundings to absorb the heat (7). The length of the pulse is a parameter that receives great emphasis in the current literature. But the removal also involves the time between the pulses. It would be expected that the frequency and the number of pulses applied in a treatment pass also gave rise to discussion. However, the Q-switched lasers that are used produce ten pulses per second at the most. Thus, measured on a scale of nanoseconds, there are eternities between the

pulses. The frequency is, therefore, not crucial for the formation of damaging heat in the tissue because the tissue can quickly lead the heat away. The low frequency – together with the extremely short pulse length – is the underlying explanation for why many tattoo pigments can be removed without creating scars.

Physically and chemically it is a chaotic situation when a laser pulse hits a pigment particle. The fragments are in a state of huge excess energy, and there is no doubt that chemical reactions of organic pigments also take place in addition to the possible removal of the generating nanoparticles. This is demonstrated by illuminating 18 organic and inorganic tattoo pigments in an agar gel – that is, under in vitro conditions in which there is no substance removal from the illuminated area (8). Here, nine cases of decolouration of the pigments were observed. Only one of these (black) contained iron, while three contained titanium. Nine other pigments became darker. They all contained either iron or titanium, or both. On this basis, it can be concluded that the inorganic pigments are experimentally photoresistant, while the organic pigments bleach and transform photochemically, probably after fragmenting.

REMOVAL DUE TO COMPLICATIONS

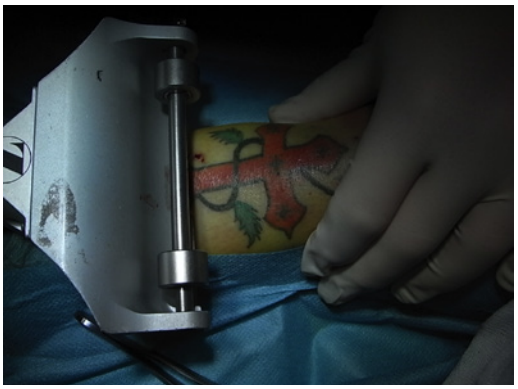
Because complications, including allergic reactions, in tattoos are rare taking the total number of tattooed people into account and with regard to the large number who want to have their tattoos removed because they regret having them, the number of cases in which surgical removal by the healthcare service is actually performed is relatively small. It is a specialised hospital task.

In case of allergy, where the intention is to completely remove the pigment, which is often concentrated in the outer part of the dermis, surgical removal of the tattoo is best and is ideally done by excision surgery, in which the entire tattoo or the affected parts of it are cut out of the full thickness of the skin down to the subcutaneous fat. But this is often not possible due to the size of the area of the tattoo, the skin's binding to the underlying structures or localisation in relation to joints, bodily orifices etc. Often the result is disfiguring and cosmetically unacceptable. There may be a need to transplant skin over the operated area or use special plastic operations. Prior balloon expansion therapy of the skin may be used, but this is a lengthy and extensive procedure.

The Tattoo Clinic of the Department of Dermatology has, together with the Copenhagen Wound Healing Center, both at Bispebjerg University Hospital, introduced 'shave surgery' for the treatment of tattoo reactions (Photos 10.2A and 10.2B) (9). The outer part of the skin is sliced off horizontally using a dermatome until the 'shaving' reaches a level where the corium does not contain any visible pigment (9). This treatment has given good results, both with regard to remedying the patients' subjective symptoms, particularly itching and pain, and with regard to late complications. The treatment has become the treatment of first choice in the surgical treatment of clinical tattoo reactions and has replaced traditional excision surgery to a large extent, as described above. 'Shave surgery' by dermatome may be used in large tattoos and, if technically applicable, over joints because the treatment does not cause significant scar formation or resulting conditions with regard to the skin's mechanical ability to stretch. 'Shaving' often leaves the skin with a degree of pigment deviation and minor scar formation, which allows corrective re-tattooing (cover-up tattooing) with a colour that is tolerated.

→ PHOTO 10.2A

The removal of tattoo reactions using a dermatome, that is, a knife for carrying out tangential cutting or 'planing off' layers of the skin cut-by-cut and based on moving the dermatome parallel to the surface of the skin. The pigment that releases the reaction is removed cut-by-cut with the skin until white corium without pigment appears, which in practice removes 'all' of the tattoo pigment. In contrast to removal using a laser, the method causes no chemical change of the pigment and can be safely used for the treatment of allergic reactions. Different instruments are used, including the Zimmerman pneumatic dermatome (as shown), the Watson hand-held knife and small curved knives, which are normally used to shave biopsies of birthmarks.



→ PHOTO 10.2B

The bottom of the base of the wound after dermatome shaving carried out cut-by-cut until the white pigment-free corium is seen in the entire area. There may be pin-head-sized post-operative bleeding. The wound heals from the base in the course of a few weeks, with the formation of new epidermis from the deeply placed sweat glands. The wound heals with a degree of colour deviation of the skin compared to the natural skin colour, and the operation may leave some scar formation. The alternative, to cut the tattoo completely out as a surgical excision followed by suturing, is most often not technically possible.

Lasers may be used as the treatment of third choice. However, as mentioned above, lasers may cause the formation of photochemical decomposition products that cause allergies and trigger an ongoing allergic reaction, or be damaging to the health for other reasons. In addition, the removal of pigment using lasers is often incomplete, especially in the deeper layers of the skin. Moreover, laser pulses are applied pointwise and thus are unevenly dosed on the surface of the tattoo and in the horizontal level. Thus, in laser treatment, there is inbuilt imprecision regarding the factual dosage of light being applied in both the horizontal and vertical levels. Using four treatment passes at 20-minute intervals (referred to as 'R20' treatment) in a treatment session may, to some degree, average the geometry of the laser dose applied to the treatment field. Laser removal of allergic tattoo reactions is controversial and is being discussed as being contra-indicated for future use after the introduction of 'shave surgery'. But there are types of clinical tattoo complications for with laser treatment is rational. Removal using lasers may be used especially in the treatment of nonallergic reactions in black tattoos, where the changes are less widespread in terms of area, and for small tattoo reactions regardless of colour, with the exception of reactions in white tattoos with titanium oxide as a pigment, because this pigment may become black as a result of laser treatment. Laser treatment may also be used as a supplement to 'shave surgery' in cases where especially deeply placed pigment islands have worked their way up to the surface after healing, and where there otherwise is scattered remaining pigment.

OTHER TATTOO-REMOVAL METHODS

For many years, tattooists have had the practice of simply tattooing water into the tattoo, in attempts to remove pigment from tattoos. The idea is that the skin is opened and the pigment empties to the surface. The method might be useable in cases where the tattooist has put too much pigment into the skin, and where the tattoo is very new, but the effectiveness is dubious with regard to removing a normal tattoo. A method has been introduced to the market in which lactic acid, in a concentration of up to 40% with a pH of approximately 3 is tattooed into the unwanted tattoo in order to cause a strong irritation or necrotising effect on the tissue, with effectively opening the skin to the surface.

High concentrations of lactic acid have been used for years for cosmetic peeling treatment of the surface of the skin. The principle of the treatment for removing tattoos is acid burning of the outer dermis, that is, quite deeply, and there is, therefore, a significant risk of wound healing problems and scar formation, which may be severe.

Metal oxides tattooed into the skin as a mix of zinc oxide and magnesium oxide supplemented with triethanolamine is another mix with a purposefully strong effect. The chemical substances are highly hyperosmotic, alkaline and white-coloured magnesium oxide has been used since olden times as an antiacidicum and as an osmotic laxative, and zinc oxide, zinc white, as a white pigment in paint. The method is caustic depending on dose and application in a tattoo subjected to removal.

None of the methods have been documented scientifically, including with regard to side effects, which may be frequent and serious; and also depend on the practitioner's experience with dosages, which cannot be practiced very precisely.

PERSPECTIVES ON TATTOO REMOVAL

There are no requirements about informing the customer about the possible effectiveness and side effects of tattoo removal. This is in contrast to cosmetic laser treatment, for which the Danish Health and Medicines Authority requires that the practitioner or supervisor of the treatment is a medical specialist in dermatology or plastic surgery, has passed a special course and is registered by the Danish Health and Medicines Authority as a cosmetic laser practitioner. Clinics and equipment must also be inspected. These requirements are not included in the Danish act on tattoos of 2013. Anyone may continue to offer tattoo removal by anybody with any kind of equipment at all, whether or not it is suitable for the purpose and with no informed consent by the customer.

Surgical and dermatological treatment of clinical complications in connection with tattoos is a new medical professional sub-specialty. The treatment should be carried out by departments or centres that have all relevant treatment possibilities and which, through a sufficient flow of patients, have the possibility to offer optimal diagnostics and treatment, which comply with the international developments in the area, and which may provide the basis for manufacturing control and scientific identification of the advantages and disadvantages of the different methods for removing tattoos.

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11

‘SEAMLESS PREVENTION’ - A NEW PREVENTION STRATEGY

THE PREVENTION OF DAMAGE CAUSED BY TATTOOS INVOLVES MUCH MORE THAN THE INK. THE ACTUAL REQUIREMENTS MUST BECOME KNOWN AND BE ACCOMMODATED. THERE IS A BROAD RANGE OF POSSIBILITIES. THIS CHAPTER DESCRIBES A NEW STRATEGY FOR PREVENTING RISKS AND COMPLICATIONS CAUSED BY TATTOOS.

SUMMARY

Tattoos are widespread, have a long historical tradition and are anchored in popular cultural ownership, which makes it difficult to prevent damage to the health through legislation, whether it is national or based in the EU.

In 2003 and 2008, through resolutions on the chemical and microbial safety of tattoo ink, the Council of Europe has attempted to improve ink safety, but the resolutions, which were narrowly directed towards control of ink for tattoos, have been met with criticism about the contents, and are only followed in some European countries in modified form. In 2014 the EU decided to prepare rules about the composition of ink and rules for tattoo hygiene, which are to apply throughout Europe. But this cannot stand on its own and there is, to a high degree, the need for a pragmatic approach to prevention both nationally and in a larger context. Due to lack of knowledge, prevention of damage to the health cannot be easily based on documented, rational means, which are known, thoroughly described and validated in the medical world or based on the literature on toxicology. In its initiative, the EU has not taken steps towards developing new and systematic knowledge about tattoos.
There are important areas in which practical prevention of complications in connection with tattoos may be implemented. Therefore, this report emphasises the importance of an integrated prevention strategy with a timeline for interventions regarding the entire course of events related to tattoos, focusing on the tattoo customer, the decision process and the tattooist. The strategy, which is called integrated prevention or 'seamless prevention', comprises a number of different conditions such as information to, and the education and certification of tattooists; the certification of businesses; practical conditions, including hygiene, informed consent, customer registration, traceability, filing of complaints/compensation; a central register of complications in connection with tattoos and the possibilities for society to take action effectively when special health hazards are identified, all combined in a broad, integrated and balanced strategy.

There is also a need to bolster the healthcare industry's treatment of complications and research on complications, as well as gathering and

coordinating preventive actions under a single professionally competent authority. The integrated strategy is centred on those who are the primary decision makers and who must change their behaviour: customers and tattooists.

INTRODUCTION

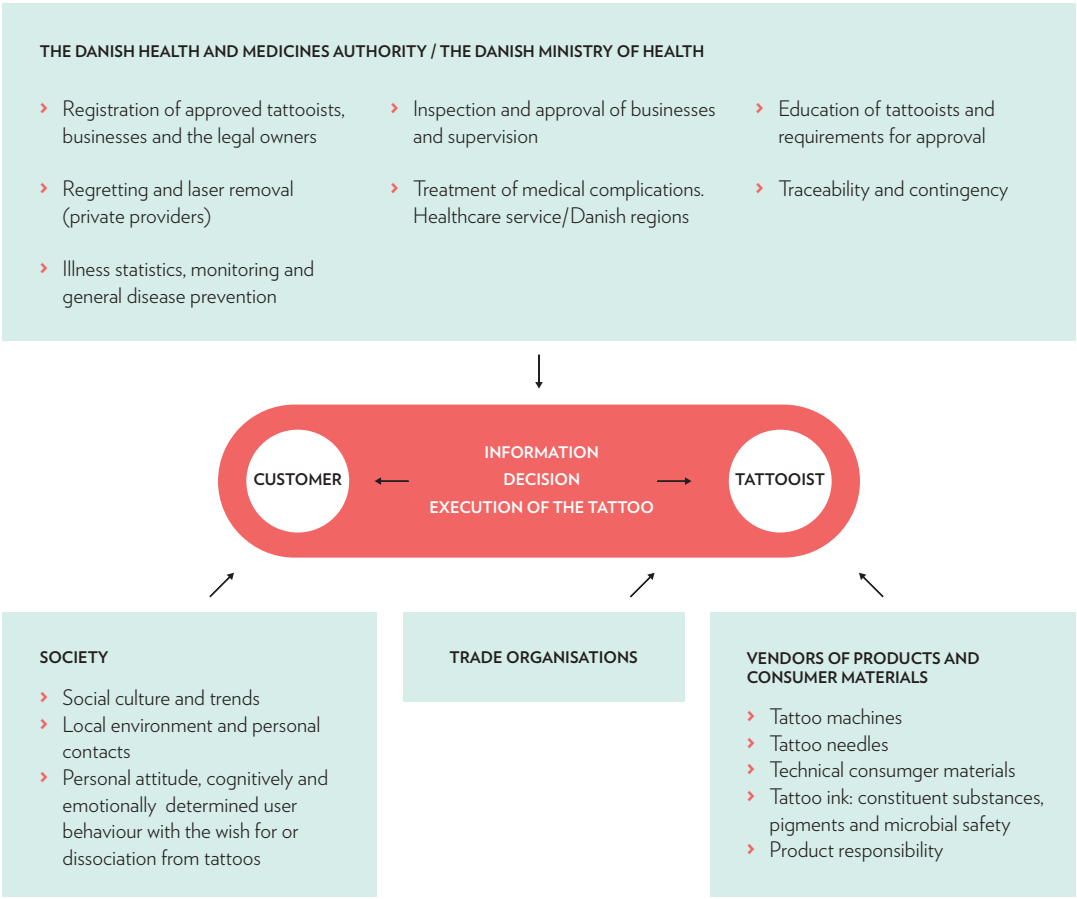
The means employed to prevent health damage due to tattoos, regardless of whether they are generally easy to understand or technical in nature and difficult to understand, must confront reality; in the end it is a parliament of tattooed people, tattooists and ink manufactures that preventive measures must meet, and which decides which means are to be used and can effectively lead to reducing damage. Seen in this perspective, it is necessary for the regulating authorities to approach the actual conditions and the reality that is expressed or that is factually documented with humility.

Because their roots go far back in history, and due to their immense prevalence around the world, the lack of tradition for regulation, as well as their often confrontational expression with regard to societal norms, tattoos are extremely difficult for political systems and authorities to deal with by introducing requirements and making changes. Tattoos are deeply anchored in popular ownership and a community around the world based on positive motivation among tattooed people, which can be difficult for others to understand and which is impossible to formulate simply (1). It should not be underestimated how an individual signature on the skin in the form of a tattoo, for many people creates happiness and self-worth in societal surroundings that exert strong norm pressure. It is characteristic that many tattooed people feel that they have a fundamental right to make decisions about their own skin. At the heart of the concept of the moral rights of the individual lies the idea that each individual has the right to – or owns – himself or herself, and that individuals may do

"If one is truly to succeed in leading a person to a specific place, one must first and foremost take care to find him where he is and begin there. This is the secret in the entire art of helping. Anyone who cannot do this is himself under a delusion if he thinks he is able to help someone else. In order truly to help someone else, I must understand more than he – but certainly first and foremost understand what he understands."

Søren Kierkegaard (Danish philosopher, 1813-1855)

→ FIGURE 11.1
Overview of major role players.



whatever they want to with themselves, as long as they do not behave in a manner that violates the moral rights of others. Thus, it is a legitimate right to be able to be tattooed.

Tattooists include professionals who tattoo in established parlours and amateurs who tattoo privately etc. Even professional tattooists are difficult to reach. Studies in Australia, where rules for tattooists regarding prevention of infections have been introduced, have shown that the guidelines were not followed by professional tattooists, and even when charged with violation of the rules, no significant improvement was seen (2, 3). If you make demands on tattooists that are neither realistic nor acceptable in content and form, you risk that they either have no effect or that tattooing will move from the professionals to the amateurs, who frequently tattoo out of sight.

To be rational, prevention must be clearly addressed to the potential customers, because it is the customers who make the final decision to have their skin be tattooed. Focusing on the customer

and on the customer's meeting with the tattooist has been relatively neglected and is, perhaps, more important than focusing on the tattooist or the tattoo ink used. The key target group and the focal point for the prevention of health damage by tattoos are the customer and the tattooist, and their meeting in a customer-tattooist relationship, which has its own kind of intimacy (4). The strong focus on ink control has taken attention away from other important prevention areas. In a study of possible risks and the customer's decision prior to the procedure, piercing, which has similarities to tattooing, was analysed based on a decision model, 'health belief model', which has also been used for tattoos (5, 6). Both the tattooed and pierced people have a changed risk consciousness, and they dare to take greater risks than others do. With regard to the prevention and treatment of complications, the study points out the necessity for proactive education of potential customers and relevant people in the healthcare system, just as the necessity for an improved systematic registration of complications is identified. The studies lift the customer's decision-making with the tattooists

The main topics for the regulation of tattoos.

- Skin infections in connection with tattoos, which, for example, may result in bacteria in the blood, sepsis and death.
- Virus infections in the form of hepatitis B and C may be spread by tattooing and cause hepatitis.
- Noninfectious complications include allergic reactions, especially in red colours with organic pigments of the azo colorant type are most frequent. Blue and green pigments may also result in allergy.
- In black tattoos, nodosities with papules and nodules related to aggregates of carbon pigment may be seen. Reactions are non-allergic and due to pigment agglomeration.
- Tattoos very often cause mild discomfort (itching and swelling) in tattooed people, often provoked by sunlight.
- Tattoos may cause serious psychosocial problems and invalidate the person.
- However an increased risk of skin cancer or cancer in the regional lymph nodes has not been documented. Systemic complications of tattooing remain a potential risk.
- 'Removal' using lasers is often not possible, expensive and may result in complications in the form of scars, pigment disturbances and, possibly, acute allergic events and flare-up of allergy when red tattoos with allergic reactions are treated. Dermatome shaving is introduced as the first line treatment.

to a level of decisive importance in the prevention of complications.

From a medical point of view, due to the significant deficit of research, prevention of damage to the health from tattoos cannot be easily based on documented, rational means, which are known, thoroughly described and validated in the medical world or based on the literature on toxicology. But tattoos may be regarded as the largest open, long-term experiment of chemical substances and particles being injected in human skin ever to take place, and the available knowledge from medical literature and empiric knowledge from the clinic will thus be the most important tools in the development of realistic preventive strategies based on the simple and sound observation that prevention must primarily prevent real events that are of significant importance to health; that is, specific conditions involved in tattooing, which actually make the tattooed person ill in a medical sense.

Among the potential risks, cancer in inner organs and reproduction toxic damage is relevant based on register data, but despite the large and noncritical use of tattoos, also among fertile and pregnant women, medical literature does not provide any examples of such damage being related to tattoos.

Thus, the goal of prevention of health damage from tattoos is to reduce or eliminate the known clinical complications in connection with tattooing and the potential risks (see the fact box) to the extent that it is relevant and possible in practice. The safest and the theoretically ultimate goal of prevention is that no one gets tattoos, because tattoos always introduce a risk that normal skin and the entire organism could do without.

THE DEVELOPMENT OF A PREVENTION STRATEGY

The development of a general strategy for the prevention of complications in connection with tattooing is necessary and requires preparation, in which the objectives are defined and analysed with regard to whether they are relevant, rational and feasible based on current knowledge and the means that can be used, including taking financial resources into consideration. The possibilities for the strategy, after having been implemented, to achieve the goals that are set may be critically assessed, for example, by using a SWOT analysis (strengths, weaknesses, opportunities, threats), a method that is often used for assessing the potential of actions in business and economics. The assessment may include whether an effective control function should and can be established, that is, proactive 'policing activities' to ensure that the regulations are complied with. It is a decisive weakness of a strategy if it can only work due to a large, finely close-meshed control system and is not supported by an element of volunteerism.

The strategy may be developed based on a top-down or bottom-up principle, or a combination of the two (7). The Council of Europe's resolution (8) is an example of a top-down based regulation that is otherwise completely devoid of any defined supervision or control function. The resolution is intended to achieve zero risks based on a 'precautionary principle', in which the European nation states, without any scientific documentation and only based on in vitro circumstantial evidence are encouraged to implement the resolution's requirements, which are practically and financially burdensome. In practice, the 'precautionary principle', which is, in fact, based on belief, strongly influenced by opinions, bureaucratic cultures, political assessments and interests, which can easily

antagonise those who are to be regulated and bear the burden of being regulated: tattoo customers and the tattoo industry. In practice, the latter may be in a dominating position of strength and in reality completely determine the effectiveness of the regulation. Based on a 'precautionary principle' that counts on zero risks, from a medical point of view it is rational to completely prohibit tattooing and piercing, and it is also medically rational to completely prohibit alcohol consumption and tobacco smoking.

In the United States, the responsibility for regulating tattoos is the responsibility of the FDA, which is an example of a combined principle, a well-developed bottom-up–element and active societal monitoring, in which the events that occur spontaneously are reported, subjected to a pragmatic risk assessment as the basis for concrete problem solving and, possibly, general intervention. The focal point is existing clinical cases of health damage caused by tattooing and not theoretical risks based on toxicological data, on the basis of non-human observations. The pragmatic background is the political reality that tattoos cannot be totally prohibited, which means that a zero-risk scenario is acknowledged as being unachievable in reality.

Focused prevention

As shown in the figure above, there are a number of independent areas and players, towards which a focused preventive action may be directed. The important areas also include regulation of the production and sale of tattoo ink. The responsibility for product safety is, as for other types of products, that of the manufacturers, and it cannot be placed on the tattooists, who do not have the required information and prerequisites. Another important area is the regulation of tattoo practice, especially with regard to hygiene control. A very important area is educating the customers so that they are informed enough to actively make qualified decisions about the risks prior to having a tattoo made.

In the tattoo ink product market there are a number of inks and ink series with claims such as 'complies with the requirements of the Council of Europe', 'complies with European Standards', 'allergy safe', etc. without the providers being able to provide acceptable documentation regarding the claims. Based on the Council of Europe's resolution, a wealth of incorrect and misleading claims has been made against which the authorities have not taken action (9). In Europe, it is still the case that a broad range of ink is available that is produced outside of Europe, and thus is not covered by national or general rules, or recommendations intended for Europe, during the manufacturing stage.

With regard to the pigments' particulate structure, and because they are poorly soluble in organic media, a number of technical analysis problems have been identified in connection with the determination of threshold values for chemical substances (especially polyaromatic amines [PAHs], primary aromatic amines [PAAs] and metals in tattoo ink, which cause uncertainty regarding the reliability of analyses, stated threshold values and ranking of chemical constituent substances in tattoo ink with regard to dangerousness based on their concentration in ink products (10). As mentioned, the Council of Europe's resolution does not indicate analysis methods other than the analysis of azo colorants using a method for dispersing textile pigments, which have other solubility conditions.

Although the Council of Europe's resolution will get a high score in a SWOT analysis for opportunity, because the lack of rules and the size of the problem is a special opportunity for the accept-

ance of the resolution, the resolution is in a situation where it is seriously challenged as a suitable element in the coming EU regulation of ink. The Danish Environmental Protection Agency's guidelines on tattoo ink (11) confront the same challenge with regard to the suitability of the content, and the guidelines conflict with the agency's own expert report. The guidelines are even controversial with regard to legality in the EU because the earlier notification of the Danish statutory order with similar content was rejected by the EU.

As mentioned, other important opportunities for focused prevention have been obscured by the ink case, which may be said to have distorted the perception of which preventive methods are realistically available. Other significant opportunities will be discussed below as elements in an integrated strategy. Each of the elements may, on their own, be brought forward and used in a focused preventive activity.

AN INTEGRATED PREVENTION STRATEGY

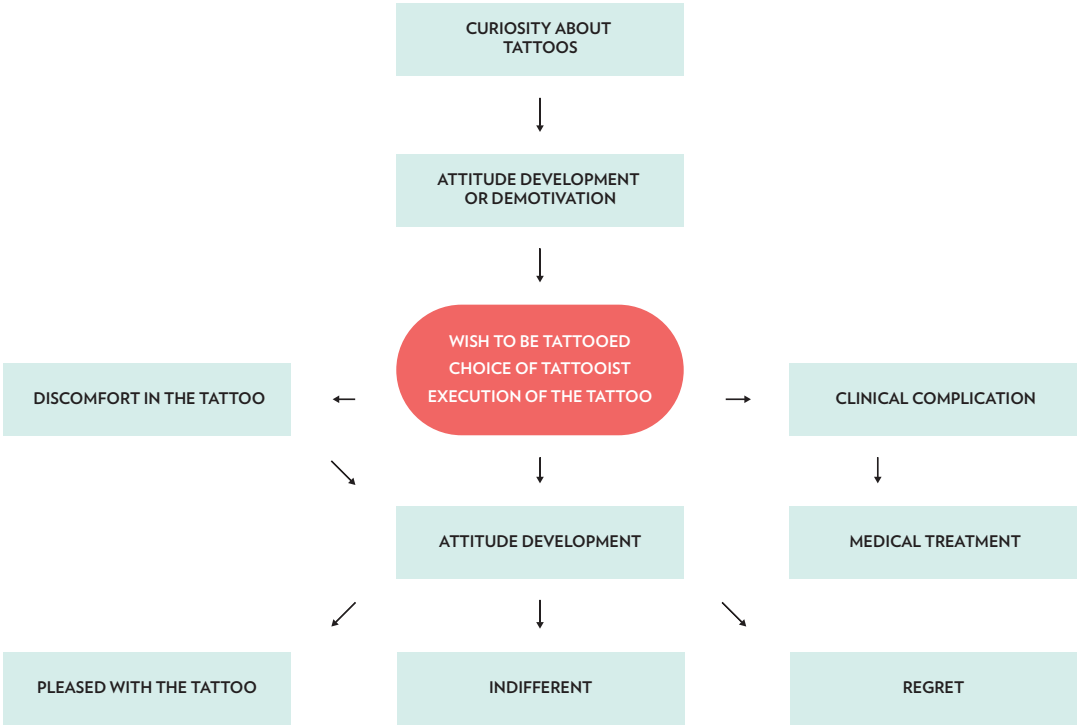
In the healthcare system, where there is a large and facetted disease panorama and many types of treatment, treatment institutions, systems and practitioners, increased attention is being given to avoiding the interruption of patients' continuous progress through the system, diagnosis and treatment due to sector transfers and gaps due to lack of service in the individual critical areas. This has given rise to the development of a strategy called seamless care or integrated care, which binds the areas together, and coordinates and adjusts treatments and the changing needs of the patients, as well as the flow in the systems with regard to a time axis, which fully describes the disease and course of treatment (12). Because the prevention of complications in connection with tattoos involves a number of players from different sectors, which have major differences, it is of interest to introduce a strategy for 'seamless prevention', which is especially applicable to the prevention of complications in connection with tattoos through a combined and adjusted effort by the different players and sectors during a synergistic cascade of events leading to safer tattoos.

The idea behind the 'seamless prevention' strategy is that the tattooed person, from having had normal, healthy skin to having skin with complications caused by the tattoo or other health damages due to the tattoo, undergoes a process over time, where the person meets different players in specific sequences. Each of these players contributes to increasing or reducing the person's risk of developing complications. The players may be involved in a strategy designed to reduce the risk. The focal point of the strategy is the interaction between the customer and the tattooist, leading to the customer's final decision about being tattooed (see Figure 11.2). The decision results in the further course of events at a more technical level, connected with the choice of ink, hygiene etc.

Popular culture and tattoo trends continue to be active and to glamorise tattoos by exposure through advertisements, celebrities and athletes. But during the last three to four years there have been a number of TV and radio programmes, as well as articles in magazines about complications in connection with tattoos, and the public debate is currently more balanced than previously. It is particularly important that prevention efforts get into contact young people. It is also important to contact those who run a special risk of complications from tattoos for medical reasons – that is, the risk groups.

→ FIGURE 11.2

Schematic overview of the 'seamless prevention' strategy with the timing, the current roles of those involved, the legality and the conditions of the authorities. The many activities and factors influencing tattoo safety need to be integrated in a balanced strategy without gaps of preventive activity if prevention shall become effective in reducing disease and social complication of tattooing.



In October 2013, the Tattoo Clinic at Bispebjerg University Hospital launched the campaign 'Tatovering, tænk før du tør' [Tattoos - Know your risk] (www.bispebjerghospital.dk/topmenu/Nyt+og+Presse/tatovering) focused on decision making before having a tattoo made. (An (English translation provided by the European Society of Tattoo and Pigment Research, www.ESTPresearch.org.) The campaign is an example of an information campaign that provides factual information about the risk areas that a person is exposed to in connection with tattooing, while respecting the person's right and ability to make qualified choices. In November 2013, the Danish Environmental Protection Agency and the Danish Health and Medicines Authority launched the campaign 'Think before you ink' (www.thinkbeforeyouink.dk) using a foreign model and design that might especially 'speak' to young people. Also this campaign provides advice about tattoos. Both campaigns can be found using links to the Council on Health and Disease Prevention's website: www.vidensraad.dk

The person's close social space and personal relationships are of great significance for individual motivation, which leads to the person's decision about getting a tattoo. At the core of prevent-

ing damage caused by tattoos is being able to influence the person's actual decision about being tattooed and motivating or building up towards a 'no thanks'. If the person wants to be tattooed, the core purpose is to motivate a decision that involves the least risk, that is, tattoos that are small in area, do not contain a red colour etc., which may be explained in more detail in the campaigns mentioned. It is significant whether family and acquaintances have or, perhaps, through campaigns have acquired the attitude that they are against tattoos.

As mentioned, the media depictions of tattoos are currently more nuanced, and there is more room for critical arguments than previously. But people live in subcultures, which have their own norms of opposition to or active contributions to the culture of society in general. There will continue to be subcultures that campaigns and - the now more nuanced - media depictions will be hard to reach. In the prevention of complications and damage caused by tattoos, it is important to use arguments professionally, both in the public media and at an individual level, maintaining a dialogue with those who are considering getting a tattoo, and motivating an understanding that tattoos always introduce risks that do not exist in non-tattooed skin.

In the commercial sciences, there is extensive literature on 'business to customer relationships', drivers behind buying behaviour and the emotional and cognitive factors that determine a decision to buy; this knowledge could probably contribute to the development of more effective methods for influencing people in the direction of not buying a tattoo.

Tattoo businesses have very different ownerships, ranging from active tattooists to purely commercial owners and bikers, who may own a number of businesses. There are a number of reasons why there is a need to systematically register the businesses, their owners and those who are legally responsible.

The business's facilities are not subject to any kind of requirements and in Denmark there is no inspection when a business is opened or as part of ongoing control.

A qualified customer decision in the form of informed consent in writing or verbally is not a requirement for tattoos. Standard information should be prepared that the tattooist is obligated to give to the customer before tattooing, and the customer should sign a receipt for having received the information.

There is no requirement that the customer must be competent enough to make a decision either. It is legal to tattoo an inebriated person who is under the influence of alcohol or drugs, or a person who is mentally ill.

The tattooist's educational qualifications and professional ethics are a challenge.
Today there are no formal educational requirements for tattooists, and neither is there any official industry-determined education and guild authorisation, although a kind of apprenticeship is practiced by some tattoo businesses. An educational programme should have components such as training in the art and craftsmanship of tattooing, a systematic introduction to machines, needles and ink, and ensuring that they are of the best possible quality, as well as maintenance and theoretical and practical introduction to hygiene and prevention of infections, and education about non-infectious complications. In addition to this, there should be education on customer information, contact with customers and tattoo aftercare, both when the

results of the process were normal and when they were abnormal.

The industry has not formulated a set of ethical norms and ethical tattooing should also be part of a tattooist's education. Tattooist's must be very familiar with the legal requirements and be prepared to comply with them. Supplementary education is also a relevant requirement.

The Danish tattoo act of 1 May 2013 made it possible for the industry itself, through approved industry associations, to ensure education and qualifications, but despite this, the law allows everyone, regardless of their qualifications, to practice tattooing professionally or as an amateur. The Danish tattoo guild [Dansk Tatovør Laug] and other players in the industry assessed this model as being too difficult or impossible for the associations to carry out, and that it cannot be used; and it has pointed out that the Danish Health and Medicines Authority must be responsible for the education and authorisation of tattooists according to rules that must be the same for everyone.

A centrally located national health authority is needed to be responsible for educating tattooists in consultation with the industry and to make requirements for the composition and duration of the educational programme, through issuing course certificates and by maintaining a central register of the tattooists who have completed the educational programme and can be approved to carry out tattoos professionally.

Hygienic tattooing and procedures for ensuring that this is prepared as a set of rules that all tattoo businesses must follow. If a tattooist has a contagious disease, especially hepatitis B or C, or HIV, it is not advisable that he or she carries out tattoos. Neither is it advisable if the tattooist has resistant staphylococci.

It has become normal practice that professional tattooists shield their equipment, use disposable gloves and clean the skin with spirits. It is normal practice that they put bandages on the freshly made tattoo and give advice about skin care during the healing process in the weeks that follow. This helps to reduce the risk of bacterial and viral infections. But is not a formal requirement for tattooists to do so. Many countries have requirements regarding hygienic furnishing of tattoo businesses and the businesses' procedures. In some countries they are checked by inspectors. But there are no such requirements in Denmark. In Sweden, the tattooists themselves have adopted quality requirements and the authorities are responsible for the registration and inspection of the businesses (13).

As mentioned previously (see Chapter 9), through the German Institute for Standardization [Deutsches Institut für Normung] (DIN) in Germany, the EU has started to prepare a joint European standard for hygienic tattooing. The worldwide international standardisation institution, the International Shopfitting Organisation (ISO) has not taken initiatives for the standardisation of tattooing, tattoo ink, tattoo needles or machines, even though this is within the ISO's area and even though the problems should ideally have a global solution.

Individual documentation of the finished tattoo with traceability requires person-related documentation of what the tattooist provides to the customer with reliable registration of the customer's identity and that specifies the details about the ink used. Information about the ink used and the identity of the tattooist and the business should be provided to the customer to ensure traceability

if an ink turns out to be dangerous to use and the danger of the ink was not known in advance. Traceability is of crucial importance for society to be able to limit damage that is systematic, extensive and dangerous in a medical sense.

Ensuring the quality of colours and tattoo ink is a problem which, as mentioned, has not been solved by the Council of Europe's resolution (8), and which can only be solved by developing new European or international requirements for manufacturers and dealers. As mentioned in Chapter 9, the EU has delegated the creation of a joint European standard for ink that is used for tattoos. Quality assurance of production sites, raw materials and the finished ink products is of key importance. The task will be extremely difficult to carry out because most of the ink that is used comes from outside the EU. Ensuring the sterility of the products alone is a major challenge. But it is a difficult or impossible task to create requirements that are scientifically acceptable and valid with regard to the contents of ink. Today, the manufacturers have no practical possibility to comply to the many and diverse requirements in different European countries, and for this reason, geographic harmonisation of rules has the possibility of being a major advance.

Tattoo needles, machines and consumer items, which may cause the spreading of bacteria and virus infections are not covered by any kind of requirements. There is no assurance that needles are sterile or that they do not release metals such as nickel and chromium. Tattoo coil-winding machines that are commonly used can, for technical reasons, neither be sterilised nor cleaned with spirits effectively. Encapsulated motor-driven machines have been developed that can be disinfected. This type of machine has been used for a number of years by cosmetic tattooists. The encapsulated machines are delivered with integrated needles and handpieces that can be sterilised.

Tattoo aftercare can be standardised and the industry can, in cooperation with the Danish Health and Medicines Authority, formulate a recommendation that tattooists and customers can follow in order to prevent the immediate complications that may arise, especially bacterial infections.

The abnormal process after tattooing, in which the customer asks for the advice of the tattooist, the quality of the advice can be ensured better in cooperation with the Danish Health and Medicines Authority by preparing guidelines that describe the danger signals and situations in which the customer should be referred to a doctor for examination and treatment.

Medical complications and unintended events are important to register in a central national register in parallel with society's registration and monitoring of health risks in a large number of other areas, such as industrial injuries, infectious diseases, congenital deformities and cancer diseases. Such a register may produce objective information as the basis for qualified intervention if a specific injury from tattooing, including damage related to an ink type, is identified. In a Danish context, a central register for tattoo damage would, naturally, be the responsibility of the Danish Health and Medicines Authority. The EU has established a warning system (RAPEX), which covers tattoo ink and any type of consumer product. This system was primarily developed for communication between the authorities themselves about any kind of illegal consumer product and is not suitable for a narrow medical purpose such as registering health damage caused by tattoos. It is not a clinical database.

The treatment of complications caused by tattoos by the healthcare system, both infectious and chronic complications, has not been addressed and there is no strategy. Diagnosis and treatment take place based on varying local arrangements. Life-threatening infections, such as sepsis, are a medical matter to be handled by hospitals, and chronic complications are a dermatological task in cooperation with other specialties, including surgery. Because complications, seen in light of the many tattoos that are carried out, are not common, a degree of centralisation for diagnosing and treatment is required. The disease panorama of tattoo complications is very broad, and a large number of mechanisms and problems are part of the picture. A high degree of centralisation is required to gain experience and for research. The Tattoo Clinic at Bispebjerg University Hospital is an example of this type of special function. The clinic will play the role of an expert in the coming tattoo regulations in Europe under the auspices of the EU.

A complaints process, complaints board and compensation are not organised, and in Denmark they are a matter of civil law and the tattooed person must bear the burden of taking legal action. In practice, the tattooed person is prevented from taking legal action based on an injury caused by tattoo ink, because ink is manufactured abroad and the manufacturers often make reservations regarding personal injury, and their identity is often not known. Because it is often not clear who the owner of a tattoo business is, and who is legally responsible, and because there is no clarification of the owner's and the practicing tattooist's responsibility in relation to each other, it may not be possible for the injured person to find out who the legal adversary is. Also, a number of tattoo businesses employ foreign tattooists, who are often recruited from Eastern Europe or who are travelling tattooists, who have celebrity status and tattoo in a number of different places. The Danish Health and Medicines Authority has, in its statutory order (14) on the basis of a revision of the Danish tattoo act adopted on 1 May 2013 (15) has required the tattoo industry itself to handle complaints, regardless of whether a tattoo business or a tattooist will always be a party in a complaint. There is no requirement for the participation of a lawyer, even though the legal conditions are complicated. Therefore, impartiality, legal competence and objectivity when processing complaints and making decisions cannot be ensured. Also, an industry association cannot impose penalties or fines. The injured person is in a very weak legal situation, both in cases regarding damage caused by tattoos and in cases regarding damage caused by laser treatment etc., because there is no legislation of any significance that protects the customer.

Society's supervisory function regarding compliance with the law and rules on tattoos, that is, the 'policing activities' is particularly insufficient. Illegal tattooing of under-age people and tattoos on the face, neck and hands takes place frequently in Denmark without the intervention of the police and courts. The situation is an expression of the low priority it is given by the police and the political system. The situation also illustrates the strength of the popular ownership in comparison with the reality that society in general lacks the will make a concrete effort to reduce the risks of tattoos.

Society's possibility to intervene in an especially dangerous or life-threatening situation caused by tattoos has, as a prerequisite analysis of systematic data, traceability of those who are especially exposed and the involvement of the relevant players followed by rational intervention. The Danish Health and Medicines Authority is positioned to play a key role. Bacteria such as resistant staphylococci (methicillin-resistant Staphylococcus aureus

(MRSA)), clostridia, extended-spectrum beta-lactamases (ESBL)-resistant bacteria, Verotoxin-producing (VTC) Escherichia coli bacteria and Streptococcus pyogenes (meat-eating bacteria) in bulk-contaminated ink, in tattoo parlours or in certain cities may comprise such a special risk situation. Chemicals that are exceptionally dangerous, for example introduced to the country as 'China ink' comprise a potentially special risk. Tattoos have a number of very open risk windows.

Cosmetic tattoos/permanent make-up (PMU) is illegal because this involves tattooing the face, but in practice this systematic violation of the law is accepted. The potential risks are, in principle, the same as for tattoos in general, but more critical because tattooing is done on the face close to the eyes and bodily orifices. Complications in this region may be deforming and socially disabling. So far, the area has not been of any significant political interest nor has any actual position been taken.

Medical tattooing carried out routinely at Danish hospitals takes place in a paradoxical situation. Doctors, healthcare professionals and tattooists inject tattoo ink, which is not registered as medicine, registered as an adjuvant, CE-labelled or proven to be sterile. This falls outside of the framework of the accreditation policy that exists in Danish and European hospitals. In some cases medical tattoos are indispensable. Future regulation of ink for tattoos prepared by the EU may give medical tattoos special treatment and provide a special solution.

Removal of tattoos using lasers, intense pulsed light (IPL) and other methods, such as acid burning by injecting lactose acid in the skin in Denmark is currently without any requirements or control by the authorities. The Danish Health and Medicines Authority has, however, recently included tattoo removal using lasers in a revision of the 'diathermy statutory order' and proposed that in the future, doctors must carry out or supervise tattoo removal using lasers. All of the methods involve tissue damage and the risk of scars, pigment disorders and infection, and there have been a number of unqualified and uncritical uses of the methods, including the use of unsuitable equipment or methods. This is in contrast to the Danish Health and Medicines Authority's strict regulation of cosmetic laser treatment and cosmetic surgery, which is reserved for medical specialists with special training and who are authorised to do so by the Danish Health and Medicines Authority.

THE ORGANISATION OF THE PREVENTION ACTIVITIES

In light of the extensive prevalence of tattoos, and therefore the increasing frequency of complications, many countries have taken initiatives regarding the prevention and regulation of conditions concerning tattooing. However, the initiatives in the various European countries are quite different, both in terms of content and with regard to the means employed.

It is a common characteristic that coordinated strategies are not developed in the countries and that the focus is on areas where an already established competent authority traditionally has a more or less relevant area of interest and thus is given the task for practical reasons. Areas such as the registration of tattooists, hygiene rules for tattoo ink, possibly formulated as a local adaptation of the Council of Europe's resolution, have come into existence and created a situation with confusing European diversity based on the resolution's actual difficulties of being implemented, because the level of ambition and the possibility to introduce the resolution in the individual countries conflict. As mentioned, on this basis and due to the request

from the countries in 2014, the EU has decided to take up the tattoo question and prepare a future regulation of tattoo ink, regulated as a consumer product under the Health and Consumer Protection Directorate General (DG SANCO) and not as a chemical substance under the European Parliament and the Council according to the European Union's regulation (EC) no. 1272/2008 (REACH), just as the EU has started a project on hygiene control. The EU initiatives cause the member states to adopt a wait-and-see attitude, which will mean that new national rules, such as those of the Danish Environmental Protection Agency's guidelines on tattoo ink (11) will not have any practical significance.

Because the tattoo area is very complex, with important international aspects and locally determined national aspects and interests, a prerequisite for the most effective strategy is that international, that is European, preventive activities take place at the same time as national activities in the many areas in which a European regulation has not been planned or will be out of the question due to national differences.

As mentioned, in the EU, the control of tattoos has been characterised by which established institutions were available in the country in question, which has taken place at the expense of a comprehensive view that is rational and integrated. In Denmark there has been a discussion between the Ministry of Justice, the Danish Ministry of Health and the Danish Ministry of the Environment about which authority has the main responsibility for regulating tattoos. The Danish Health and Medicines Authority under the Danish Ministry of Health is the logical medically competent player in the prevention of health damage due to tattoos, just as the Danish Health and Medicines Authority, by virtue of its knowledge about the area of medicines, has knowledge about the safety assessments of chemical substances and particulates injected into people, as if they were medicine. The Danish Health and Medicines Authority also has competences regarding infections and infectious diseases, and will thus be the relevant competent authority with regard to microbial contamination of tattoo ink.

PROPOSALS FOR POSSIBLE ACTIVITIES

One of the purposes of this report is to qualify and promote the political decision-making process with regard to the problems that are described in this chapter and in overview form in Appendix 1. With regard to the prevention of infections in connection with tattoos, this report concludes that this area is sufficiently clarified for rationally based political decisions to be made with regard to limiting the risk.

There is an extremely large knowledge deficit with regard to constituent substances in tattoo ink and their precise significance for the health of tattooed people. The large lack of knowledge means that there may be doubts about the extent to which tattoo ink can be regulated precisely at all, and on a rational basis, regardless of the fact that it is clearly recognised that the ink must not contain unlimited amounts of any given ingredient. This report points out that control of tattoo ink is, for a number of reasons, a European and international matter, and that isolated national regulation has little or no possibility to be of significance. The EU has started a process in order to establish joint rules for controlling tattoo ink in Europe in a couple of years (see Chapter 5).

For political reasons in Denmark and Europe as a whole, decisions are limited to areas where there is

an urgent need and a practical possibility to affect the situation and where there is a scientific basis to make decisions that can result in preventive effects, the decisions are limited to the following topics:

- Establishing a programme for efficient registration of tattoo businesses and tattooists, clarifying the legal framework for businesses.
- Establishing a programme for quality assurance of tattoo businesses when they are founded and that carries out ongoing control under the supervision of a public authority.
- Requirements for the education and certification of tattooists as a prerequisite to be able to practice the profession.
- Certification by a competent healthcare authority.
- Establishing a complaints process and ensuring that the legal status of tattoo customers is satisfactory in case the tattoo is carried out incorrectly and/or has caused health damage.
- A requirement for the consent of the tattoo customer before the tattoo is carried out.
- A requirement for the tattooist regarding recording the tattoo with regard to the individual customer, including a requirement for precise registration of the tattoo ink used, as well as written information for the customer about this.
- The creation of a national register and, ideally, a European register of complications from tattoos with ongoing monitoring of development patterns and with the possibility for active intervention (an emergency preparedness function).
- The creation of a national and, ideally, a European product register of tattoo ink that contains the manufacturers' specifications of the constituent substances and with a requirement that only registered ink may be used legally.
- Ensure a qualified offer for specialised medical treatment in cases where complications occur.
- Carrying out campaigns and general prevention information activities directed towards the population.
- Regulating who may 'remove' tattoos in case of regret, with a special focus on the practitioner, the method and the equipment being suitable for the task, and that they comply with good and recognised professional standards.
- The preparation of a total, integrated strategy for regulative and preventive activities in order to increase tattoo safety.
- Clarify which authority is the authority with overall responsibility, which can ensure coordinated and adapted preventive activities, and which has healthcare competence.
- The development of intensified research on tattoos and tattoo damage in order to make up for the extremely large knowledge deficit in the area of tattoos, culture and health.

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12

KNOWLEDGE DEFICIT

PREVENTION OF COMPLICATIONS IN CONNECTION WITH TATTOOS IS MADE DIFFICULT DUE TO THE LIMITED KNOWLEDGE ABOUT THE AREA. AN ACTIVE PREVENTION STRATEGY REQUIRES NEW EMPIRICAL KNOWLEDGE. A BRIEF OUTLINE OF THE RESEARCH PERSPECTIVES IS PROVIDED.

SUMMARY

Our knowledge about the interaction between tattoos and culture is very limited, despite the fact that a large proportion of the population today has tattoos. Therefore, there is a need for systematic knowledge gathering about tattoos, culture and society, including knowledge about which campaigns and interventions involve and reach the target group.

The tattooing process with the injection of tattoo ink in the skin involves a number of known risks, especially the risk of introducing infections. More knowledge is needed about:
The different elements of the tattoo process (tattooist, equipment, ink, risk to customers etc.)
The precise risk of injury or complications
The chemical and physical composition of ink for tattoos and the industrial manufacturing values for potentially hazardous ingredients

There is a need to develop new in vitro and in vivo models, as well as animal models, which can assess the health consequences of tattoos in the short run and in the long run.

The clinical and epidemiological knowledge about tattoos, discomfort and medical complications is characterised by casuistic information and minor clinical materials, and there is a lack of major, controlled studies and epidemiological studies that describe the incidence and prevalence of discomfort and complications.

Nationwide or European registers for reporting damage and clinical complications from tattoos would be able to contribute to having and overview of both the medical and cultural conditions regarding tattoos. Such a register would also contribute to an emergency preparedness programme, so that new and current complications may be identified at an early stage.

There is a lack of a clinically based diagnosis system because WHO's diagnosis index does not include disease codes for tattoos with complications. Improved diagnosis is a prerequisite to the development of algorithms for guidelines about clinical therapy. There is a lack of knowledge about treatment methods, both medical and surgical treatment methods, including lasers, their indication, limitations, effectiveness and side effects.

The tattoo industry is currently a largely unregulated market, resulting in many potential health complications for many people in many social classes. A combined, coordinated prevention strategy is needed in Denmark and at the European level.

INTRODUCTION

Tattooing of the skin involves a large variety of scientific areas, which are very different in nature and their use of methods. Because tattoos, as the essential focal point, satisfy a subjective need on the part of the tattooed person, and because tattoos involve the injection of chemical substances into the skin and the body, different areas of research, which scientific theories should be used and how the truth should be measured and defined, is to a very high degree a matter of consideration and discussion. These fundamental conditions about values are also a premise for the preparation and substantiation of rational strategies for the prevention of health damage due to tattoos.

This chapter only outlines the research challenges regarding tattoos. We will attempt to indicate areas that are especially important in light of society's need to introduce interventions that are rational, and that can effectively improve tattoo safety and measurably reduce ill-health.

TATTOOS, CULTURE AND SOCIETY

An important benefit of the knowledge that is provided by this report is that information to target groups can be based on insight into their motives and barriers regarding tattoos and ink. However, there is no guarantee that determining which arguments and linguistic pictures should be used can be gained directly from this insight, and that they will be understood correctly and have the best possible effect. Therefore, it is important that every communication effort is tested in the way that, for example, qualitative market research tests companies' communication based on some basic, but decisive parameters. An example is questions that may be investigated for use in a campaign about why customers should choose tattooists who offer certain kinds of ink (including the relevance of the message, barriers to acceptance, the user's framework for understanding and media clarification).

It is important to know about the tattoo users' motivation, the social dynamics regarding this and the decision to get a tattoo. What are the various considerations that are made when considering getting a tattoo and choosing a tattooist? How does this develop after the first tattoo and the decision about getting more? From a disease and complication prevention point of view, it is important to know the subcultures there are in the tattoo environment because they must be addressed differently with different messages.

TATTOOISTS AND TATTOOING PRACTICE

The number and demographics of tattooists is unknown. It is also not known to what extent and in what circumstances amateurs carry out tattoos. There is no systematic knowledge about the extent to which preventive activities, such as the use of gloves, disposable equipment etc. are used and how effective they are in practice. The education of tattooists is not known or described in detail. There is a need for detailed, relevant clarification of the conditions in the industry, including both professionals and amateur tattooists. There is also a need for systematic information about which needles and machines are currently in use, not least information about what ink, which manufacturers and which purchase channels are used. It is important to know whether purchases are made by a legal person who can be responsible for legal product liability, subject to Danish, European or other legislation. The industry's compensation liability in case of personal injury is not clear.

The industry's legal framework and details with regard to Danish legislation and legal practice are, taken as a whole, incomplete and imprecise. These free conditions place tattoo customers in a weak position. There is a lack of a consistent, thoroughgoing description of the relevant legal aspects of tattooing as the basis for legislators and others to take action towards improving the situation. It is not known what the situation is in terms of practice and liability when foreign tattooists carry out tattooing in Denmark.

There is a lack of knowledge about whether, under which conditions and who is involved with regard to infections caused by ink, needles, techniques, transfer from the person herself or himself, from the tattoo or the parlour. There is a lack of knowledge about the effectiveness of using gloves and other activities such as washing with spirits and aftercare with regard to the frequency of infections compared with optimal conditions with sterile draping etc. used routinely at medical clinics and hospitals for minor surgery, where tattooing is involved The extent of microbial contamination of needles and machines before, during and after use is unknown and has not been systematically studied. It is not known whether infections occur more frequently in some areas of the body, in case of large tattoos, or when special needles or techniques are used. There is a lack of precise knowledge about which groups of people among tattoo customers are particularly predisposed to being infected and thus are especially vulnerable (risk groups).

An important focus area for future research will be tattooists. Here, the approach can be anthropological, which precisely describes interactions, objects, environments and their moods, and interprets these in the context of the norms, values, social status and life histories of the people who are studied. The analysis also includes the further context, which is comprised of the societal changes that are technological, stylistic, and legal in nature.

In such an ethnographic study, it is important to remain as open and inductive as possible, and build up the analysis according to the patterns that prove to be important in the field. At the same time, it is also possible to maintain a special focus on phenomena that are of strategic interest. The tattooists' own decision-making process regarding the purchase of ink is one possible focus area. The route of ink from the manufacturer to the tattooed person's body would be able to be clarified as a whole as a study of the interaction between local role players through the global network.

The tattooists' knowledge of problems with ink will also be crucial. Do they recognise a problem? And how do they themselves explain the cases of which they are aware? Do customers who have problems contact them? And what happens then? How do they perceive the types of ink they have, and is there any basis for certification in the area, which would make it possible for tattooists to see a financial advantage in advising customers about other types of ink and thus be able to present themselves as artists who offer a safer practice?

TATTOO INK, MANUFACTURING AND RAW MATERIALS

Although studies have been carried out on ink based on the register of potentially hazardous constituent substances stated in ResAp(2008)1, there is a lack of more detailed studies of chemical substances and impurities in tattoo ink in addition to those mentioned in the resolution. There is a need for new knowledge about chemical impurities in raw materials in ink, both with regard to chemical classes and manufacturing methods. There is a lack

of knowledge about manufacturing methods, their role as a source of impurities with characterisations of risk-prone parts of the manufacturing chain. There is a lack of development of new methods with which especially pure pigments classified as high purity analogously with pharmacopeia quality that can be manufactured industrially. There is a lack of optimised manufacturing and manufacturing standards at a level of good manufacturing practice (GMP), which may be used by manufacturers and by authorities in their checks.

The profound lack of knowledge about tattoo ink and its production mentioned above requires comprehensive technical and industrial research in many areas of the manufacturing chain. This includes innovative research on completely new types of tattoo ink, which are simple and pure in composition, safe, can be decomposed using lasers and are possible to manufacture to such a high standard that human use is defensible.

THE TATTOO INDUSTRY

The tattoo industry should be able to be examined using research methods from the commercial sciences. These methods may also be used to clarify customers' emotional and cognitive motivations for buying tattoos. This knowledge may be used counterproductively, for example, in campaigns. The ownership of tattoo businesses and their business structures are unknown, as is the competition situation with regard to unorganised amateurs. Such conditions are of great importance when interventions to improve the safety of tattooing are to be determined and implemented.

The ink industry and the production and sale of machines and needles are international. In reality, deliveries flow freely across national borders and typically have their origins in countries that have few, if any, restrictions. The identification of the manufacturing countries, sales channels and purchase behaviour regarding products used for tattoos is largely unknown territory, but it is important to clarify and determine these areas as a basis for developing interventions.

CHEMISTRY AND PHOTOCHEMISTRY

Most of the chemical studies that have been carried out so far on tattoo ink have dealt with the determination of impurities and decomposition products, especially from organic pigments. The results of these studies were used as the basis for existing regulations within this area. The identification of organic pigments in tattoo ink is, however, not included in the safety requirements for tattoo products. Therefore, there is a need for analytic chemical research and the development of suitable analysis methods that can also be used routinely in laboratories.

A niche area with regard to tattoo ink is the use of fluorescent pigments that are not activated until the tattoo is exposed to UV light. Basically, there is a lack of knowledge about the identity of these pigments and assessments of their safety.

It is well known that certain types of tattoos react to sunlight in the form of itching and irritation, among other discomforts. Therefore, it is relevant to study the extent to which different UV sun filters (UVA and UVB) may provide protection against these discomforts. Such an experiment could be made relatively easily under controlled conditions.

When removing tattoos using lasers, the colour pigments are decomposed to smaller molecules, which are colourless. But there is no description of which substances are formed by these reactions.

Because carbon black is a colour pigment that is frequently used in tattoos, research to clarify laser-induced decomposition products from this substance is an obvious idea. Such a research project would be able to be completed in a financially and professionally manageable manner.

INK AND PIGMENT AS NON-PARTICULATE MATERIAL

The particulate structure of pigments has great significance for absorption, distribution, metabolism and the elimination of the particles' constituent substances. There is limited or no knowledge about the particles' route through the body other than the known deposits in the regional lymph nodes. The conditions regarding the particles' release of substances under physiological tissue conditions is a largely un-researched area, which is of critical importance for an assessment of the safety of ink from a long-term perspective. Laboratory studies, in which particles are exposed to powerful organic solvents, acids, reductive and oxidising effects etc. are non-physiological and have no direct relevance in the in vivo scenario with regard to tattooed skin, where the cellular and enzymatic process, which primarily take place in an aqueous tissue environment, must be dominating. The area of particulate properties of tattoo pigment is important and has a very great research potential.

TATTOO INK AND IN VITRO RESEARCH

There is a large range of toxicological in vitro test methods, especially in the area of medicine, which might be used to assess the effect of chemical substances in inks. In general, the methods were developed to evaluate specific and pure chemical substances, which are more or less soluble in aqueous and lipophilic media. To a certain extent, but not with any clear precision, the methods may be used to assess isolated and carefully chosen chemical ingredients in tattoo ink. But the various in vitro test methods are not suitable for, and cannot be validated for a study of poorly soluble substances and particulate elements such as pigments, where the dosage exposure is far from being simple, and presupposes physiological conditions, including active cellular processes and enzymatic effects, which, in time, may result in the formation of, for example, sensitising substances. In studies using in vitro test systems, consideration must also be given to the fact that the strongly coloured pigments may make the methods technically unreadable.

In vitro test methods for toxicological assessments of ink for tattoos and their ingredients and particulate content have large methodological reservations because there is a lack of validation studies for this application.

There is a great need to establish a skin pharmacological in vitro model for determining the skin's content, metabolism and elimination of ink ingredients. Such a model could be inspired by the Franz diffusion cell, which is often used in skin pharmacology and can be mounted on the skin from pigs and humans and is used as a flow through version, in which perfusion imitates washing out to the bloodstream. This type of evaluation might be indicative of the biokinetic profile of ingredients, their quantity and timeline in skin. It may be possible to use systems of this type for screening new ink and ingredients.

TATTOOS AND ANIMAL MODELS

The most important animal models in this area are based on rodents and pigs. Mice may be suitable experimental animals for clarifying conditions such as irritation and corrosive properties, as well as

studies of the distribution of particulate material in inner organs after realistic and unrealistic exposures. Mice and rats may be used to determine acute toxicity and clarifying lethal dosages. Mice are suitable for testing dermal carcinogenicity and testing photo carcinogenicity. However, mice are not suitable models in more precise biokinetic studies because the skin of mice and rodents is too thin for tattooing to be carried out in a way that is comparable to tattooing and the exposure of human skin, where the pigment is injected in the dermis only, and not in the underlying tissue, including the muscles. The few published studies of biokinetics in mice have been uncritically applied to the human situation. Pigs have a skin thickness and a microscopic skin structure that is close to that of human skin. Therefore, pigs are clearly the most suitable experimental animals for assessing biokinetics and toxicology in clarifying ink for tattooing. Pigs also have a distribution volume that is closer to that of humans and this animal species is, therefore suitable as a model for the depositing of substances in and affecting distant organs, including by measuring of DNA damage. Pigs would be suitable for studies of local tolerability, wound healing after tattooing and the impact on the skin of the combined effect of multiple needle trauma and dermally injected ink. Development, validation and the use of experimental animals, especially pigs, for assessing the biokinetics and safety of ink for tattooing is one of the most urgent medical research areas that can be identified, which is also stated in the Council of Europe's latest working document prepared by a group of experts for the Council of Europe as a follow-up on ReasAP(2008)1.

There are no animal models that can clarify the sensitising properties of ink because sensitising due to allergy in tattoos takes a long time and takes place through haptenation in the organism, a process that may be regarded as being species-dependent. There is a lack of specific studies on tattoos, tattoo ink and mutagenic and reproductive toxic damage. A prerequisite for the induction of cancer is normally a form of accumulative or chronic exposure of a significant dosage of the carcinogen and in a relevant organ, which is predisposed to developing cancer by exposure to precisely the specific carcinogen. The skin and the regional lymph nodes, despite exposure to potential carcinogens in tattoo ink, have proven to be resistant to the development of clinical cancer, a condition that can be researched further. It is of particular importance and a goal of future research to clarify the possibility for reproduction toxic damage because tattooing as an isolated injection and peak exposure given at a critical time during the development of the embryo has the potential possibility of damaging the embryo. It is not known which study model would be able to be used to clarify this.

CLINICAL AND EXPERIMENTAL STUDIES WITH HUMANS

Knowledge is needed about how to ensure good hygiene in connection with tattooing and the sterility of tattoo ink. There is also a need for knowledge about how to effectively implement this knowledge in the tattoo industry throughout the entire chain from ink ingredients and raw products in manufacturing to pigment injected into a person's skin. Allergic reactions and the allergens that trigger them remain an un-researched or unanswered area. There is a lack of research on which raw materials in the ink, which metabolites and which tissue elements or substances from the sensitised person that form the allergen and trigger the allergy, which characteristically does not materialise until months or years have passed.

Neither in dermatology nor in medicine is there a tradition for diagnosing tattoo reactions. There is a need for research in diagnosing and classifying reactions based on the condition that a diagnostic system must be suitable for general clinical practice and comprise guidelines for the choice of therapy. There is a need to set up diagnosis and treatment algorithms based on sufficient patient material and broad clinical experience. A prerequisite for clinical research is that a centralisation takes place so that patients with clinical complications are treated only a few places, which can function as knowledge centres. The development of a nuanced and validated treatment offer presupposes clinical research on treatment methods, including surgical methods and new types of lasers used in defined indication areas. There is a need for research on new and innovative treatments of complications in connection with tattoos and better methods for removing tattoos if they are regretted.

EPIDEMIOLOGY, REGISTER RESEARCH AND TRACEABILITY

The incidence and prevalence of discomfort and complications from tattoos are not precisely known and can only be estimated on the basis of a few studies. Neither is there any detailed knowledge about which types of ink and which pigments are in use, and that are associated with complications. There is no systematic registration of damage and complications due to tattoos. Therefore, there is no possibility to detect new or frequently occurring damage caused by introducing new, possibly dangerous, ink in the market. There is no traceability so ink that has caused serious or lethal complications may be identified and eliminated from use. There is a need to establish a monitoring function in the form of a central register, to which discomforts and complications from tattoos are reported, ideally precisely identifying the ink that was used. The latter is of great significance if new cases are to be prevented. A central register of tattoo activity, clinical complications and the ink used will be an important tool for researching and a necessary tool in prevention, and will fulfil an emergency preparedness function to be used in case of especially dangerous ink, where quick action is important.

REGRETTING TATTOOS AND REMOVAL METHODS

There is a lack of knowledge about how many people regret their tattoos without the assessment being influenced by factors such as the person's knowledge about the high expense of removal, the possibly incomplete result of removal, and the possibility of resulting conditions such as scars and pigment deviation. There is also a lack of knowledge about the effectiveness of removal using lasers and customer satisfaction. There is a tremendous need for studies on the effectiveness of and side effects caused by tattoo removal using lasers, and knowledge about which types of tattoos and colours are suitable or unsuitable for removal using lasers, which clarify indications and contraindications. This research field is hot because new and improved picosecond lasers were recently introduced in the market. Femtosecond lasers with even shorter pulse durations are under development. Advanced and expensive new lasers for tattoo removal penetrate the market swiftly and directly, typically without systematic documentation of clinical effects and side effects. Research-based documentation of removal of tattoos by lasers performed up to accepted principles for good medical research is greatly needed.

There is, furthermore, a lack of research that systematically clarifies which substances are formed by laser treatment of a broad assortment of the

most typically used tattoo pigments compared to register data regarding any unfortunate properties of such new substances.

Because it is known that not all tattoo colours can be removed or bleached by using laser treatment, there is a need for more research on pigments and substances that can be safely removed by using lasers, and that may be transformed and eliminated without any toxic effects. There is a need for research on and development of completely new types of pigments, which can be safely removed by using lasers or another technique. There is still a need for research on and development of laser-based techniques and treatment programmes for removing tattoos.

Other and new methods for removing tattoos based on other modalities have been introduced. Removal using lactic acid that is concentrated by 20-40% has been carried out as a kind of deep peeling with necrosis of the outer skin, because the acid is introduced to the skin using tattoo needles. However severe scarring and depigmentation due to irreversible loss of pigment cells have been observed in many cases, and the method is presently not acceptable for general use. Optimisation of the method and treatment schedules, which creates controlled superficial acid burning without the risk of causing scars and with individualised treatment with dosage titration may be a subject for research. There is a great need for research in other, new methods for safe and complication-free removal of tattoos, because the need to remove them will be significant in the future, and because lasers have a number of known limitations.

An area of knowledge that has not been covered is the group of people who regret having been tattooed. Why do they regret them? Have they experienced disadvantages that confirm the literature about the potentially stigmatising effect, or should the literature be expanded with a new understanding of the disadvantages of tattoos? Or is it really about styles, which at some point were unique and exotic, which later become mainstream and, finally, vulgar and out of date?

PHILOSOPHY AND SOCIETY

In recent years, tattoos have found a new status of normality in society. There is a lack of a more precise assessment of and position on society's norms and values, visions and real possibilities to intervene and control the tattoo area based on a given strategy. Today there is no visible general strategy in Denmark, in Europe and internationally regarding tattoos, even though it involves a high percentage of the population, economics and the extent of ill-health in the populations. Politically, in industrialised countries, the tattoo situation has been 'parked' as a problem, which for decades has not been taken seriously. The political decision-making process, and the premises and processes for making decisions in which tattoos from a general perspective may be compared with problem areas such as tobacco smoking, work-related illnesses, personal injuries in traffic, circumcision of boys, the use of hash and narcotics, prostitution, provoked abortion etc. are an important area for sociocultural research from the perspective of society's prioritisation of health and interventions, improving health relative to actual conditions of society and the population. Reasons behind the political willingness to institute prevention and be proactive or to refrain from being active despite obvious threats, challenges and health risks is a research area in itself. In the process of prioritising and decision making tradition and the fact that resources are not unlimited obviously plays a major role. However, as exemplified above, the scene is very inconsistent and may appear very irrational as

seen from a medical viewpoint. Tattoos and health has traditionally had low priority. Political decision makers should revisit the tattoo problem and look for supranational solutions.

In the final analysis, improving the safety of tattoos depends primarily on the motivation of the customers and the entire tattoo industry. To be effective, the prevention and reduction of health damage due to tattoos requires a change of conditions and behaviour of the industry's practitioners at all stages based on positive motivation in the industry down to the very core. This also requires dialogue and responsiveness among coming tattoo customers, who must also change behaviour by either not getting tattooed or choosing to have the tattoo made the way that involves the fewest risks.

Research on the effect of the integrated 'seamless prevention' strategy that is introduced and highlighted in this report needs to be implemented at an early stage, and must include analyses of its elements and the strategy's total effectiveness directly on incidence and prevalence of disease and disability .