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Review Article

Does Aluminium Trigger Breast Cancer?

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Summary. Breast cancer is by far the most common cancer in women in the western world. In 90% of breast cancers, environmental factors are among the causes. The frequency with which the tumour occurs in the outer upper part of the breast has risen with above average rates in recent decades. Aluminium salts as ingredients in deodorants and antiperspirants are being absorbed by the body to a greater extent than hitherto assumed. Their toxicity for healthy and diseased breast tissue cells includes various well-documented pathomechanisms. In the sense of primary and secondary prevention, the cancer-triggering potential of aluminium and its use in anti-perspirant deodorants must be re-evaluated. For the same reason the access to a targeted diagnosis and treatment of aluminium loading must be facilitated.

Key words: breast cancer; environmental factors; aluminium; prevention, therapy

1. Introduction

Individual cases of women affected and a series of scientific investigations, which throw light on the possible cancer-triggering mechanisms of aluminium, are attracting public attention. Thus, in spring 2014, a statement by the Federal Institute for Risk Assessment (BfR) caused a sensation. In it the BfR stated that through most deodorants the human skin was absorbing more aluminium than the EU considered to be a tolerable weekly quantity [1]. Although it has so far not been conclusively resolved, whether and to what extent, aluminium compounds contribute to carcinogenesis, this should, however, not be seen as an opportunity to play it down. On the contrary: it would be irresponsible given the existing data situation to wait until a "statistically significant" number of women had become ill, who would be sufficient for unequivocal proof. In the WHITE BOOK for a future chemical policy, the EU Commission requires that political decision-making must be based on the principle of prevention if there is a substantiated suspicion that a substance could be harmful [2]. This should also apply to the use of aluminium in deodorants and cosmetics.

"If there are reliable scientific indications that a chemical substance could have negative effects on human health and the environment, but there are still uncertainties from a scientific point of view about the exact nature and severity of the potential damage, then the political decision-making must

be based on the principle of prevention in order to prevent damage to health and the environment." [2]

2. Aluminium Production Is Regarded As Carcinogenic

The cancer-triggering potential of aluminium production has been examined several times by the International Agency for Research on Cancer–IARC [3]. Based on a relatively large number of studies there are sufficient indications showing a raised risk of cancer during the production of aluminium. Accordingly, the workplace exposure during aluminium production has been graded by the IARC as "carcinogenic for people". This concerns the genesis of cancers of the bladder and the lung. With these results one should bear in mind that the workers often come into contact with carcinogenic polycyclic aromatic hydrocarbons (PAH). Further potential exposure in producing aluminium also arise through sulphur dioxide, fluoride, aluminium fluoride, aluminium tetrafluoride, carbon monoxide and carbon dioxide, chrome, nickel, asbestos, extreme heat and high static magnetic fields. Due to the multiplicity of influences on the workers during aluminium production it is difficult to say which factor alone in itself or which combination of different factors is carcinogenic. First and foremost, the IARC blames the PAHs, well-known as carcinogens. In contrast, the cancer-triggering potential of aluminium and its compounds as a single factor has so far not been evaluated by the IARC.

3. Environmental Factors Are Some of The Main Causes of Breast Cancer

For more than 12 years, the English scientist Philippa Darbre has been pointing out that deodorants used in the armpit are a cause of breast cancer. In 2001 she published an article in a medical journal in which she presented her theory for the first time [4]. She states that breast cancer is the most common women's cancer in the western world and, with increasing frequency, worldwide. Investigations on women show that some of the causes are environmental factors in 90% of breast cancer cases and that western lifestyle also plays a significant role. Darbre considered that the precise cancer-triggering environmental factors had, unfortunately, not yet been ascertained to the requisite extent. On the basis of her own investigations she was able to demonstrate that the frequency, with which breast cancer occurs in the outer upper part of the breast, had risen at an above average rate in the last few decades. Whilst in 1926 just over 30% of breast cancers started in the outer upper quadrants, in 1947–1967 it was between 43–48% and in 1994 already as many as 60.7%. This equates to a doubling of the relative frequency of cancer cases in the proximity of the armpit within just less than 70 years.

The sad reality is that breast cancers have been occurring with a marked greater frequency in the last few decades and increasingly affecting young women as well. This does not sufficiently explain however why tumour localisation is not evenly spread over the breast tissue. So why do such an above average number of cancer cases occur in the proximity of the armpit? A plausible explanation was already being sought for this unusual fact at the start of the 70s. The area, in which breast cancer occurs with above average frequency, lies nearest to the armpit and, in contrast to the rest of the glandular tissue of the breast, is particularly exposed to deodorants. In a text book C. D. Haagensen posed the theory that more epithelial cells are located in this region, which is often the place where breast cancer starts. Haagensen himself however said that this was only pure supposition and that he simply did not have any other explanation [5]. This supposition is still being resorted to today.

In a briefing from 2013 the European Aluminium Association (EAA) points out the fact that, according to the American Cancer Society, most carcinomas occur in the upper outer quadrants of the breast because this is where the most breast tissue is found [6]. This too is probably a supposition and does not explain why the frequency of this tumour localisation has risen steadily in relation to the other areas of the breast. To leave pure speculation on one side, one would be better finding out which environmental factors, which are undisputedly some of the main causes of cancer, particularly affect the breast tissue in proximity to the armpit. This has been a long-lasting omission. It has even been said that, given the lack of a credible hypothesis, continuing research on the potential cancer risk of deodorants containing aluminium would have little value [7].

This is also invoked by the EAA, the association of European aluminium producers. The question remains as to who is served more by such statements: producer protection or consumer protection.

It is all the more gratifying that some scientists have continued to engage with this subject and have gained fresh insights. Philippa Darbre observes that, over the course of the last few years and decades, the use of antiperspirants has greatly increased. The sales figures speak for themselves: in the USA alone they rose from 30 million US dollars in 1947 to 300 million in 1970 and to more than 1 billion US dollars in 1983 [8].

This likewise reflects the increasing use of deodorants in large quantities. This means their contents are also able to penetrate the skin of the armpit and its surrounds more frequently and more easily, and get into the tissue. Although the skin, in contrast to mucous membrane, consists of several layers of cells, which should make penetration by toxins more difficult, whether this is sufficient to ward off the contents of deodorants has to be a matter of doubt. For a long time one assumed that only approximately 0.014% of the aluminium contained in deodorants is absorbed via intact skin.

Accordingly, it was believed that only approx. 4 micrograms of aluminium is absorbed each time a deodorant containing aluminium was used in both armpits.

The investigation, upon which this assumption is based, stems from 2001 [9]. For a long time it was regarded as the main argument for the case proving that no quantity of aluminium worth mentioning is absorbed from deodorants. Thus hardly any further studies were conducted. The problem with this is that, at the time, only 2 persons were investigated: one man and one woman. Moreover, the results of the investigation showed considerable differences between the two test subjects.

These deficiencies alone should be enough of a reason to scrutinise the significance of this study and conduct further investigations on people thus enabling more accurate statements. Unfortunately, this has been wanting for over 10 years. There is, however, an investigation using cell cultures from 2012. In this, differing penetration rates of 0.65%, 0.18% and 0.96% were measured depending on mode of application (spray deodorant, roll-on and stick) [10].

Overall, this investigation points to a considerably greater aluminium uptake than the investigation on the 2 subjects from 2001. If microwounds are caused by shaving then the protective layer of the skin is damaged. Although aluminium salts should in fact not be used on damaged skin, who is aware of this and who heeds this? Probably no one can say exactly how much aluminium is actually absorbed by the damaged skin. Nevertheless, results from a cell culture model do indicate an aluminium uptake 6–10 times greater than with intact skin [10]. Even if one probably cannot transfer a cell experiment 1 : 1 to humans, nevertheless, the results should be a cause for increased vigilance from the consumer protection standpoint.

4. Aluminium Content of Antiperspirants

The aluminium content is not equal in size in all antiperspirant deodorants. The European cosmetics ordinance has limited the aluminium content of aluminium zirconium chloride hydroxide to a maximum of 20% (as a water-free aluminium zirconium chloride hydroxide), which equates to a pure aluminium percentage of approx. 5%. Another frequently encountered aluminium compound (aluminium chlorohydrate) is currently not regulated by the cosmetics ordinance [1]. Therefore, if a deodorant contains aluminium chlorohydrate, then there is no upper limit prescribed for this. The information leaflets of the German industry association Körperpflege- und Waschmittel e.V. [Bodycare and Detergents reg. soc.] specify, by way of example, concentrations of up to 30% aluminium chlorohydrate [1] for deodorant creams. In one French deodorant there was even a 38.5% aluminium chlorohydrate content [10].

If one assumes an application once a day, lasting for 2 seconds for each armpit, then between 3.3 to 15.7 milligrams of aluminium reach the skin. Research by the RTL TV channel produced this result [11]. Only a small fraction of this reaches the breast tissue. This small quantity is nevertheless enough: in a statement on 26 February 2014, the Federal Institute for Risk Assessment comes to the conclusion that more aluminium enters the human body through deodorants containing aluminium than is desirable.

If one goes by the recommendations of the European Food Safety Authority (EFSA) for the tolerable weekly intake (TWI) of 1 mg of aluminium per kilogram of body weight for oral intake via food, then parallels can be drawn for the aluminium intake from deodorants. The Federal Institute for Risk Assessment has done this and has reached the conclusion that, with the daily use of aluminium- containing deodorants, the tolerable weekly intake as recommended by the EFSA can be exceeded. In the same breath, the FIRA also considers that, in the event of damaged skin, such as after being cut with a razor, the values are much greater than this.

5. How Does Aluminium Affect Breast Cells?

The use of aluminium-containing deodorants over a long period results in a particularly high and, in part, decades-long localised contact with aluminium in the surrounding tissue. If aluminium contained in deodorants is not effectively washed off the skin, then some of the aluminium salts can remain on and in the skin. Over time this leads to a high local aluminium concentration and increases the risk of breast cancer [12]. Thus it is also no surprise that higher aluminium concentrations have been measured in human breast tissue than in the blood serum [13]. Cell cultures provide some indication of the changes, which aluminium causes to healthy and diseased breast tissue cells. For 30 years one has known that aluminium-containing anti-perspirants can occasionally cause inflammations and granulomas [14]. Up until now scant attention has been paid to these observations although it is well-known that a chronic inflammation is a risk factor in carcinogenesis.

In recent years new information has revealed the effect of anti-perspirant aluminium salts on healthy breast tissue cells. Aluminium chloride [$AlCl_3$] already causes changes in the cells at a dose 100,000 times lower than that normally found in deodorants [15]. The cells in the human body are constantly subjected to the influence of growth-promoting and growth-inhibiting signals. These form the basis for the renewal and repair of the body's organs. Growth-inhibiting signals are important for preventing uncontrolled cell division, which leads to tissue proliferation and tumours.

One cell touching its neighbouring cell is an important signal, which inhibits further unrestrained cell growth. If the cell to cell contact necessary for this is destroyed, this can then lead to uninhibited cell growth and carcinogenesis. $AlCl_3$ destroys the cell to cell contacts of healthy breast tissue cells and stimulates uncontrolled growth of cells. Minimal quantities of aluminium chloride trigger double strand breaks in the nucleic DNA of healthy breast tissue cells [15]. Damage to the genetic material is regarded as one cause of carcinogenesis.

These cell experiments do not yet prove that aluminium chloride in deodorants leads to carcinogenesis, but they do indicate that one should deal with this topic cautiously and conscientiously.

The effect of aluminium and its compounds on healthy and diseased breast tissue is not only limited to one or two pathomechanisms but is multifactorial. Aluminium salts damage the iron metabolism. They cause an intracellular accumulation of iron. The associated increased formation of reactive oxygen species (ROS) causes nerve cell death [16] and is viewed as an additional risk factor for the damaging of healthy breast tissue cells [13]. If the aluminium concentration increases in the event of chronic exposure in the mitochondria, this leads to changes damaging for the entire cell metabolism [17]. Mitochondrial damage has long been known to be a contributing factor in causing cancer cells [18]. There are also indications, which should be taken seriously, that aluminium salts, which have been acting on breast cancer cells over a long period (8 months), increase their mobility and their ability to metastasise [19].

As the overwhelming number of female breast tumours are hormone-dependent, the hormone-like effect of aluminium and its compounds is of particular significance. Aluminium has the ability to bind with the oestrogen receptor and imitate oestrogen-related functions [20]. Here the presence of oestrogen is even not required. Metals with this ability are designated as metallo-oestrogens.

They are regarded as having a significant role in the formation of hormone-dependent breast disorders. In addition to aluminium, cadmium, copper, nickel, chrome, lead, mercury and other metals also belong to the group of metallo-oestrogens [21]. Due to the activation of oestrogen receptors, the production of nitrogen oxide (NO) is increased in the cell. In a significant quantity this can lead to limiting cell vitality not to mention cells dying off [22]. Metallo-oestrogens also trigger changes in the oestrogen binding locations of the genes in the cell nucleus. In breast gland cells this leads to increased cell division. As a result, more errors in the reproduction of the DNA arise, which then has a correspondingly increased cancer risk.

Cells that have already mutated into breast cancer cells and are oestrogen receptor positive are stimulated to grow by these metals [23]. How significant oestrogen receptors are for the genesis and growth of breast cancer becomes clear if you think that they play a key role in over 70% of invasive tumours [24]. If one now draws a parallel between metallo-oestrogens, oestrogen receptors and frequency of breast cancer, then the interesting question poses itself as to whether aluminium and other oestrogen-related metals are involved as the original cause or partial cause in 70% of the high risk breast cancer cases. The question probably cannot be answered with any great certainty but it does allow an insight into the dimensions of the difficulties faced.

At the same time new perspectives are arising from this for the prevention and treatment of oestrogen-dependent tumours: by deploying chelating agents, the stress on the body from metallo- oestrogens can be measured and treated [25–28]. Thus risk factors can be identified on an individual basis and treated accordingly. This is in fact what one would wish of a causal cancer therapy.

Unfortunately, in practice these possibilities are only treated as a method outside the main stream. In response to a question in the German parliament about which methods are planned short-, medium- and long-term to improve prevention and treatment of cancers, which may be caused by heavy metals, the German government answered [29]: ”In general the treatment of cancers does not take place in relation to causes, as the causes in most cases cannot be precisely determined due to the multifactorial genesis, but takes place according to the respective type of cancer and tumour stage. The same applies to the general early diagnosis of cancers.”

To put it plainly: this means that there is no interest in measuring the metal exposure of cancer patients and those at risk, let alone treating it. So quickly was this crucial topic finished with. What can however be anticipated from a risk factor that is simply being ignored and shelved? Has it thus been dispensed with completely? Or will it continue to inflict damage? Unfortunately, diseases and risk factors take no heed of decision made at a desk. For this reason the problems of metallo-oestrogens and their significance in carcinogenesis remain current.

6. Proof and Treatment of Aluminium Uptake

Due to its long half-life in the human body, aluminium belongs to the group of summation toxins. Minimal, non-toxic quantities of aluminium at the time of uptake, can first of all lead to minimal changes, which do not yet trigger a disease. Some of the metal does however remain stored in the body. If, over the course of weeks, months and years, there is further intake of aluminium, then the existing damage can be intensified and re-occur until, ultimately, a disease is triggered. The duration the aluminium remains in the human body can be shortened with the use of chelating agents. This effect can be used to prevent and treat disease-triggering aluminium loading therapeutically.

First of all, one ought however to measure whether a chronic aluminium loading exists at all. This is not entirely simple as the usual laboratory investigations are not suitable for this. The extent of the body’s loading with aluminium cannot be proven and ruled out with certainty by blood and urine readings alone. The “Human Biomonitoring Commission” of the German Federal Environment Agency came to this conclusion [30]. As aluminium only has a half life of 30 to 60 minutes in the blood, ”the aluminium concentration in this medium only represents the immediate uptake and is therefore less suited for environmental medicine queries”– according to the German Federal Environment Agency (UBA).

The aluminium content in the urine also only reflects the current, but not the chronic, exposure. Measuring the aluminium in a hair mineral analysis (HMA) is likewise not suitable for environmental medicine purposes according to the UBA. Only for very high aluminium loadings has an increase in the aluminium readings been measurable in the HMA. In contrast, chronic loadings cannot be proven with the desired certainty by HMA.

Chronic aluminium loadings can only be proven with the use of chelating agents according to a statement from the UBA [30].

The UBA has proven the effectiveness of deferoxamine (DFO) in hospital for patients with kidney failure in proving aluminium loading but, at the same time, emphasises that the DFO test cannot be used practically for environmental medicine. A reason to justify this is not given. For doctors, who have specialised in the diagnosis and treatment of chronic, environment-induced metal loadings, there is however a whole series of highly effective chelating agents with minimal side effects available. To these belong EDTA, CaDTPA, ZnDTPA, DMPS and DMSA. The UBA says that DMPS and DMSA "are well tolerated, relatively specific and easy to administer antidotes, which have become indispensable for the treatment of acute metal poisoning" [31].

7. Summary Demand

Given everything that has so far become known, it must be demanded that the possible health risks from deodorants containing aluminium should be taken seriously enough to protect consumers as far as possible. In addition, the reimbursement of costs should be made easier for the diagnosis and treatment of chronic aluminium loading. So far these are methods outside the mainstream and are only deployed by some specialised physicians.

Conflict of Interest

The authors declare that there is no conflict of interests.

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