

Increasing incidence of burnout due to magnetic and electromagnetic fields of cell phone networks and other wireless communication technologies

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Burnout syndrome (BOS) is a psychosomatic stress disorder. Exogenous stress leads to oxidative cellular stress, the formation of excessive reactive oxygen species, reactive nitrogen species, and reaction products (ROS/RNS). This then leads to mitochondrial metabolic dysfunction, which results in a lack of ATP (adenosine triphosphate) and subsequently in a diminished performance of cells. Lack of ATP is a crucial factor in BOS, as well as in chronic fatigue syndrome (CFS). A crucial element in the multisystem disease BOS is inflammation as a consequence of nitrosative and oxidative stress, as well as the acquired mitochondriopathy. Weak ambient magnetic fields (e.g. from transformers in devices) and various radio-frequency resonances increase the level of free radicals and their reaction products that have toxic effects. The nonionizing radiation of cell phone networks and other wireless communication technologies (cell towers, cell phones, Wi-Fi, etc.) also leads to cell stress. There is a correlation between the stress trigger due to living conditions, magnetic fields, and RF radiation of cell phone networks and other wireless communication technologies. The affected person will suffer from functional impairment and diseases; and if these are hereditary, they will be passed on to the next generation as a pre-existing defect, as is the case with e.g. "acquired energy dyssymbiosis syndrome" (AEDS).

Keywords: *burnout, electromagnetic fields, mobile telephony, RF radiation, stress, chronic fatigue syndrome (CFS), chronic inflammation, chronic multisystem illness (CMI), acquired energy dyssymbiosis syndrome (AEDS)*

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Increase in chronic multisystem diseases

In medical history, the definition of general fatigue, depressiveness, and avolition as a pathological condition is discussed against the backdrop of societal developments; in the past, they were referred to as melancholia, vapors, neurasthenia, and depression (EHRENBURG 2009) and today as burnout syndrome. Stress always plays a central role in these conditions. Benkert offers a timely definition: *"The burnout syndrome is a specific result of continuous stress."* (BENKERT

2009) Burnout belongs to the chronic disorders (GEUENICH & HAGEMANN 2012) with increasing prevalence within the group of the so-called chronic multisystem illnesses (CMI) (see Fig. 1). Conditions with diffuse symptomatology include:

- MCS (multiple chemical sensitivity),
- CFS (chronic fatigue syndrome),
- BOS (burnout syndrome),
- PTSD (post-traumatic stress disorder),
- Fibromyalgia syndrome.

Zusammenfassung

Steigende „Burn-out“-Inzidenz durch technisch erzeugte magnetische und elektromagnetische Felder des Mobil- und Kommunikationsfunks

Das Burn-Out-Syndrom (BOS) ist eine psychosomatische Stresserkrankung. Exogener Stress führt zu Oxidativem Zellstress, einer übermäßigen Entstehung von Freien Sauerstoff-Radikalen, Stickstoff-Radikalen und Folgeprodukten (ROS / RNS). Dadurch entstehen mitochondriale Stoffwechselstörungen, die zu einem Mangel an ATP (Adenosin-triphosphat) und in der Folge zur verminderten Leistungsfähigkeit der Zellen führen. ATP-Mangel ist ein wesentlicher Faktor beim BOS als auch beim Chronic Fatigue Syndrom (CFS). Ein zentrales Element der Multisystemerkrankung BOS sind die Entzündung (Inflammation) als Folge von nitrosativem und oxidativem Stress so wie die erworbene Mitochondriopathie.

Aus der Umgebung stammende schwache Magnetfelder (z.B. Gerätetransformatoren) und diverse Hochfrequenzschwingungen erhöhen die Ausbeute von Freien Radikalen und toxisch wirkenden Folgeprodukten. Die nichtionisierende Strahlung der Mobil- und Kommunikationstechnologie (Mobilfunkmasten, Handys, WLAN u.a.) führt ebenso zu Zellstress. Es besteht eine Wechselwirkung zwischen der Stressauslösung durch Lebensumstände, Magnetfelder und Mobil- und Kommunikationsfunkstrahlung. Der Mensch leidet an Funktionsstörungen und Krankheiten und - soweit sie vererbbar sind - gibt er sie als Vorschädigungen an die nächsten Generationen weiter, wie z.B. beim ‚Acquired Energy Dyssymbiosis Syndrom‘ (AEDS).

Schlüsselwörter: Burn-out, Elektromagnetische Felder, Mobilfunk, Stress, Chronic Fatigue Syndrome (CFS), chronische Entzündung, chronische Multisystemerkrankung (CMI), Acquired Energy Dyssymbiosis Syndrom (AEDS)

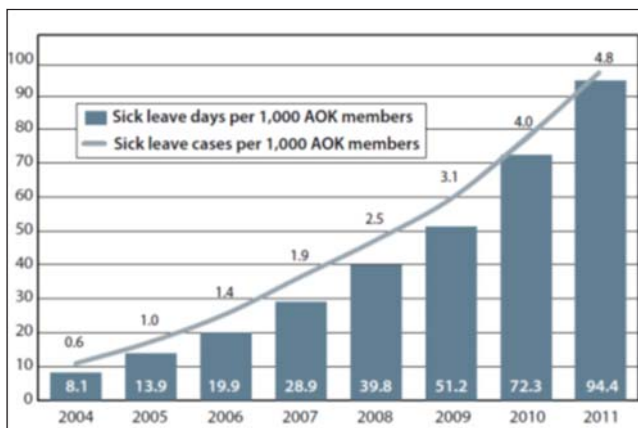


Fig.1: Burnout: the number of diagnoses rises rapidly (WIDO 2012, AOK = General German health insurance)

The prevalence of chronic multisystem illnesses is estimated to comprise at least 25% of the population in western industrial countries - with an increasing trend. For CFS alone, a prevalence of 522 cases per 100,000 in females and 291 per 100,000 in males is given for the U.S. (AACFS 2003). According to a study of the University of Chicago, the prevalence of CFS thus easily exceeds those of HIV infections (125/100,000), lung cancer (43/100,000), or breast cancer (26/100,000)(JASON et al. 1999).

The pathogenesis of CMI syndromes and all other CMI-associated illnesses involves free radicals and inflammatory events of the immune system.

Special focus: oxidative stress

The crucial role of oxidative stress is generally known and scientifically acknowledged:

“Cell processes require redox homeostasis, which must be maintained by a multitude of antioxidant enzymes... When the organism’s homeostatic balance is tipped in favor of oxidative processes, we speak of oxidative stress. Oxidative stress is associated, among others, with the aging of cells. Furthermore, a severe accumulation of reactive oxygen species (ROS) with a simultaneous decrease in the level of the body’s own antioxidant glutathione is considered a known cause of acute and chronic degenerative diseases such as stroke, arteriosclerosis, diabetes, Alzheimer’s disease, and Parkinson’s disease” (HELMHOLTZ ZENTRUM 2008). The Robert Koch Institute confirmed these relationships (RKI 2008).

In persons with burnout syndrome, changes can be observed in the following cell functions, among others (BAUR 2012, BIEGER 2012, MÜLLER 2012, VON BAEHR 2012):

- Oxidative cell stress (ROS), chronic inflammation, and nitric oxide formation result in an increased formation of peroxynitrite;
- Lower levels of the body’s own antioxidants, especially superoxide dismutase (SOD2);
- Decrease in ATP production and diminished energy supply through mitochondria;
- Disruption of the neuroendocrine stress axis, slowing down of the catabolism of catecholamines, and modulating effects on the neuroendocrine immune system.

Beside mental stress, environmental stressors, including EMF (electromagnetic fields, see Fig. 2), are discussed as triggers. Both mental stress as well as environmental stressors lead to cell stress (= oxidative stress); the interactions provide a model to explain the increasing incidence of burnout.

Parallels between biological stress symptoms and adverse biological effects of RF radiation

Why do we need to worry that these phenomena of general loss of performance also may have a causal relationship, among others, with the ubiquitous cell phone and wireless networks? The “digitization of our world” means that, since ca. 1998, our cells have been exposed to a continually increasing level of nonionizing radiation to which they have not adapted. There is a relationship between triggers of stress due to living conditions and RF radiation. Research results regarding the effects of nonionizing radiation on cells show similar effect mechanisms as the burnout research in environmental medicine (see Fig. 3).

Radio-frequency electromagnetic fields (RF-EMF) interfere with cell processes:

- RF-EMFs produce excessive cell-damaging free radicals and strongly reactive oxygen and nitrogen species, which in turn can damage the DNA (see below).
- The body’s own defense in the form of endogenous radical scavengers (antioxidants) is weakened by RF-EMFs (see below).
- The repair of DNA damage is impaired (BELYAEV et al. 2005).
- RF-EMFs interfere with the center of our metabolism, the mitochondria, and thus interfere with our energy production: ATP production is inhibited (SANDERS et al. 1980, 1984, 1985).
- The decrease in ATP production debilitates the entire system.
- The exposure to RF radiation triggers a downward spiral of disease. RF-EMFs accelerate toxic cascades.

“The clinical picture of AIDS or acquired energy dyssymbiosis syndrome ... describes a deficiency in cell energy with a simultaneous deterioration of the cell milieu. This leads to mitochondriopathy. Energy production is blocked; the power plants of the cell are transformed into efficient sources of free radicals.” (WARNKE 2007)

Unnatural environment and little protection

All living organisms, especially those living in the atmosphere, are immersed in ever-growing layers of radio-frequency radiation as well as electric and magnetic fields. Satellites show that the highest level of radiation of technical origin is found across Europe; the U.S. and China are somewhat less exposed (LIGHT et al. 2001).

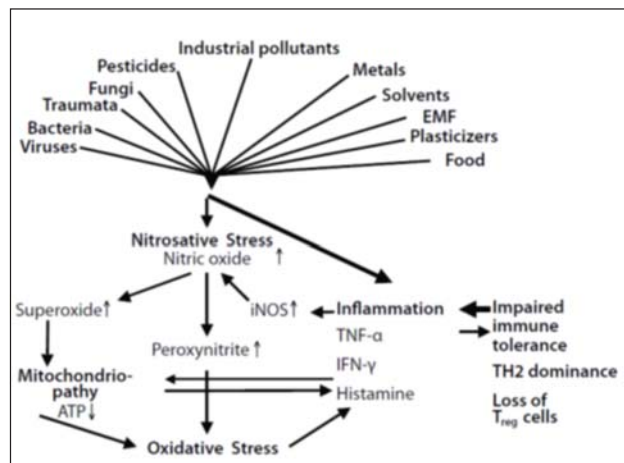


Fig.2: Pathogenesis of inflammation, mitochondriopathy, and nitrosative stress as a result of the exposure to trigger factors (VON BAEHR 2012)

The statements by those in power (politicians, network providers, “experts”) have remained the same for years: “According to the current body of scientific knowledge, there is no risk to human health below the exposure guidelines.” In Germany, the exposure limits of the 26th Ordinance Implementing the *Federal Immission Control Act* apply. And the authorities keep repeating the same statements, assuring the public that, based on current knowledge, cell phone radiation is safe. Those findings that do show effects would not be reproducible. People who refer to themselves as electro-sensitive are labeled as experiencing a nocebo response or suffering from a mental illness. And the spurious argument that there is no effect mechanism that would explain a risk also keeps coming up. The quantum energy of the radiation, it is said, is far too low; it is several orders of magnitude below the thermal noise level, which is why it would not have the power to impair or damage living organisms.

Normally one would expect that the biological response to weak and very weak magnetic fields and RF radiation of cell phone and other wireless communication technologies would be masked by the - stronger quantum -thermal noise inside the human body. Because at temperatures between 20 °C and 40 °C, as occur in the human body, molecules and their components are in constant random motion. A signal with lower energy than that cannot change this motion in any meaningful way. Adverse effects could therefore not exist as long as the allegedly damaging fields are lost in this random noise and an increase in temperature can be prevented. And this is what current exposure limits guarantee, and all worldwide experts in politics and industry adopt this argumentation from one another.

Yet disastrously, it is exactly this central point of their placating argument that is false. There is not only a conceivable but even a completely plausible effect mechanism, which is able to explain DNA damage and all other described symptoms for such low-energy, nonthermal fields, and this completely independent of an increase in temperature. It is the

production of free radicals through nonionizing radiation of wireless networks, which provokes the destruction of body cells and genes.

Then what is the rationale for how electromagnetic fields of cell phone and other wireless communication technologies generate disease?

Fact #1: Never before has the Earth’s atmosphere been saturated with so many electric and magnetic fields and nonstop electromagnetic radiation of technical origin, and this radiation exposure continues to increase.

Fact #2: Inflammation triggered by oxidative stress and its resulting cardiovascular diseases (e.g. infarct, arteriosclerosis, etc.) are the number one cause of death in industrial countries, closely followed by tumors (see Fig. 4). Alzheimer’s disease, Parkinson’s disease, diabetes, amyotrophic lateral sclerosis (ALS), among others, show an increasing trend.

Question: Does a causal relationship beyond the presently known risk factors exist?

Numerous consistent scientific findings show that the radiation of cell phone and other wireless communication technologies can produce additional ROS/RNS in living organisms; this can occur in the presence of both ELF magnetic fields as well as RF electromagnetic fields. The energy of these fields that can trigger effects is several orders of magnitude below the average thermal noise level (FRIEDMAN et al. 2007).

RF-radiation-induced increase in free radicals: nitric oxide (NO) and reactive nitrogen species (RNS)

Cell phone radiation at 900 MHz induced increased nitric oxide or NO levels in rat brains. Malondialdehyde (MDA) levels, xanthine oxidase (XO) activity, und adenosine deaminase (ADA) activity were also increased. At the same time, superoxide dismutase (SOD) and glutathione peroxidase (GSH-Px) activities decreased in the brain. These unfavorable changes could be prevented through appropriate doses of ginkgo biloba extract as an antioxidant (ILHAN et al. 2004; for similar results also see OZGÜNER et al. 2005, 2006, PAREDI et al. 2001, YARIKTAS et al. 2005).

RF-radiation-induced increase in reactive oxygen species (ROS)

Numerous single studies demonstrate the production of oxidative stress through nonionizing radiation. The study by MOUSTAFA et al. 2001 showed that cell phone radiation at 900 MHz produces oxidative stress by increasing lipid peroxi-

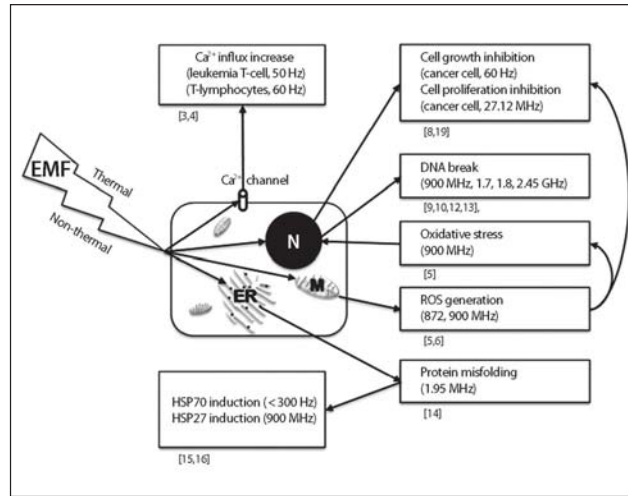


Fig.3: Summary of effects on the cellular level caused by electromagnetic fields (GYE & PARK 2012)
EMF: electromagnetic field; N: nucleus; ER: endoplasmic reticulum; M: mitochondria

ation and interfering with antioxidant activities. This already occurred in adult male volunteers while the cell phone was still in standby mode in their coat pocket. Plasma lipid peroxide levels increased significantly after 1, 2, and 4 hours in standby mode. The activity of the radical scavengers SOD and GSH-Px in human erythrocytes had decreased. It says in the abstract:

“These results indicate that acute exposure to radiofrequency fields of commercially available cellular phones may modulate the oxidative stress of free radicals by enhancing lipid peroxidation and reducing the activation of superoxide dismutase and total glutathione peroxidase, which are free radical scavengers. Therefore, these results support the interaction of radiofrequency fields of cellular phones with biological systems.” (MOUSTAFA et al. 2001, summary EMF-Portal).

A human blood platelet suspension was exposed to 900 MHz cell phone radiation for 1, 3, 5, and 7 minutes. After 1, 5, and 7 minutes, the malonaldehyde (MDA) level increased and at the same time the SOD activity decreased. At 3 minutes, the activity levels were temporarily reversed (STOPCZYK et al. 2002). The 930 MHz cell phone radiation only increased the reactive oxygen species (ROS) level in rat lymphocytes when the cells were treated with iron ions (ZMYSLONY et al. 2004). A study by the Department of Environmental and Radiological Health Sciences, USA, found that melatonin levels - an effective antioxidant - decreased considerably with cell phone calls of longer than 25 minutes (BURCH et al. 2002). The cell phone radiation increased the malondialdehyde (MDA) concentration in rat brains, but not phospholipids and p53 immune reactions (DASDAG et al. 2004, 2009).

RF radiation at 1800 MHz causes damage to the mtDNA. This research project was financed by the Chinese government. In this project, DNA damage in mitochondria of rat cortical neu-

rons was demonstrated, which had been induced by cell phone radiation with a pulse of 217 Hz. The 1800 MHz RF radiation caused the oxidative damage through the formation of reactive oxygen species (ROS), which are implicated in various nervous system diseases (XU et al. 2009).

Additional research findings confirm that RF-EMF causes oxidative stress, and that at power density levels well below the exposure limits (ATASOY et al. 2012, AYATA et al. 2004, AYDIN & AKAR 2011, CAMPISI et al. 2010, CEYHAN et al. 2012, ELHAG et al. 2007, ESKEMAYA et al. 2011, GULER et al. 2010, GUMRAL et al. 2009, GUNAY et al. 2007, KESARI et al. 2010, 2011, 2012, KIHRAZOVA et al. 2012, KOYU et al. 2005, LU et al. 2012, OKTEM et al. 2005, OZGUR et al. 2010, SOKOLOVIC et al. 2008, YAO et al. 2008, YUREKLI et al. 2006). See also the summary paper by Desai et al., in which a detailed effect mechanism is outlined (DESAI et al. 2009).

— Effects on the endocrine system

An increasing number of research findings demonstrate the effect of cell phone radiation on the stress hormone axis. Several studies indicate effects on the endocrine system (AUGNER et al. 2010, BUCHNER & EGER 2011, DJERIDANE et al. 2008, ESME-KAYA et al. 2010, MEO et al. 2010, MISA AGUSTINO et al. 2012, SAROOKHANI et al. 2011, SEYEDNOUR & CHEKANIAZAR 2011, VANGELOVA & ISRAEL 2005). A systematic review of this topic is still missing.

— Electron transport enzymes are magnetosensitive

The stimulation of free radicals including NO by physical fields and radiation has been reliably validated by science. This alone, however, does not prove the existence of damage as long as the primary effect mechanism is not known. A connecting link that explains the adverse effect was shown by Friedman et al.. The enzyme NADH oxidase shows a high - and entirely reproducible - sensitivity to magnetic and electromagnetic fields of cell phones. Friedman et al. found that exposing rat cells to RF-EMF caused an immediate activation of the enzyme NADH oxidase, which resulted in an increased production of free radicals. And the study also offers an effect mechanism: *“This study delineates a detailed molecular mechanism by which electromagnetic fields at mobile phone frequency induces short-term MAPK activation and thereby transcription and other cellular processes. ... The first step is mediated in the plasma membrane by NADH oxidase, which rapidly generates reactive oxygen species.”* (FRIEDMAN et al. 2007, according to EMF-Portal)

NADH oxidase is quite important in another respect. It is also found in the cell nucleus where - depending on the redox system - it can regulate gene expression, but also damage genes (USHIO-FUKAI 2006).

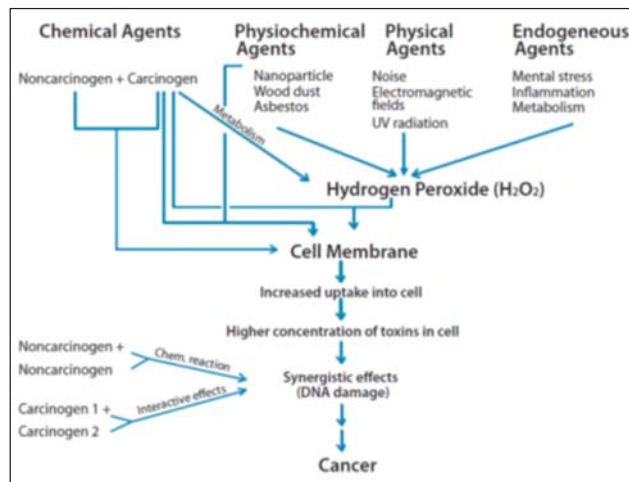


Fig.4: Graph of possible combination effects, which can result in additive and synergistic DNA damage, also including electromagnetic fields (WITTE 2012)

Severe pathological deterioration manifests itself when, due to magnetic field and radio-frequency radiation exposure, additional reactive oxygen species (ROS) such as superoxide radical and hydrogen peroxide are produced that combine with the also increasingly produced NO to form the highly toxic peroxynitrite, which in turn reacts with hydrogen to form even more hydrogen peroxide (see Fig.4).

The agreement between the cascade triggered by magnetic field and RF radiation exposures and the findings of the burn-out research is obvious. Müller writes in his article *Fatigue from the Perspective of Clinical Environmental Medicine*:

“The situation becomes especially critical when, under the influence of environmental toxic agents and / or an increased formation of peroxynitrite, the functioning of the mitochondria is impaired. They have the task of making the energy carrier molecules adenine triphosphate (ATP). There is much to suggest that the functional impairment of the mitochondria is equivalent to the disease pattern called burnout, whereas the prolonged damage to mitochondrial DNA induces chronic fatigue.” (MÜLLER 2012)

As early as 1985, the study by Sanders and colleagues showed a decrease in ATP production due to weak RF radiation exposure (nonthermal effect): *“Since brain temperature did not increase, the microwave-induced increase in NADH and decrease in ATP and CP concentrations was not due to hyperthermia. This suggests a direct interaction mechanism. It is consistent with the hypothesis of microwave inhibition of mitochondrial electron transport chain function of ATP production.”* (SANDERS et al. 1985, according to EMF-Portal).

Both approaches (cell phone research, burnout research) suggest that the mitochondrial dysfunction is a result of damage to the mitochondrial function complexes caused by ROS/RNS: *“Mitochondriopathies lead to progressive inactivation of the respiratory chain and other mitochondrial functions, and in turn to severe neuropathies, encephalopathies, cardio/myopathies, and endocrinopathies.”* (BIEGER 2012).

Extending the lifetime of free radicals

This pathological cascade is enhanced by EMFs because even rather low magnetic field intensities affect chemical reactions and extend the lifetime of free radicals (BROCKLEHURST & MCLAUCHLAN 1996, NEITZKE 2012, WARNKE 2009). The model of Scaiano et al. demonstrates that in the presence of a magnetic field the radical concentration increases. The half-life of free radicals is extended (SCAIANO et al. 1994). The possibilities for radical reactions to occur have thus increased. Within a magnetic field, the lifetime of free radicals is extended in such a way that the electron transfer within the DNA can be affected, which in turn also changes the protein induction (MOHTAT et al. 1998). Magnetic fields extend the lifetime of free radicals by impairing the intersystem crossing in triplet radicals (CHIGNELL & SIK 1995, WARNKE 2009).

Regarding the question of health problems and risks

The effect mechanism documented by Friedman et al. (2007) is of such utmost importance because it shows that there is a well-explained biological basis for the subjective symptoms many people suffer from. By studying the cascades listed below, it is easier to understand why electrosmog is dangerous.

Functional impairments and disease patterns

EMF-induced excessive ROS/RNS stimulation can be divided into three areas of effects, which are run through one after another:

- Stimulation of free radicals,
- Stimulation of highly toxic peroxyxynitrite,
- Stimulation of highly toxic peroxide radical.

The consequences of these processes are serious: cell components are destroyed; antioxidants taken up with food and the electron-rich substances manufactured by the body are used up; the damaging cholesterol increases. Such a person feels tired, tense, fights various inflammations and a broad range of associated illnesses, which show similarities to the burnout syndrome.

Acquired energy dyssymbiosis syndrome (AEDS)

The clinical picture of AEDS or acquired energy dyssymbiosis syndrome describes a deficiency in cell energy with a simultaneous deterioration of the cell milieu. This leads to mitochondriopathy. Energy production (ATP) is blocked; the power plants of the cell are transformed into efficient sources of free radicals. These changes have serious consequences:

Inflammatory processes spread and release additional substances that have adverse effects (tumor necrotic factor TNF α and again nitric oxide) at excessive levels. We should always bear in mind that in our industrial society inflammation-based illnesses continue to increase and that arteriosclerosis such as myocardial infarction - the number one cause of death - is basically one of them. Today this view has gained acceptance among the scientists of the medical community.

Aerobic glycolysis (glycolysis despite the presence of oxygen) is activated as an emergency power generator, which in turn is associated with:

- Stimulation of proto-oncogenes (precursors of oncogenes)
- Increased release of superoxide radicals
- Lactate acidosis (hyperacidosis).

Eventually the genome of the mitochondria will mutate. But exactly this pathological change can also be inherited from the mother. The offspring will have to carry the burden, and the change becomes integrated into the genetic material of generations to come.

This is the disease state of a growing number of people within our polluted environment. It can manifest itself as burnout syndrome or electromagnetic hypersensitivity. This pathological cascade reveals that the nonionizing radiation of wireless communication technologies does not directly cause damage to cells like ionizing radiation does, but it triggers many diseases based on oxidative stress through an indirect pathway by producing free radicals, and thus can cause burnout syndrome or exacerbate it.

H.-P. Neitzke (ECOLOG-Institut) states: *“With the current and soon to be available technology, it will not be possible to realize the AACC visions of “Anytime, Anywhere Communication and Computing” in a manner that is compatible with human health.”* (NEITZKE 2010, EMF-Monitor 6/2010)

(Note: A comprehensive version of this article is published in German as a research report by the Kompetenzinitiative e.V. and Diagnose-Funk e.V.. Available as a free download at: www.kompetenzinitiative.net & www.mobilfunkstudien.de)

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