

BENEFICIAL EFFECTS OF ENVIRONMENTAL GASES: HEALTH PROSPECTIVE

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Abstract

Radioactive radon gas is widely considered to be a health hazard by environmental agencies in the United States and in Europe. Yet despite the warnings of these agencies, thousands of people annually expose themselves to radon for therapeutic purposes, in facilities ranging from rustic old mines, to upscale spas and clinics. The inert natural radioactive gas radon has been used since the beginning of the century in the treatment of rheumatic diseases. In many places in the world, radon is used for therapeutic purposes for various diseases. Radon inhalation is applied in a thermal gallery with atmospheric radon concentrations up to 100 kBq/m³, elevated temperature up to 41°C, and humidity close to 100%, or in the form of radon baths where Rn is emanated from water with high natural Rn activity. Frequently, a combination of both treatment procedures is applied. Evidence from empirical experience and from clinical observational studies suggests that radon has analgesic, anti-inflammatory and immune-stimulating effects.

Ozone is one of nature's most powerful oxidants. It increases the effectiveness of the antioxidant enzyme system, which scavenge excess free radicals in the body. It is used in water purification and sewage treatment and is now being applied medically to treat many diseases from wounds and colitis to cancer, stroke and AIDS. According to the dosage and concentration range, medical ozone is a pharmaceutical agent that exerts specific properties and a well-defined range of efficacy.

This paper describes the medical application of environmental gases: radon and ozone

Introduction

About a century ago, the therapeutic use of the newly discovered gaseous “emanations” from the radioactive elements radium and thorium commenced in Central Europe on a rapidly expanding scale. However, relatively little is known in the English-language scientific and popular literature about the therapeutic use of Rn-222, the noble gas which is a decay product of Ra-226 (with a varying contribution of its further radioactive decay products known as “radon daughters”, in this article summarized as “radon”). Instead, reports about the potential health hazards of radon in mines and homes, claimed to cause large numbers of lung cancers, dominated in recent decades the scientific and popular literature (1-3).

There have been several stages in the history of radon therapy, including the times when it was only indirectly known by its positive effects millennia ago; the first decades of scientific exploration of its properties and concentration in various sources

of mineral waters after its discovery, and uses in old or newly established therapeutic facilities. During this period, the terms “radium” and “radon” were used frequently as synonyms, resulting in names such as “Radiumbad” in German-speaking countries.

Soon the careful medical supervision of the treatment procedures and their results was initiated with many reports on the results, thus narrowing the sometimes very wide spectrum of applications essentially to the first known uses, namely painful rheumatic and arthritic joint and spine diseases. In particular in the former Soviet Union, radon therapy became very widely studied and used, with numerous publications on this subject and over a million of annual treatments.

There have also been doubts about the merits of radon therapy, comparing it with various types of placebo effects in “traditional”, “natural”, or “folk medicine” treatments such as acupuncture, various herbal and animal products, minerals, etc., used for many centuries in Eastern Asia and Africa, or homeopathy in Europe. Some of such cures have been demonstrated in serious animal and human studies as being effective, while most of them clearly belonged into the category of “alternative medicine” placebo effects and the firm believe in the desired effect.

As it turned out, radon did not belong into this category, and in fact helped to prevent the serious side effects of the pharmaceutical treatment of painful rheumatic and arthritic diseases: While it is estimated that, for example, approx. 12.000 persons annually die from side effects of non-steroid antirheumatic drugs such as ASS and diclophenac (mostly due to stomach problems and internal bleeding) in the USA, and approx. 1.000 in Germany (4), no lethal complications have ever been observed from radon treatments. In addition, it is an advantage of radon therapy that it is inexpensively available in poorer parts of the world without affordable access to commercial pharmaceuticals for a large part of the population.

The first written documents on health effects observed in Ischia are by Gulio Jasolino in 1559 on “the natural therapy on the island Ischia”, followed in 1835 by a book by J.E. Chevalley de Rivaz on thermal water treatments in Ischia. In 1917, M. Curie discovered high radioactivity in Lacco Ameno and identified it as radon. Further studies by scientists from the hydrology institutes of Rome and Naples Universities followed soon. The treatment is usually by inhalation or bathing, but also with sand which is also heated by emerging volcanic steam. Main indications for treatment are arthropathies. They are usually applied four times a day at 32-37 °C for 10-15 min., with intermissions between the sessions (5).

The miners had uranium containing ore residues sewn into their clothes. They drank water which originated in the mines, and the local population has been known for a long time to use pitchblende packages for the external treatment of inflammatory diseases (6). A C. Bruschi already wrote in 1548 in a description of the high-radon Fichtelgebirge/Germany: “Here people get very old, have few diseases, and recover quickly if they have any.”

The first publication about the radon in spa water (then called “radioactive emanation”, following a suggestion by E. Rutherford in 1900) appeared in two reports about the thermal sources of Gastein/Austria in 1904 (28, 29). Mache also introduced the first unit for radon activity concentrations, which was named after him (Mache-

Einheit, ME) and mostly used in the German/Austrian region, while the anglophonic countries preferred the “Curie” that had been introduced in 1910 by the First International Radiology Congress.

Further developments followed soon. For instance, in 1906, a list of the radon content in more than 30 sources in 11 spas in Austria, Bohemia, Germany and Italy has been published (Sieveking), with values up to 80.000 Bq/L in Gastein, 70.000 Bq/L in Baden/Germany, and 182.000 Bq/L in Schlema/Germany (Hindenburgquelle) (7). Currently, the Wettinerquelle in Brambach/Germany is considered the strongest in the world, but there are Japanese claims to this “world record”.

Radon treatments can be carried out by inhalation from “natural” sources, e.g. in mine shafts or caves, or by bathing in Rn-containing water. Drinking radon water became less popular as time went by. However, radon can also be produced independently from the availability of local natural sources by “artificially” extracting it from radium sources. The first proposals for the therapeutic use in 1903 in England actually suggested the inhalation of thorium emanation for the treatment of tuberculosis (8). In 1904, the first results of such a treatment have been published (9), and the radon uptake into the human body was at this time studied in Germany (10).

Also in 1904, the first experiments with radon treatments were carried out in Vienna by Neusser and Dautwitz, 1905, who also experimented with the external application of uranium ore material, or uranium-containing sand in bathtubs in order to produce radon-containing water. The first specific application for acute and chronic rheumatism of joints was reported in 1907 in Bohemia (11). Around the same time, a physician in Braunschweig/Germany (Loewenthal in 1906) studied using radon water made from Ra compounds, whether “in small concentrations emanation causes any constant reactions in the healthy of the human body”.

Around the same time, traditional spas in which high radon concentrations had been found, such as Gastein/Austria and Baden-Baden/Germany, had started with specific radon treatments. Probably the first traditional spa that installed an overground radon inhalation facility was Bad Kreuznach/Germany. The “radon inhalatorium” was inaugurated May 18, 1912, and connected to underground mine shafts (12). It was destroyed in WW II, and reopened in 1974 (13). Treatment has also taken place in the mine shafts since 1912. Many similar overground inhalation facilities were later established in France.

In the Association of German Radon Spa Physicians, about 14 German and Austrian radon spas treating approx. 75.000 patients annually are associated and meet regularly for the exchange of data and experiences, and a periodical is since 1994 almost completely devoted to radon balneology (14).

Among the currently most known and popular radon treatment centers with medical supervision are in

- Germany: Bad Brambach, Bad Kreuznach, Bad Münster am Stein, Schlema, Sibyllenbad, Bad Steben,
- Austria: Bad Gastein, Bad Hofgastein, Bad Zell,
- France: Plombières,

- Italy: Ischia, Meran,
- Russia: Pyatigorsk, and
- Japan: Misasa.

In addition, there are numerous less known radon therapy centers, for example nine in Greece with radon concentrations up to 8.000 Bq/L in Ikaria (15),

Painful inflammatory or chronic rheumatic and arthritic diseases, such as rheumatoid arthritis, have historically been the first indications for radon treatment. They are among the most widespread health problems in humans, in particular with advancing age, and still remain the primary indication for radon therapy today. But there are also related illnesses, such as spondylitis ankylosans, a painful permanent bending of the spine, better known as Morbus Bechterew. It occurs in around 0.1 to 5 % of the population, depending on geographic regions and populations. In Europe, the rate is around 0.2 %, and it becomes evident first between 16 and 40 y of age. For the determination of the severity or the degree of relieve, several quantitative parameters such as the maximum possible distance between the head and a wall while standing, and between the fingers and the ground while bending, are easily measurable parameters.

Among the about 7.000 annual patients in Gastein/Austria, most are treated for this disease. In a careful recent study, it has been found that the radon group showed a clear reduction in the pain and improvement of the spine flexibility up to nine months after the treatment (16). Most of the current results of radon balneology have been published in European journals (17), with only few articles in the English-language literature (18, 19).

There still remained doubts about the true effect of radon treatments in large parts of the medical and scientific community, because it evidently contradicted the widespread “official” (regulatory) paradigm of the lung-cancer inducing effects of the alpha radiation from radon down to even extremely small doses. Radon treatments were thus considered part of non-scientific, more or less obscure traditional medicine, and classified as placebo effects by many physicians. One of the problems in the quantification of pain-reducing effects is that there exists not yet a method for absolutely measuring chronic pain. There are, however, well-established methods, such as the application of a defined spot pressure (in kg/cm²) to established pain-sensitive “tender points” on a scale between zero and unbearable pain, and using this scale as a rather well reproducible test. Complicating factors may also be confounders such as other constituents of the mineral waters, and the impossibility to carry out double-blind studies in mine shafts

Between 1961 and 1987 the number of patients increased from 10.000 to 26.000, the average pain threshold in the 16 trigger points in patients treated with pure radon bathes, and with a mixture of 50 % radon and 50 % CO₂, continued to be slightly better among the pure radon patients for at least four months after the treatment (20).

Around 1984 about 10.000.000 (ten million) radon applications were delivered to one million patients annually in spas, sanatoriums, and in outpatient departments of the USSR health system (21).

There have been many types of radon application in USSR, some of which quite different from those in Western Europe, including

- full or partial bathes in bathtubs and swimming pools with and without other balneological components being added,
- partial or full-body air exposures, with or without air circulation
- inhalation (with or without decay products),
- irrigation of nose, mouth, rectum, vagina,
- local applications (ointments, packages, etc.).

The spectrum of indications which has been tried more or (often less) successfully is also very wide, including

- heart and circular problems (hypertonia, etc.),
- blood circulation (arterosclerosis, thrombophlebitis),
- pulmonary problems (asthma bronchiale, chronic bronchitis),
- inflammatory or degenerative diseases of the skeleton (which is in Western Europe nowadays the primary indication),
- diseases of the nervous system (e.g. neurosis),
- chronic inflammations, sterility and climactic problems in gynaecology
- skin problems (psoriasis, neurodermitis, chronic eczema), and
- gastrites, ulcus ventriculi, etc.

The best results have been obtained with rheumatic diseases, in gynaecology, skin diseases and hypertonia. Frequently radon has been used in combination with other agents, depending on the special conditions of the patient.

The contraindications in the SU clinics have been more similar to those in Western Countries: Acute infections, psychic diseases, pregnancy, tumors, active tuberculosis, epilepsy, acute serious diseases of internal organs, infected open wounds, and haematological problems. As a curiosity for Russia, alcohol was also forbidden during the treatment. Incidentally, a classification of radon concentrations in water used for treatments has been used with

- low concentrations up to 500 Bq/L,
- medium concentrations up to 3.000 Bq/L, and
- higher concentrations above this level.

In study done by Strelkova et al.1980 (12), various rheumatic diseases have been compared, in particular groups with 148 patients each with cervical pain syndrome. In the response to 12 bathes at different radon concentrations, and the control group with normal sweet water, 25 % showed improvement with normal water, 40 % at 500 Bq/L, and 55 % at 5.000 Bq/L. However, undesirable side effects were observed above 2.500 Bq/L.

According to Russian studies (23), the radon in bathing water penetrates the skin and forms a depot accumulating up to 60 % of the radon uptake, and reaching 20-30 % of the radon concentration in the water. The radon is then absorbed in the fatty tissues, and the radon daughter products are accumulated in the kidneys. The organ doses for a 15 min. bath at 1.500 Bq/L has been calculated at 0.09 mSv for the skin,

0.003 mSv for the kidney, and 0.0015 mSv for body fat. Two hours after bathing, only 10 % of the original radon intake still remains in the body. Short-lived radon daughters contribute about 70 % to the absorbed dose. Diffusion of free radicals produced in the skin may contribute to the effect by affecting skin receptors and regulatory mechanisms.

More recently, the somewhat general explanations such as the general stimulation of the immune system (e.g. Soto 1997 (24), with 60 references) have been replaced by more detailed studies such as the influence of the Langerhans cells, increase in the enkephalin level, reduction of oxygen radicals in the neutrophils and macrophages, influences on homeostasis, factors influencing the attachment of leukocytes at joint tissues, etc.

For example, in a series of animal (rat) experiments by a Japanese group (25), the effect of inhaled radon on the activity of an important enzyme, superoxide dismutase (SOD) in different tissues has been investigated as a function of the radon concentration, showing substantial stimulating effects in liver and kidney. In conclusion: Unlike the essentially pain-relieving non-steroid drugs, the radon effect is by most experts nowadays considered primarily a stimulating effect on the defensive immune system.

There are recent studies on the surprisingly long-lasting radon progeny activity on skin and hair after exposure to the humid warm air in the Gastein mine shaft (18). Due to these high adhesive properties, the period of exposure of the Langerhans cells is extended, with perhaps systemic effects mediated by their alteration. Otherwise, as demonstrated in measurements of radon exhalation rates in persons submerged in radon water and other investigations, the half-life of radon in the body has repeatedly been confirmed to be short (in the order of a few hours or even less), depending somewhat of the aerosol size distribution in case of inhalation. It accumulates primarily in fatty tissues. In one of those studies, the transfer of radon through the skin to the lungs and exhalation has been studied with human volunteers, resulting in an almost complete exhalation 50 min. after the commencement of a 24 min. bath (26).

One of the problems for the more widespread use of radon therapy are governmental radiation protection regulations, which are based on the ICRP/IAEA/NCRP/EU assumption of the hazards associated with radon. It was well established in recent years that there is a threshold around 600 to 1.000 Bq/m³ in air for the permanent intake, in particular at home and at the working place in areas of high natural U/Ra geological situations, for the lung cancer induction by radon in humans. All the observed effects essentially have been due to smoking.

Nevertheless, the new “radon protection regulations” to be legally enforced in some countries make it very difficult, if not impossible to introduce radon treatment in some countries. In others (such as Austria, Czechia, and Germany) with a long tradition in this field, radon therapy with natural water or air sources is at least tolerated by the authorities, as long as the personnel working there is supervised by personnel monitoring devices, according to the regulations for “radiation workers”. Both passive track etching polymer track etching detectors introduced by the author

some 35 y ago, and more recent electronic systems are widely used for this purpose. Radon balneology continues to flourish in all the traditional radon spas as the world.

Among other problems of the widespread use of radon balneology are:

1. The intense radiophobia caused by anti-nuclear political and media campaigns scaring many potential patients.
2. National health insurance systems, with increasing financial problems due to the demographic and economic situation in Western Europe, are in the process of reducing their services, e.g. by excluding from their coverage “natural” treatments” such as mineral and radon spas.
3. Governmental organizations are split into those responsible for radiation protection, and others in charge of public health. While the first are using all opportunities to promote the public “dangers” due to even low residential and professional radon exposures, the health authorities are becoming reluctant to promote research in areas which some of the public health administrators may consider controversial.
4. Last but probably not least, the influential lobby of the pharmaceutical industry is more interested in promoting the profitable large-scale use of non-steroid antirheumatic drugs, and succeeded to convince most of the medical community of this form of therapy instead of exploring the drug-free and relatively inexpensive radon treatments.

It is well known that the same physical or chemical agent may, depending on dose and other factors, have detrimental as well as beneficial health effects. Regarding radiation, (27).

Regarding radon therapy, it could for precautionary reasons be assumed that there may indeed some negative effect at very high radon levels, and on particularly sensitive persons such as children and pregnant women, which may thus be excluded from treatment. On the other hand, the beneficial effects on people with painful degenerative joint and spine problems far outweigh such minimal, and to a large degree hypothetical potential risks, and should not prevent the therapeutic application of radon under medical control.

Another Environmental gas which is the Ozone is normally present as a gas made of three atoms of oxygen with a cyclic structure. The medical generator of ozone produces it from pure oxygen passing through a high voltage gradient (5–13 mV) according to the reaction:



Whenever orthodox medicine fails to solve the medical problem, the physician has the duty to fully inform the patient of all valid options available before beginning ozone therapy. I dislike antagonizing ozone therapy to orthodox medicine because I believe that there is only good medicine, which is the one that is able to cure the patient. So far our experience is ample only for chronic limb ischemia (30, 31), cutaneous chronic ulcers due to ischemia and diabetes (30, 32), and in the atrophic form of age-related macular degeneration (ARMD) (30). In chronic limb ischemia, the orthodox treatment is performed by prostanoid infusions, but the benefit is inferior and far more expensive than ozone therapy. Ozone therapy really helps about 70% of the ARMD

(dry form) patients (30) because there is no other conventional option. The neovascular, exudative (or wet form) must be first treated with photodynamic therapy (33) or radiation (34) or with other experimental approaches based on blocking the activity of extracellular vascular endothelial growth factor (34).

Other pathologies where ozone therapy can be proficiently combined with orthodox therapies:

1) Acute and chronic infectious diseases, particularly due to antibiotic or chemoresistant bacteria, virus and fungi (30). Even parasitic infections such as giardiasis and cryptosporidiosis have been treated in children by Cuban physicians after administration of ozonated oil (30).

2) Osteomyelitis, pleural empyema, peritonitis, abscesses with fistulae, bed sores, chronic ulcers, diabetic foot, burns, insect and jellyfish stings, infected wounds, onychomycosis and candidiasis. These infections, often supported by antibiotic-resistant bacteria, like methicillin-resistant *Staphylococcus aureus* and poor penetration of antibiotics into infected areas, are responsible for too many cases of death occurring in hospitals of even the most advanced countries. In such cases, ozonated AHT associated with the topical application of ozonated olive or sunflower oils allows a rapid disinfection and enhances healing tremendously. Unfortunately, the use of ozonated oils is hardly known and a detailed description of their preparation, application and results is reported in my most recent book (30).

3) Herpetic infections (HHVI and II), herpes zoster and papillomavirus infection. The modality of the intramuscular injection of minor ozonated AHT, used as an autovaccine and associated with the topical therapy with ozonated oil, is very effective in preventing relapse of herpetic infections. This approach, particularly when used in combination with the acyclovirs, can cure herpetic infections in the majority of patients (30).

4) Autoimmune diseases (multiple sclerosis, rheumatoid arthritis, Crohn's disease): results with AHT seem encouraging but are anecdotal.

5) Other chronic ischemic diseases (cerebral and heart ischemia). Ozone therapy exerts beneficial effects because it can a) increase oxygen, glucose and ATP delivery within ischemic tissues, b) enhance neoangiogenesis and possibly facilitate the implantation of bone marrow stem cells, which can provide neovascularization and tissue regeneration, c) induce the preconditioning phenomena by upregulating the expression of antioxidant enzymes and heme oxygenase I and d) trigger a neurohumoral response for improving quality of life.

6) Degenerative disorders: AHT helps patients in the early phase of senile dementia. On the other hand, it is rarely and minimally useful in diabetic retinopathy, retinitis pigmentosa, sudden hearing loss and chronic tinnitus.

7) Pulmonary diseases: emphysema, asthma, chronic obstructive pulmonary disease (COPD) and acute respiratory distress syndrome. COPD is becoming the fourth cause of death in spite of orthodox therapy based on the inhaled combination of corticosteroids plus long-acting b2-agonists and antibiotics, when necessary (36).

8) Terminal nephropathies are progressively worsened by a chronic oxidative stress not yet controllable by orthodox medicine and therefore ozone therapy could stabilize this serious dysfunction and improve the quality of life of these patients (30).

9) In a similar manner, ozonated AHT combined with topical application of ozonated oil is proving to be very useful in the metabolic syndrome well exemplified in patients with type 2 diabetes suffering from chronic ulcers with no tendency to heal (30).

10) Chemoresistant metastatic cancer; therapy of cancerrelated fatigue: we have reported (30) that a 6-month, biweekly, ozone therapy session in preterminal patients previously heavily treated with chemo- or/and radiotherapy does improve their quality of life but is unable to block cancer progression. On the other hand, ozone therapy may be far more useful immediately after surgery, possibly combined with chemo- or/and radiotherapy. Not only could it potentiate the effect of the cytotoxic drugs but by inducing the antioxidant response, it could reduce chemotoxicity (37)

11) Orthopedic diseases (the problem of backache): the direct intradiscal injection of oxygen- ozone is a great success in about 75% of patients (30, 37) and is one of the few modern techniques able to solve the problem of a hernial disc with a mini invasive approach.

12) Chronic fatigue syndrome and fibromyalgia: AHT has been found beneficial in the majority of patients (30).

13) Dentistry and stomatology: ozone has been found very useful for treating primary root carious lesions (38).

14) Emergency situations such as those occurring after extensive trauma, burns, acute peritonitis and toxic sepsis often lead to multiple organ failure and death. The combination of the best orthodox therapy with three to four daily mild ozonated major AHT can prevent or reduce the worsening of the metabolic impairments and reduce mortality.

Many treated patients loudly say that it is very beneficial. The compliance is excellent and the patients, as soon as the therapeutic effect declines, ask for a new cycle. This is an excellent proof that provided we are using judicious ozone concentrations, there is neither acute nor chronic toxicity. It has been unfortunate that, in the past, the direct intravenous injection of the gas, now prohibited, and misuse of ozone by incompetent quacks has generated the dogma that ozone is toxic and should not be used in medicine. This concept is wrong and has also been based first on non-physiological studies (39) performed in washed erythrocytes, hence unprotected by the plasma antioxidants and second, in not recognizing the profound difference between the endogenous chronic oxidative stress, occurring every day during a lifetime or during a chronic disease, and the calculated, extremely brief and exogenous oxidative stress that we induce on blood by using a precise and small ozone dose. We know that any drug, depending upon its dosage, can be either therapeutic or toxic.

The following elementary observation is even more compelling: the normal glucose concentration in the plasma ranges between 0.7 and 1 mg/mL and is essential for survival. However, when this concentration falls below 0.4 mg/mL, the consequent

hypoglycemic coma can be deadly. On the other hand, if the glucose concentration remains constantly above 1.3 mg/mL, it induces the metabolic syndrome, as is well exemplified by the current diabetic epidemic. Thus, the dogma about ozone toxicity is futile because, after millions of treatments, it was never observed any acute or chronic toxicity. Moreover, most of the patients report a feeling of wellness. Needless to say, ozone therapy does not “cure” ARMD or other chronic pathologies but, by performing the maintenance therapy, it does improve the condition and maintain a good quality of life. On the other hand, even orthodox medicine, with the exception of several infectious diseases thanks to antibiotics, antivirals, antibodies and vaccines and far less frequently of cancer thanks to surgery/chemotherapy, is unable to “cure” most human diseases such as atherosclerosis, advanced cancer, diabetes, degenerative, metabolic and autoimmune diseases.

The great strides of molecular biology and gene therapy during the last decade have not yet been paralleled by comparable advances in therapeutic innovations and many unforeseen difficulties still have to be overcome (40). It is often unable to predict the pitfalls when new treatments are applied from mice to patients. This is probably one reason for the worldwide boom of complementary medicine, not only in underdeveloped countries but also in the U.S. Patients, as human beings, are often disappointed by the high-tech therapist.

One important characteristic of ozone therapy is that it can be experimentally verified both at the biochemical and clinical levels. So far, the most advanced and reliable approach has been the major ozonated AHT but today there are also other technical possibilities and the optimal method could be selected for different pathologies. As far as chronic diseases are concerned, the problem is that official medicine tends to treat symptoms rather than the cause(s) of the disease. Besides the fact that the etiology is too complex or remains obscure, the treatment is often limited and remains unsatisfactory. On the other hand, a simple gaseous molecule like ozone, that probably is even produced in vivo (41), by acting on many targets, at least in part can recover functional activities that have gone astray.

There are good reasons to believe that the therapeutic power of ozone therapy consists of simultaneously improving circulation and oxygen delivery, in enhancing the release of autacoids, growth factors and cytokines and in reducing the endogenous, chronic oxidative stress. In other words, ozone therapy seems to act as a biological response modifier.

Finally, there are some drawbacks. Although the cost of ozone is very low, it represents an impractical drug because it is unstable and cannot be stored in any form. However, by using a portable ozone generator we can perform domiciliary AHT treatments, useful for the elderly and for those patients with chronic diseases. Moreover, rectal insufflation of gas can be easily done by the patient at home, under the ozone therapist’s supervision. Topical therapy of chronic ulcers and infectious wounds with ozonated oil is very practical and easy because we have standard and stable preparations. The last, but certainly not the least, problem is the lack of financial support for performing controlled and randomized clinical trials, whose results are critical and urgently needed to prove the validity and toxicity of ozone therapy in various diseases. Objective results from clinical studies represent the unique possibility of convincing the biased opponents of this approach.

The private ozone therapists, or even the small existing national associations, in comparison to the pharmaceutical industries that can register an annual profit of 340 billion dollars, have no financial power.

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