

## Effect of GSM-900/1800 microwaves on concentration of exhaled nitric oxide in humans

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### Objective

Endogenous nitric oxide (NO) plays an important role in a large number of biochemical processes in human body. These molecules are involved in the transmission of nervous impulses, regulation of vascular tension and the development of inflammation. For example, gaseous NO, which is produced in upper airways and present in exhaled air, is useful for the detection of inflammation processes in patients with respiratory diseases (bronchial asthma, bronchitis, etc.). The possibility of using endogenous NO in human breath as gaseous bio-marker for noninvasive diagnostics of complications and disorders caused by, or related to, human exposure to electromagnetic fields generated by cellular phones (CPs) was the aim of this study.

### Method

10 healthy volunteers with no chronic diseases, aged between 27 to 50 (70% female, 30% male), were involved in the trial. Exposure was to a GSM cell phone operating at 900/1800 MHz, and a UF-chemiluminescence NO analyzer was used to measure the NO content in exhaled air. Sensitivity of the NO detection with this technique was about 0.5 ppb (part per billion), the response time being better than 0.1 second. Special oscillators (Intl. patent application: WO 93/25270) were used to protect test subjects from the electromagnetic fields of the CP. Preliminary control measurements of exhaled NO were made on all subjects for a period of 5 days, prior to the start of the experiment. Individual concentrations of NO were measured, and their temporal variations observed; these were used to normalize the subsequent measurements. All subjects were asked to use a CP for 45 minutes per day for four weeks. During the first two weeks, the CPs were unprotected, but during the second two weeks, all subjects had Tecno-AO oscillators attached to their CPs – see Figure 1. Measurements of the NO content in the bronchial part of the exhaled air were conducted on all subjects every working day, between 10:00 and 12:00 a.m. Ergonomic and environmental symptom checks were conducted weekly for every subject in order to monitor the condition of their health during the course of the experiment.

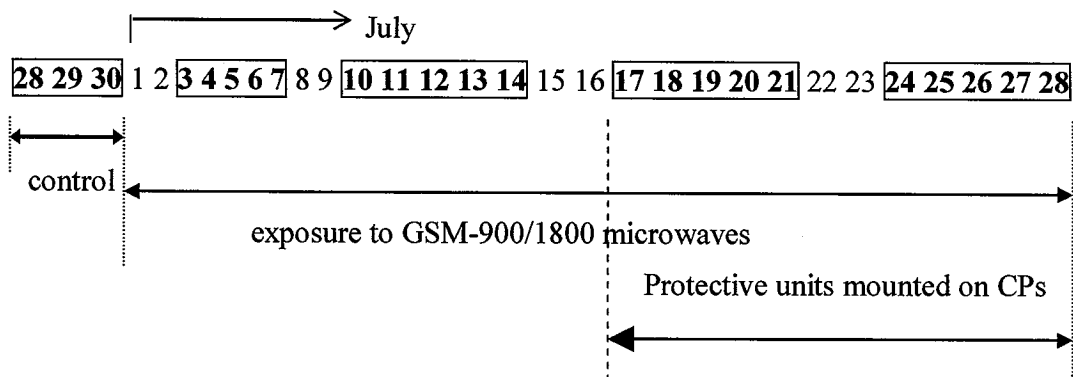


Figure 1. Time schedule of the experiment

## Results

Data from only 6 persons was used, because one person got an acute respiratory infection, two others displayed strongly fluctuating unstable readings, whilst the fourth person needed to break her participation in the experiment. A plot of the normalized NO content, averaged over these 6 subjects, is shown on Figure 2. An increase by about 40% of this average value is evident for the time interval corresponding to the maximum chronic exposure to CPs without protection, with a standard deviation (SD) of ~35%. At the beginning of the third week of the experiment, each CP was equipped with the above oscillator, and after 10 days, the NO level had returned to its initial state. It should be noted that the effect of CP on NO production and the protective effect are *not* artifacts of any filtering of the data; averaging over all the 10 persons tested does not obliterate the biological effects of the CP and

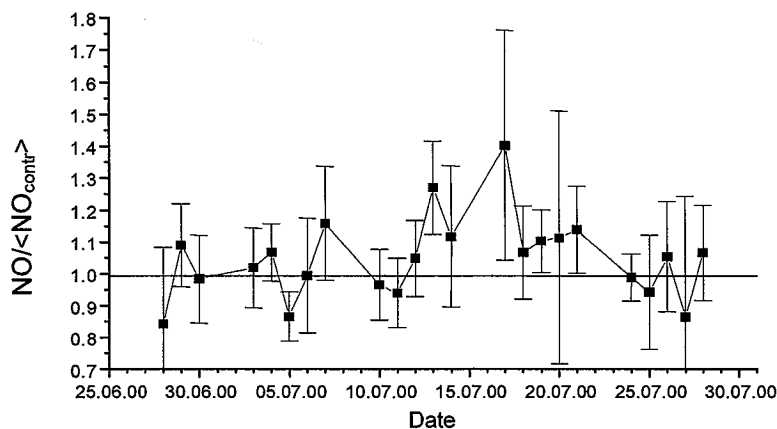


Figure 2. Nitric oxide concentration (normalized values, mean over 6 persons) in exhaled air

protection, although a reduction to about 7% is found. These preliminary data, which need further statistical improvement, correlate with the results of the ergonomic and environmental symptom checks, in particular, of (i) *Symptoms*: headaches; cough/sneezing; dry, itchy or tired eyes; blocked or runny nose; tiredness/fatigue; rashes, itches, dry skin; cold or flu like symptoms; dry throat, thirsty; sore throat; breathing difficulties, (ii) *Pain stiffness or discomfort in*: lower back; shoulders; neck; arms &

elbows; hands, wrists & fingers, (iii) Occasionally feeling: irritable, tense; depressed/pessimistic, and (iv) Occasional problems with: concentration; short term memory; sleeping difficulties. The total symptom score was 12 for the control week, and 18, 20, 14, and 8 for the weeks of the experiment.

## **Conclusion**

An increase of the end-tidal NO concentration in exhaled air was observed (for the first time) after intermittent exposure to GSM cell phone radiation for 2 weeks. After fixing the protective units to the CP handsets, the NO concentration was found to return to the control level.