

# Mortality of Chicken Embryos Continuously Exposed under GSM Cell Phone and Validation of the Effectiveness of a Protective Device\*

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GSM cell phones radiate microwaves (MW), as well as extremely low frequency (ELF) fields. We investigated potential interference from GSM cell phone radiation, either as a whole (MW + ELF fields) or with substantially attenuated MW power (i.e. mainly restricted to its ELF component), with embryonic development in chickens. The effectiveness of a protective device designed to reverse pathological effects associated with irradiation was also assessed.

The source of electromagnetic (EM) radiation was a commercial 900 MHz GSM digital cell phone (SAGEM, France) with 2W maximum power output. When necessary, grounded copper gauze (Soulas & Cie, Montreuil Sous-Bois, France), with sufficiently fine mesh diameter (350  $\mu$ m) and permeable to ELF fields, was used to attenuate the power of MW involved in the cell phone EM spectrum. The magnitude of MW and ELF fields was measured and showed the highest power in close proximity to the cell phone case and aerial. The study was initiated with fertilized chicken eggs from the Kabir Blache strain (Couvoir Cévennes Camargue, France). Four groups with 60 eggs each were studied. The control group was incubated in the absence of the cell phone. The cell phone group was exposed under operating cell phone, i.e. under whole EM spectrum of the cell phone. The cell phone + protective device group was exposed under operating cell phone equipped with the protective device. The cell phone + copper filter group was exposed under operating cell phone, but was shielded from MW by means of the copper filter. The cell phone was held horizontally, 4 cm above the egg surface. The eggs were incubated for 21 days under  $38 \pm 1$  °C, 45-50% humidity and permanent darkness. Irradiation was continuous during embryonic life (21 days). Embryonic mortality was noticed by candling the eggs at 2-day intervals from 3 to 13 days of embryonic development (ED3, ED5, ED7, ED9, ED11 and ED13) and on the day of hatching (ED21). Each assay group was studied with concurrent control group and 7 independent experiments were performed: experiments 1-3 (cell phone vs. Control); experiments 4-5 (cell phone + protective device vs. Control); experiments 6-7 (cell phone + copper filter vs. Control).

Overall mortality was higher in the cell phone and cell phone + copper filter groups than in their respective controls. Relative to total number of dead embryos, mean mortality rate specifically induced by the cell phone radiation was 52 % in the cell phone group and 54 % in the cell phone + copper filter group. In both instances, radiation and mortality distribution maps overlapped, and maximal mortality density for irradiated embryos occurred in the vicinity of the cell phone, contrasting with sparse distribution for controls. The death rate specifically induced by radiating cell phone equipped with the protective device (cell phone + protective device group) was 15 % and was comparable to mean mortality rate recorded in the control group for overall experiments (14 %). Meanwhile the mortality map displayed a rather sparse distribution comparable to that observed for controls.

Taken together, these findings indicate that GSM cell phone radiation, either as a whole (MW + ELF fields) or mainly restricted to its ELF component, was toxic for chicken embryos. This lethal effect was mitigated by the protective device tested.

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\*) Original paper