Japan EMF Information Center

Rapid Response Group*

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Paper: An assessment of illness in U.S. government employees and their families at overseas embassies.

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Introduction: A standing committee of the US National Academies of Sciences, Engineering and Medicine was convened to advise the Department of State (DOS) on unexplained health effects among US Government employees and their families at overseas embassies. Embassy staff in a number of different countries, including Cuba and China, have reported various symptoms that were not common to all employees, and included headaches, nausea, dizziness, loud sounds, feeling of severe pain and intense pressure on the face, as well as cognitive dysfunction. This included staff serving in both US and Canadian embassies in these countries.

Similar health complaints were reported by staff at the US embassy in Moscow in the early 1960s to mid 1970s. This was thoroughly investigated by a group from Johns Hopkins University (Lilienfeld et al. 1978) and by the US Food and Drug Administration's Bureau of Radiological Health (Silverman, 1980), who conducted an exhaustive comparison of the health status of State Department employees who served in Moscow, with the health status of US employees working in other Eastern European posts during the same period. A detailed report of these investigations was compiled by Pollack (1979), who concluded, that there was no convincing evidence to implicate the exposure to microwaves at the Moscow embassy in the causation of any adverse health effects. However, over 50 years later, EMF technologies have made rapid advances, so claims of health effects from embassy staff in overseas locations should be investigated.

This review only addresses the standing committee's conclusion that "…considering the information available to it and a set of possible mechanisms, the committee felt that many of the distinctive and acute signs, symptoms, and observations reported by DOS employees are consistent with the effects of directed, pulsed radio frequency (RF) energy."

Methods: The 19-member committee collected health information and investigated possible causes of these non-specific, clinical signs and symptoms to determine whether they could be caused by infectious disease, chemical exposure, psychological issues or physical stimulation. While experts on microwaves provided reviews of the committee's text, it appears from the standing committee membership there were no experts on the health effects of microwaves, specifically as microwave exposure relates to the symptoms reported by embassy staff.

Unfortunately, the committee "faced several challenges in assessing these clinical cases, including lack of access to individual-level health and other information, evolving and changing clinical features over time, and a highly heterogeneous population in terms of the timing and type of clinical symptoms and signs, to include those whose symptoms were only acute, only chronic or both.".

Also important was the fact that the committee could not conduct or have access to any measurements within the embassies, especially for the RF environment.

While the committee was able to conduct direct discussions with many of the embassy staff involved, they had no measurement data to work with, and could only make an analysis of the reported symptoms to suggest a cause, thus precluding being able to make definitive conclusions about the causes and origins of the health effects. In the foreword to the review, it notes that the committee "was not in a position to assess or comment on how these DOS cases arose, such as a possible source of directed, pulsed RF energy and the exact circumstances of the putative exposures."

Results and discussion: In assessing the clinical symptoms reported by embassy staff, the committee summarised them as follows: "A distinct set of unusual clinical manifestations occurred abruptly in some individuals at the onset of their illness, and the illness became chronic and debilitating for some, but not for all. The most distinctive clinical aspects of the illnesses were the nature of the onset and the initial features: the sudden onset of a perceived loud sound, a sensation of intense pressure or vibration in the head, and pain in the ear or more diffusely in the head. Most individuals reported that the sound or these other sensations seemed to originate from a particular direction and were perceived only when the individual was in a specific physical location. Some also reported sudden onset of tinnitus, hearing loss, dizziness, unsteady gait, and visual disturbances."

Following an analysis of possible causes of embassy staff symptoms, the committee finally suggested the most plausible mechanism was directed, pulsed radio frequency (RF) energy. Members felt this was consistent with the unusual presentation of acute, directional or location-specific early phase signs, symptoms and observations they reported. The committee then sought evidence for this mechanism from the scientific literature, which is substantial and the quality of the studies is highly variable.

Scientific support for the committee's probable mechanism includes a number of studies that have neither been replicated or are unsupportive of the mechanism. A review of "selected" studies by Pall (2016) included a high number of cross-sectional studies to prove a relationship between electromagnetic fields and depression and other symptoms. This type of study is not suited to give evidence for the symptoms reported. Pall also includes an extremely low frequency electric and magnetic fields study (Lisi et al., 2006) with the studies of RF fields to claim that RF fields induce neuropsychiatric effects, supposedly via voltage gated calcium channels (VGCCs). Wood and Karipidis (2020) published a very comprehensive review of the action of RF on VGCCs, which included reviews by Pall. Wood and Karipidis concluded that the currents induced by RF fields at the ICNIRP (2020) guideline limits are many orders of magnitude below those needed to affect gating, and there would need to be a biological mechanism for detection and rectification of the extremely-low-frequency (ELF) modulations, which has not been demonstrated. Overall, experimental studies have not validated that RF fields affect Ca^{++} transport into or out of cells.

In addition, the committee's support for the mechanism of directed, pulsed RF energy is based on Salford et al. (2003), who suggests nerve cell damage occurs from mobile phones (never replicated), Ilhan et al. (2004) suggesting ginkgo biloba prevents mobile phone-induced oxidative stress in rat brain, and a speculative hypothesis (Froehlich et al., 1988) for which there is no supporting evidence.

A better approach would have been to cite "blue ribbon" committees that have conducted comprehensive reviews of all relevant studies, and drawn conclusions that could be established from quality science, such as those of the European Commission (SCENIHR, 2015) or the International Commission on Non-Ionizing Radiation Protection (ICNIRP, 2020), that recently

published their updated RF standards, and specifically addresses this topic. The recently revised C95.1-2019 standard developed by the International Committee on Electromagnetic Safety (ICES) of the Institute of Electrical and Electronics Engineers (IEEE, 2019) also has reviews on the biological and health effects of electromagnetic exposures.

Human studies: The committee's statement that symptoms such as dizziness, headache, fatigue, nausea, anxiety, cognitive deficits and memory loss are "consistent with known RF effects" is inconsistent with the results of dozens of high-quality double-blind experiments conducted with human volunteers. Systematic reviews of studies have not provided evidence for a relation between the RF exposures and the symptoms (Schmiedchen et al., 2019) or physiological responses that might explain the symptoms (Rubin et al., 2011). Similarly, no relation has been found for long term exposures from observational studies (Röösli et al., 2010, 2011; SCENIHR, 2015; SSM, 2018). The studies reviewed are all from exposures at relatively low exposure levels, including pulsed RF.

Sound perception and microwave hearing: The perceived loud sound and its directional dependence described by embassy staff were reasons why pulsed RF exposure might be a focus, since "microwave hearing" is a well-documented phenomenon (Frey, 1962; Chou et al., 1982; Lin and Wang, 2007; Yitzhak et al., 2009). However, the induced sound is very weak, even with the head exposed next to the antenna, and can only be heard in a very quiet environment. The committee noted most individuals reported the sound or other sensations seemed to originate from a particular direction. This does not support the cause being exposure to pulsed RF causing microwave hearing, since Frey (1961) and Elder and Chou (2003) confirmed that the apparent location of the perceived sound was a short distance behind the head and at the same location regardless of the body's orientation to the pulsed beam (radar). The loud sound and direction of origin do not fit the characteristics of microwave hearing, which is a very faint sound and no sound localization.

Elder and Chou (2003) noted that high peak power microwave pulses, with sufficient energy, can cause a "click" perception, even at very low average power densities (6 minutes average). But these pulses would not cause "a loud sound". Trains of microwave pulses can cause a buzzing sound at lower peak power density. In this case the average power density is not so small. The perception threshold for microwave hearing was reported to be at least 90 mW/cm^2 or 820 V/m peak and 0.32 mW/cm^2 average (Frey and Messenger 1973). Exposure levels would have to be much higher in both peak electric field and average power density to elicit a sensation of "a loud sound".

Guy and Chou (1982) reported high intensity pulsed exposures can stun rats when the brain temperature reaches 46 ^{O}C. The stun effect required a specially designed waveguide to deliver intense microwave energy to the rat brain. The threshold energy absorption rate for producing the stun effect is 28 kJ/kg, which is many orders of magnitude higher than the microwave hearing effect thresholds in the range of 5-180 mJ/kg.

Foster (2018) summarised the evidence for microwave hearing and the effect of RF pulses on brain cells. "To elicit auditory sensations, individuals must be exposed to intense but brief (microsecond) pulses of microwave energy. The pulses are sufficient to heat brain tissue by a few microdegrees in a few microseconds, and the resulting thermal expansion launches an acoustic wave in the brain that the subject perceives as sound. The acoustic pressures are many orders of magnitude too weak to cause tissue damage. They elicit audible sensations only because of the exquisite sensitivity of the human auditory system, and represent a near-threshold hearing phenomenon. To actually damage the brain, the microwaves would have to be so intense they would actually burn the subject, which has never happened in any of these incidents."

Other possibilities relating to a non-RF explanation for the sound were not discussed in the report. However, US personnel in Cuba released a recording of the high-pitched sound. When the sound

was analysed by a team of biologists, they identified it as the calling song of a short-tail cricket (Stubbs and Montealegre-Z, 2019). Others have suggested it could be a by-product of ultrasonic listening devices (Foster, 2018).

Electromagnetic interference

The committee noted that when embassy staff symptoms occurred there was no reported interference with any electrical device. The committee cites Hoad (2007), a doctoral thesis that discusses electromagnetic disruption, such as compromising the function of information systems. Hoad's thesis does not deal with simple electromagnetic interference effects, for example creation of "noise" on computer monitors, interfering with Wi-Fi etc. So, this reference is not relevant to the question whether high power RF pulses could have caused electromagnetic interference.

Interference immunity of electronic equipment is tested at the levels of 1 – 30 V/m (IEC, 2010). Electronic equipment can therefore experience interference by electromagnetic fields above the test level. Severe interference of personal computer was reported from exposure to electromagnetic fields at 200 – 2 000 V/m (Hoad, 2004). So, an RF exposure to elicit the sensation of "a loud sound" would interfere with digital equipment. Further, the RF fields from cell phone base stations typically range from 0.03 – 3 V/m (Rowley and Joyner, 2012). Interferences with existing telecommunications would reasonably be expected to have occurred if such high peak power microwaves were used on embassy staff.

Transcranial magnetic stimulation (TMS) and RF action on nerves: The committee states that the benefits from purposeful short-term exposures to therapeutic neuromodulation (transcranial magnetic stimulation, TMS) contrast with the adverse neurologic and neuropsychiatric symptoms described by individuals exposed to electromagnetic fields (e.g., high tension electrical transmission cables) over longer periods of time (Pall, 2016) as summarized by Stein and Udasin (2020). However, the nature of the exposure applied for TMS is very different from exposures resulting in "microwave hearing". For TMS techniques strong low frequency magnetic fields are applied to induce relatively strong electric fields that may depolarize nerves cells (see e.g., Hansson Mild and Møllerløkken, 2018). The committee's statement about TMS is not relevant when discussing a potential effect of microwaves.

The much higher frequency exposure from microwaves will not have any similar effect on neurons (ICNIRP, 2020). The "vibrations" of tissue due to thermoelastic expansion caused by high intensity pulsed microwaves may stimulate the sensory cells in the labyrinth of the inner ear, which again will stimulate the afferent nerves. However, there is no indication that pulsed microwaves have a direct effect on other nerve cells.

Chou and Guy (1978) studied nerve conduction in isolated neurons (an effect known to be temperature sensitive), and showed no nerve stimulation at specific absorption rates (SARs) up to 1500 W/kg (CW) or up to 220 kW/kg (PW), when the nerve was kept at its normal temperature by cooling techniques. Chou et al. (1982) demonstrated that cochlea microphonics are induced in guinea pigs and cats by microwave pulses which indicated mechanical vibrations in the cochlea (due to thermoelastic expansion pressure) and not due to direct auditory nerve stimulation.

Mass psychogenic illness: An alternative explanation for the reported symptoms is mass psychogenic illness. "The committee noted two constellations of signs and symptoms, one of them acute, occurring at the onset of some cases with more distinct and unusual features, and the other chronic, occurring later in the course of these cases or with subacute onset in other cases. However, in the absence of patient-level data, the committee could not identify index versus subsequent cases. Furthermore, the committee received no epidemiological evidence about patterns of social contacts that would permit a determination about possible social contagion. Without access to these data, a

retrospective diagnosis of mass psychogenic illness is considered to be speculative at best and subject to necessary criticism (Jacobsen and Ebbehøj, 2016, 2017; Jansen et al., 2016). Thus, the committee was not able to reach a conclusion about mass psychogenic illness as a possible cause of the events in Cuba or elsewhere."

While the committee did not reach any conclusion about mass psychogenic illness as a possible cause of the unusual pattern of symptoms, it is a common cause of symptoms that are attributed to a hazardous exposure (Page et al., 2010). Certainly, this illness is a much more likely cause of the symptoms than directed microwave energy. Mass psychogenic illness is characterised by subjective symptoms in the absence of any objective markers of disease or any identifiable, physical exposure. Symptoms are often triggered by an initiating event that is interpreted as threatening, particularly if it coincides with someone else who has a high social status displaying or reporting symptoms (Bartholomew and Wessely, 2002). In such incidents, the belief that an exposure is harmful can lead people to experience symptoms, regardless of the nature of the exposure itself (Webster et al., 2016). This has been demonstrated, among other things, for RF fields (Witthoft and Rubin, 2012), chemical exposures (Winters et al., 2003), and infrasound from wind turbines (Crichton and Petrie, 2015). Such 'nocebo' effects can also coincide with other pre-existing or coincidental symptoms becoming attributed to the putative exposure (Rief and Broadbent, 2007). An explanation based on mass psychogenic illness has already been suggested as being consistent with many of the features of the incident, including the heterogeneity in symptoms, the spread of the illness to staff in other embassies and countries, and the lack of any generally accepted organic abnormality (Bartholomew and Baloh, 2020).

Conclusions: Science can never prove a negative; that something does not happen. The best science can do is produce high quality studies that provide convincing evidence that an agent does or does not cause an effect. The committee could not "…rule out other possible mechanisms and considers it likely that a multiplicity of factors explains some cases and the differences between others. In particular, the committee could not be certain that the individuals with only the chronic set of signs and symptoms suffered from the same cause(s) and etiologic mechanisms as those who reported the initial, sudden onset set of signs and symptoms." However, a more thorough job of reviewing the quality scientific literature should have been done before reaching its conclusion that "the unusual presentation of acute, directional or location-specific early phase signs, symptoms and observations reported by DOS employees [is] consistent with the effects of directed, pulsed radio frequency (RF) energy".

Factors that decrease the plausibility of the sounds perceived by embassy staff being due microwave hearing include:

- Huge peak and average microwave power densities would be needed to elicit the sensation of "a loud sound". This would require large microwave generating equipment, such as military radars, used close to the target.
- Embassy staff did not report any thermal sensation that would be caused by high average power densities.
- There were no reports of electromagnetic interference that would certainly result from exposure to such high peak power densities.
- The reported directional nature of the sound does not fit the description of the microwave hearing effect.

Not only would it be technologically challenging to produce such equipment, but no convincing evidence has been produced that pulsed RF at high or low powers can produce the symptoms reported by State Department staff or account for the incidents that occurred to US embassy personnel in Havana and China. Ultrasonic listening devices have been suggested as a cause of the

sound (Foster, 2018), while mass psychogenic illness and related psychological mechanisms remain a plausible explanation for the symptoms (Bartholomew and Baloh, 2020).

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Annotation from JEIC:

* Rapid Response Group (RRG): The RRG provides a rapid response on the analysis of newly published scientific studies that JEIC considers important and in need of expert scientific review to provide information for all stakeholders. The RRG is composed of a coordinator and experts in all areas of science appropriate for reviewing and assessing scientific studies. Prof. M. H. Repacholi has served as the coordinator from the time of launch of RRG in 2010.

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