Electrohypersensitivity and multiple chemical sensitivity: two clinic-biological aspects of the same disorder?

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Inclusion criteria

1. Absence of known pathology.
2. Reproductibility of symptom occurrence under the influence of electromagnetic fields (EMFs) and/or multiple chemicals whatever their incriminated source.
3. Regression or disappearance of symptoms in the case of EMF and/or multiple chemical avoidance.
EHS and/or MCS-self reporting patients:
A prospective clinical study

Total investigated: 1216
Total presently analyzed: 839
Neither EHS nor MCS: 29
Not evaluable: 83
Evaluable: 727
  EHS: 521
  MCS: 52
  EHS+MCS: 154

Sex ratio:
  495F (68%)
  232M (32%)

Age:
  Mean: 47.9+/-12.4
  Median: 47 [16-83]

Origin: Patients from France, Europe, Northern America, Other ...
## Age and sex ratio in EHS and/or MCS self-reporting patients

<table>
<thead>
<tr>
<th></th>
<th>EHS</th>
<th>MCS</th>
<th>EHS/MCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>521</td>
<td>52</td>
<td>154</td>
</tr>
<tr>
<td>Mean age</td>
<td>48.2+/-12.9</td>
<td>48.5+/-10.3</td>
<td>46.7+/-11.2</td>
</tr>
<tr>
<td>Median age and [extremes]</td>
<td>48 [16-83]</td>
<td>47 [31-70]</td>
<td>46 [22-76]</td>
</tr>
<tr>
<td>Sex ratio</td>
<td>344F/177M</td>
<td>34F/18M</td>
<td>117F/37M</td>
</tr>
<tr>
<td>percentage</td>
<td>66%</td>
<td>65%</td>
<td>76%</td>
</tr>
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</table>
Histamine in the peripheral blood of EHS and/or self-reporting MCS patients

<table>
<thead>
<tr>
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<tr>
<td>N</td>
<td>521</td>
<td>52</td>
<td>154</td>
</tr>
<tr>
<td>Histamine &gt;10 nmol/l</td>
<td>182/491 (37%)</td>
<td>18/44 (36.7%)</td>
<td>59/142 (41.5%)</td>
</tr>
</tbody>
</table>
Histamine release by neuroinflammation-associated cells

In the healthy brain the “bulk” concentration of histamine is very low. Upon brain injury, degeneration or infection, the inflammatory response may trigger degranulation of mast cells, leading to a massive release of histamine in the blood and in the cerebrospinal fluid, leading to an increase of blood brain barrier (BBB) permeability through oxidative stress.

Rocha et al. Front Cell Neurosci. 2014 Apr 30;8:120.
Stress-induced neurogenic inflammation involving histamine synthesis by inflammatory cells and mast cell degranulation - Histamine release as a key mechanism in Electromagnetic field intolerance syndrome (EMFIS)

- Constant 35 mT magnetic fields
- Small constant applied electric fields
- Magnetic fields at 50 Hz and:
  - 2 kA/m
  - 16 kA/m
  - 32 kA/m
- Pulsed electromagnetic irradiation of 100 mT magnetic induction

HISTAMINE (NO) 

Blood brain barrier opening

S. Gangi and O. Johansson. A theoretical model based upon mast cells and histamine to explain the recently proclaimed sensitivity to electric and/or magnetic fields in Humans. Medical Hypotheses. 2000, 54, 663-671.
Auto-antibodies in the peripheral blood of EHS and/or MCS self-reporting patients

<table>
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<tr>
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<tbody>
<tr>
<td>n</td>
<td>521</td>
<td>52</td>
<td>154</td>
</tr>
<tr>
<td>Anti-O-myelin</td>
<td>109/477 (28.8%)</td>
<td>8/47 (17%)</td>
<td>33/140 (23.4%)</td>
</tr>
<tr>
<td>Anti-Hsp 70 &gt;5 ng/ml</td>
<td>91/486 (18.7%)</td>
<td>4/52 (7.7 %)</td>
<td>36/142 (7.6%)</td>
</tr>
<tr>
<td>Anti-Hsp 27 &gt; 5ng/ml</td>
<td>123/476 (25.8 %)</td>
<td>6/52 (11.5 %)</td>
<td>42/132 (11.5 %)</td>
</tr>
<tr>
<td>Anti-O-myelin and/or anti-Hsp70 and/or anti-Hsp27</td>
<td>197/457 (43.1 %)</td>
<td>12/48 (25 %)</td>
<td>65/127 (52 %)</td>
</tr>
</tbody>
</table>
How to interpret the increase in anti-O-myelin, anti-Hsp70 and anti-Hsp27 auto-antibodies?

Protein can be modified by oxidation. Extensive oxidative leads to denaturation and loss of biological activity, while initial step of oxidation may change their specificity due to the chemical alteration of the paratope*.

Our hypothesis is that under the influence of electric and/or electromagnetic fields and/or chemicals, oxidation of cerebral proteins may progress to auto-immunoreactivity leading to the occurrence of auto-antibodies against O-myelin and the chaperone proteins Hsp70 and Hsp27, which therefore lose their cell defensive properties.

S100B protein and nitrotyrosin in the peripheral blood of EHS and/or MCS self-reporting patients

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<tr>
<td>N</td>
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<td>52</td>
<td>154</td>
</tr>
<tr>
<td>S100B &gt;0.105 µg/L</td>
<td>73/495 (14.7%)</td>
<td>6/51 (19.7%)</td>
<td>28/142 (10.7%)</td>
</tr>
<tr>
<td>NTT* &gt;0.9 µg/ml</td>
<td>77/259 (29.7%)</td>
<td>6/29 (26%)</td>
<td>22/76 (28.9%)</td>
</tr>
<tr>
<td>Increased S100B and/or NTT</td>
<td>133/250 (53.2%)</td>
<td>12/22 (54.5%)</td>
<td>46/73 (63%)</td>
</tr>
<tr>
<td>Increased histamine, S100B and/or NTT</td>
<td>220/327 (71.8%)</td>
<td>27/36 (75%)</td>
<td>91/125 (79.1%)</td>
</tr>
</tbody>
</table>

*Nitrotyrosin is a marker of peroxinitrite (ONOO⁻) production: \( \text{O}_2^- + \text{NO}^+ \rightarrow \text{ONOO}^- \)
# How to interpret S100B and NTT increase?

<table>
<thead>
<tr>
<th>DATA</th>
<th>interpretation</th>
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<tbody>
<tr>
<td>S100B NTT</td>
<td>BBB opening* (cerebral hypoperfusion)</td>
</tr>
<tr>
<td></td>
<td>BBB opening** (oxidative stress)</td>
</tr>
</tbody>
</table>


24H urine melatonin/creatinine ratio in EHS and/or MCS patients

**EHS (N=300)**
- Mean: 0.042 +/- 0.003
- Lower limit of normal: [0.002-0.625]

**MCS (N=21)**
- Mean: 0.041 +/- 0.016
- Lower limit of normal: [0.005-0.344]

**EHS/MCS (N=89)**
- Mean: 0.048 +/- 0.006
- Lower limit of normal: [0.001-0.343]
Cerebral hypoperfusion in EHS and/or MCS self-reporting patients

Cerebral hypoperfusion is not specific but is a quasi-constant fundamental abnormality similar to that found in Alzheimer’s disease and other neurodegenerative disorders.
Echodoppler of the middle cerebral artery

Explore 60% of the hemisphere

ARTAC
Centimetric ultrasound recording of cerebral pulsatility: Encephaloscan

- Combination of a computer with a cerebral tomosphygmograph
- Source emitting pulsed ultrasounds
- Explore the temporal lobes
Are EHS and MCS syndromes two aspects of a unique pathologic disorder involving the limbic system and/or the thalamus?

1. Similar symptomatic pictures
2. Similar biological abnormalities
3. Opening of the Blood Brain Barrier in both cases
4. Association in the same patient
5. Similar therapeutic results
Scientific arguments strongly suggesting that self-reported EHS and/or MCS are causally-related to EMF and/or chemical exposure

1. No already recognized pathology
2. Appearance and disappearance of clinical symptoms as well as imaging and biological abnormalities depending on electromagnetic source exposure
3. Biological abnormalities detected in humans identical or similar to those observed in experimental animals submitted to EMFs
4. Association of MCS with EHS
5. Limited or no value of negative retrospective interview-based epidemiological studies because of a lack of science-based inclusion criteria and immediate and/or retrospective memory deficiencies
Thank for your attention!

www.ehs-mcs.org