Preventive Telemedicine Challenges in Russia

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Features of Russian Healthcare

* Most of qualified physicians concentrate in big cities, biggest part in Moscow. Direct access to qualified medical assistance in rural or distant regions in most cases is impossible.

* Big distances create problems in transportation of ill people, so medical monitoring of the population and preventive telemedicine become extremely important.

* Population is aging, need for medical help is increasing.
90% of Mortality from Chronic Diseases

- Cardiovascular diseases
- Cancer
- Respiratory diseases
- Diabetes
The system is based on proven diagnostic methods of noninvasive health monitoring.

Proven methods are supported by multiple simple sensors, providing additional robustness and predictive power to the RMMS system.
Synergetic Breakthrough

- Multiple simple measuring devices combined with basic devices with proven efficiency may significantly increase reliability and predictive power of the technology
Basic Noninvasive Sensor Technique #1: Optical Biomedical Skin Diagnostics

Fluorescence Detector

Model 213 for skin analysis

The Fluorescence Detector Model 213 (NPO “Khimavtomatika”, Moscow) can measure endogenous fluorescence in vivo on human skin. A fiber-optic bundle accessory transmits light to the skin and returns the fluorescence emission to the detector.

The Model 213 is capable of in-vivo monitoring of endogenous skin fluorescence from a highly scattering background such as human skin, with high sensitivity and precision.
Fluorescence spectroscopy has demonstrated a way to characterize and quantify skin aging and photoaging. The Model 213 allows direct in-vivo monitoring of endogenous skin fluorescence, which makes it possible to follow markers (tryptophan and collagen) in skin, and their changes in healthy state of the human and while illness.

Devices of this type were used in the rehabilitation department of MONIKI clinic to evaluate effect of transdermal treatment of more than 2000 patients by herbal drugs. Results were found to be extremely informative and reliable.
Basic Noninvasive Sensor Technique #2: Oxidative Stress Monitoring

- Oxidative stress is a predecessor and companion of most diseases
- Oxidative stress is an increased content of the reactive oxygen and nitrogen species and free radicals in body tissues

[Diagram showing oxidative stress substances such as H$_2$O$_2$, O$_2^-$, $^{1}$O$_2$, and •OH, with arrows pointing to STRESS, UV-IRRADIATION, TOXICANTS IN FOOD, ENVIRONMENT POLLUTION, and SMOKING]
## Diseases associated with oxidative stress

<table>
<thead>
<tr>
<th>Cardiovascular diseases. Atherosclerosis</th>
<th>Rheumatoid arthritis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myocardial infarction</td>
<td>Neurodegenerative disease (Alzheimer’s disease, Parkinson’s disease, Autism et al)</td>
</tr>
<tr>
<td>Ischemic brain</td>
<td>Chronic kidney disease</td>
</tr>
<tr>
<td>Cancer Disease of All Tissues</td>
<td>Osteoporosis</td>
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<tr>
<td>Diabetes (types I and II)</td>
<td>Pancreatitis</td>
</tr>
<tr>
<td>Pulmonary hypertension</td>
<td>Systemic sclerosis</td>
</tr>
<tr>
<td>Lung Diseases/ Asthma</td>
<td>Cataract genesis</td>
</tr>
<tr>
<td>Inflammatory disease</td>
<td>Crohn disease</td>
</tr>
<tr>
<td>Many other (more than 100) diseases</td>
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</tbody>
</table>
THE ADVERSE FACTORS LEADING TO OXIDATIVE STRESS OF THE PERSON

- an irradiation (radioactive, the UV-irradiation, etc.);
- any possible stresses (mental, physical, etc.);
- toxicants and super toxicants in food nutrition;
- carcinogenic, mutagen and immunosuppressive environment pollution;
- consumption of some medicines (drugs);
- consequences of some medical procedures such as irradiation, sunbath in the solarium, oxygen cocktails, ozonation, etc.);
- alcohol;
- smoking;
- addiction;
- obesity, etc.
ROAD MAP (TECHNOLOGY) OF ELIMINATION OF OXIDATIVE STRESS AND HOW TO STOP THE PROGRESSION OF THE DISEASE

* reliable diagnosis of oxidative stress by watching after markers of oxidation of DNA molecules, proteins, lipids;

* an estimation of the general conditions of human being on the basis of determining of redox potential;

* antioxidant therapy with drugs-antioxidants, vitamins-antioxidants, specially developed biocorrectors – antioxidants created on the basis of the Data bank of antioxidants (more than 1000 items), commissioned by the Moscow City Government;

* monitoring of treatment and efficiency of antioxidant therapy.
OXIDATIVE STRESS

Oxidation by free radicals

- DNA
- Proteins
- Lipids

Biomarkers of oxidative and nitrosative stress

- Modified nucleosides
- Derived tyrosine
- Malondialdehyde

Determination biomarkers by liquid chromatography (LC) (degree of oxidative damage)

Antioxidant therapy

Control of antioxidant therapy by LC
## Relationship of reduction/oxidation forms of biomarkers for evaluation oxidative stress and determination the general state of health of the human

<table>
<thead>
<tr>
<th>No</th>
<th>Relationship of reduction/oxidation forms</th>
<th>Structure formula</th>
<th>Method determination</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Glutathione: Reduction / oxidized forms (GSH/GSSH)</td>
<td><img src="image1" alt="Chemical Structure" /></td>
<td>HPLC with AD and UV</td>
</tr>
<tr>
<td>2.</td>
<td>Ubiquinone / ubiquinone</td>
<td><img src="image2" alt="Chemical Structure" /></td>
<td>HPLC with AD and UV</td>
</tr>
<tr>
<td>3.</td>
<td>Cysteine/ Cystine</td>
<td><img src="image3" alt="Chemical Structure" /></td>
<td>HPLC with AD, UV and FLU</td>
</tr>
<tr>
<td>4.</td>
<td>Uric acid: the reduction form to the oxidized</td>
<td><img src="image4" alt="Chemical Structure" /></td>
<td>HPLC with AD and UV</td>
</tr>
<tr>
<td>5.</td>
<td>Ascorbic acid / deoxyascorbic acid</td>
<td><img src="image5" alt="Chemical Structure" /></td>
<td>HPLC with AD and UV</td>
</tr>
</tbody>
</table>
Main Benefits of Oxidative Stress Diagnostics and Treatment

- Diagnostics of preexisting diseases;
- Suppression of the disease at an early stage;
- Significant reduction in the number of cases of dangerous diseases such as (cardiovascular, cancer and diabetes);
- Increase in longevity in a capable position due to growing the number of people of retirement age;
- Significant reduction of the cost of medicine;
- General improvement of the quality of human life.
Liquid chromatograph for determination of biomarkers of oxidative stress
Instrument for express determination of antioxidant status
Supplementary Simple Low-cost Sensors

- Thermometer
- Infrared imaging camera
- Digital stetoscope
- Tonometer
- Conductivity meter
- Electrocardiograph
Local central processor: data acquisition from the sensors and data reduction, temporary local data storage

Data transfer via mobile network, local network, etc.

Cloud or Grid – based permanent storage and analysis of the data, simple backward communication (advices, reminders, etc.)

Centers for processing of most complicated cases, including complicated diagnostics and creation of hospitalization requests

Permanent work on re-evaluation of collected data to improve reliability and predictive power of the technology
Institute of Solid State Chemistry and Mechanochemistry of Siberian Branch of Russian Academy of Sciences is developing transdermal drugs using herbs from the Altai Mountains for disease prophylaxis, especially for oxidative stress compensation. New solid state chemistry and mechanofermentative processes are used for production. These drugs by no means replace conventional drugs, they just help the human to improve the state of the healthy body, so that immune system of the human is well-prepared for the meeting of infection.

RMMS system can monitor results of biocorrector intake to avoid harm to the health or to select preferred drug for the individual.
Two levels of deployment:

- Simplest set of devices can be installed in households, small companies, medical centers, allowing screening of maximum number of patients.

- Extended set of devices can be installed in small laboratories, providing more details for screening and also supporting treatment of disease suspects.
2011-2014 – creation and further development of the Remote Multi-parameter Monitoring System using financial support of Skolkovo Foundation

2013 - start using RMMS in Russia

Further perspectives include creation of carry-on versions of devices, expanding to other markets
Participants

* **Chimavtomatika** – more than 40 years of experience in analytical instrumentation hardware development, scientific support of oxidative stress monitoring;

* **Ampersand Ltd.** – more than 22 years of experience in analytical instrumentation software development;

* **MONIKI (M.F. Vladimirskiy Research and Clinical Institute of the Moscow Region)** – scientific support of the technology;

* **Institute of Solid State Chemistry and Mechanochemistry of Siberian Branch of Russian Academy of Sciences** – development and production of biocorrector drugs;

* Financial support of **Skolkovo Foundation**