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INSOLATION AND COVID-19: PROTECTION FROM THE AGGRESSOR

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Places lacking the sunlight
are often visited by doctors

ABSTRACT

The article reviews the importance of insolation as a factor of prevention and containment of infectious diseases and epidemics. The authors consider insolation not as a mean of curing the Coronavirus Disease (WHO fairly calls such possibility "a myth") but as a means to lower the risks of dissemination of the infection, to reduce viability of the virus in the environment, to support human protective immune mechanisms affecting susceptibility of the population as a whole, severity and recovery time, i.e. both sanitary and hygienic and prevention factors of the COVID-19 epidemic containment. Apart from the germicidal and virucidal sanitising effects of solar rays, the article reviews anti-epidemic capabilities of insolation as a microclimate factor and a psychological and physiological regulator of human protective capabilities as well as the insolation standards as a mechanism of development density regulation. It is impossible to efficiently combat massive dissemination of highly contagious infections without concerted utilisation of all available means and measures: both medical and preventive and organisational. The unprecedented mobilisation of healthcare systems and large-scale restrictive quarantine measures are under special attention of the society. This article reviews the importance of insolation as a universal natural anti-epidemic factor which is undeservedly placed in the end of the list of effective infection combating measures.

Keywords: insolation, communal hygiene, insolation standards, sunlight, psychophysiology, anti-epidemic measures, prevention, health security, COVID-19

1. INTRODUCTION

It is impossible to efficiently combat massive dissemination of highly contagious infections without concerted utilisation of all available means and measures: both medical and preventive and organisational. The unprecedented mobilisation of healthcare systems and large-scale restrictive quarantine measures are under special attention of the society. This article reviews the importance of insolation as a universal natural anti-epidemic factor which is undeservedly placed in the end of the list of effective infection combating measures. The authors do not consider insolation as a remedy against the Coronavirus Disease (replying to Donald Trump's statement, WHO fairly called such possibility "a myth"), but as a means to lower the risks of dissemination of the infection, to reduce viability of the virus in the environment, to support human protective immune mechanisms affecting susceptibility of the population as a whole, severity and recovery time, i.e. both sanitary and hygienic and prevention factors of the COVID-19 epidemic containment.

Since the period of establishment of communal hygiene as a scientific discipline, the range of tools of doctors and hygienists has been largely enhanced by cheap and efficient antiseptics, hardware and pharmacologic means of diagnostics and treatment as well as artificial substitutes of solar radiation, UV emitters.

The shift of emphasis from natural means of protection to technical, disinfection, and pharmacological ones stems from the fact that, other than high efficiency of the latter, the natural factors are not goods as they are available everywhere and, not being commercially attractive, have no other ways of "promotion" apart from common sense, applicable standards, and self-sacrifice of a few specialists. On the contrary, many of recognised factors of hygienic security of the artificial human habitat, which are specified in standards, raise the prices of municipal infrastructure maintenance and reduce profitability of construction, and targeted pressure on sanitary and hygienic standards, which have allegedly lost their applicability in the new urban reality brought by concerned parties (construction investors and customers), including via government entities, is associated with it.

However, as we can see through the example of the COVID-19 epidemic, contemporary cities and contemporary people have not become less vulnerable to new infections, primarily those caused by viruses.

Lack of efficient means to be used for prevention and containment of the COVID-19 epidemic makes it necessary to solve the problem using restrictive and quarantine measures, which are the most damaging for economy and ultimately for the most of population. But if we say that all possible resources shall be used for combating the epidemic, it is fair to start with the least resource-intensive, available to everyone and essentially free natural factors, and especially with insolation.

Someone may doubt the efficiency of insolation as an anti-epidemic resource given that no country has avoided the pandemic irrespective of the degree of direct sunlight availability. Undoubtedly, the key factors of dissemination of COVID-19 included intensity of transport flows, population density and traditionally social forms of labour and leisure. However, since the moment the infection appeared, further development of the epidemic process has been regulated by the entire set of anti-epidemic factors, both targeted and natural or occasional ones. In terms of the subject matter of this article, the following significant features of the centres of the pandemic are obvious:

– Geography – currently, the morbidity of COVID-19 per 1,000 individuals is much higher in the countries located in the Northern hemisphere which are now leaving the period of seasonal deficiency of sunlight;

– Population density – COVID-19 mostly affects megalopolises with high density of development, a factor that determines insufficient availability of sunlight in urban areas, especially in conditions of its seasonal deficiency.

It is important to bear in mind that the hygienic importance of insolation is not only defined by direct sanitising effect of the short-wave region of sunlight spectrum. The climate-forming role of insolation is of the same importance for containment of the infection, including formation of microclimate of indoor spaces, buildings and territories, which had been specified as a "general health-improving effect" in Russian insolation standards before 2001. Let us consider each group of factors separately.

2. SANITISING EFFECT

The direct antivirus effect of solar radiation, especially of direct sunlight (insolation) specifically against the COVID-19 virus, is associated with damage of the RNA molecule of the virus, which makes it impossible to replicate it in a host cell. It is not possible to evaluate the degree of sunlight resistance of the COVID-19 virus based on the materials available as of now. However, even if the results of such studies had been available, their practicability would have been low since actual insolation is determined by constantly changing factors: cloud amount, state of atmosphere, the Sun angle, sunshine duration as well as the position of the exposed surface and its texture. Nevertheless, availability of the UV-B component in the sunlight spectrum [1] guarantees its virus-inactivating effect, and given the duration of sunshine on clear days (at least 2 hours in Moscow even in winter [2]), the virucidal potential of insolation may be comparable with that of short-time irradiations by means of germicidal UV emitters and even largely exceed it in summer months. With that, the virucidal potential of insolation manifests itself everywhere and dynamically: depending on the date and time which define the position of the Sun in the sky. Not only and not so much the indoor spaces and territories are insolating with the standardised insolation regime, but also all urban areas are, such as streets and roads, parks, urban air, facades of houses open to sunlight, and all indoor spaces where insolation is not required as per

standards but its sanitising effect is also efficient and necessary.

Insolation of urban areas and facades provides also efficiency of another hygienic factor, natural ventilation of indoor spaces.

3. CLIMATE AND MICROCLIMATE

Based on preliminary results of the publicly available studies [3], temperature of (5–9) °C and humidity of (35–50) % are the optimal conditions for dissemination of the COVID-19 virus, and its viability in the environment is reduced when temperature is increased and humidity is lowered, and virulence of the virus falls down to zero at 30 °C. Therefore, the infra-red region of the sunlight spectrum also has the same sanitising effect which the short-wave UV region has. Ingress of direct sunlight through double glazing rises the temperature of an irradiated wooden or plastic surface by (14–15) °C, which will be equal to (35–40) °C at room temperature of (20–25) °C, the conditions neutralising activity of the virus. In open urban areas, the heat effect of insolation has the same values ((13–15) °C depending on the Sun angle and the state of the atmosphere), and temperature of concrete and asphalt surfaces rises from (1–10) C° to 1(4–15) °C[1] during the inter-season periods most favourable for the infection, which makes them an unfavourable environment for survival of the COVID-19 virus and promotes its inactivation.

Simultaneously with increase in temperature of insolate surfaces, humidity also reduces during the inter-season periods, which is also a factor of infection containment.

4. PSYCHOPHYSIOLOGY AND IMMUNITY STATUS

Apart from the direct physical and biochemical virucidal effect, insolation directly and indirectly contributes to regulation of some physiological processes in human body, which also significantly affects the course of the entire epidemic process defining susceptibility to the infection of population as well as severity of the disease and recovery time. This set of factors is called psychophysiological action. In this case, the entire visible part of sunshine spectrum is of importance, and direct and scattered sunlight affect retina simultaneously with further transmission of nerve impulses to endocrine control centres via the visual pathway. Illuminance within a light spot increases by more than 30 times under direct sunlight. With the size of a light spot of (2.5–3.5) % of the floor area, illuminance on the horizontal surface in the centre of an indoor space increases by (2–2.5) times at height of 0.8 m above the floor level and by (3–3.5) times at a floor level just by means of reflected light (beyond visual line of sight of the light spot). A light spot of 20 % of the floor area increases the same values by 4.5 and 9 times, respectively[2]. Given the fact that a physiological standard value of daylight factor in indoor spaces is (5–10)% (based on recommendations of WHO), and standard illuminance of, for instance, residential spaces is 0.5 %, contemporary residents of cities live in conditions of constant deficiency of environmentally friendly, free, and unexpendable daylight. Increase of illuminance by several times by means of direct sunlight on sunny days eliminates this deficiency partially or completely.

The subject ‘light and health’ has been repeatedly discussed in the Svetotekhnika Journal [4, 5, 6, 7]. Therefore, it is sufficient just to list the “light-dependent” psychological and physiological processes in the context of this article.

High levels of daytime illuminance promote proper work of circadian rhythms responsible for normal endocrine control of physiological processes in a body. Impairment of the sleep-wake cycle, including insomnia, diurnal somnolence, performance decrement, and apathy is the most well-known consequence of circadian rhythm deregulation. Low levels of illuminance, which do not provide necessary light contrast between day and night, is the cause of development of seasonal affective disorder (SAD) during autumn and winter, which causes development of depression and reduction of distress tolerance. The said negative consequences of insufficient daytime illumination (and sufficient natural illumination without direct sunlight is impossible in megalopolis environment) reduce the immunity status of body, which manifests itself in increased susceptibility to the infection, poor im-

[1] The data of changes in temperature of insolated surfaces is based on the authors’ own reference measurements made on April 21, 2020 in Moscow

[2] The data of dynamics of illuminance in insolated indoor spaces is based on the authors’ own reference measurements made on April 21, 2020 in Moscow

mune response and, subsequently, harder development of the disease. A number of studies conducted in the 20th century [8] confirmed the well-known fact that wound healing is much faster in well-insolate wards than in insufficiently insolate wards provided that disinfection and antiseptic regimes in both wards are the same.

Even short-time contribution of direct sunlight to formation of a lighting environment 'adjusts' the inner clock of a body by forming daytime light accents, which increases human psycho-emotional status, promotes distress tolerance and supports efficiency of all protective mechanisms including immune ones.

5. INSOLATION STANDARDS AS A REGULATOR OF DEVELOPMENT DENSITY AND POPULATION DENSITY

With all importance of the climatic factor, immune status of population and quality of healthcare systems, it must be admitted that the main factor of COVID-19 dissemination is population density and associated load of public transport and social centres such as cultural, trade and sports areas. It should be noted that one of the only factors preventing urban densification is standardisation of insolation and natural illumination, and the dynamics of modifications of such standards demonstrates a number of highly doubtful from the scientific point of view opportunistic compromises between requirements of sanitary and epidemiological security and interests of the urban development industry. Over the half-century history of insolation standardisation, the norms have been shortened from (3–4) hours to an hour and a half or two hours [9], the calculation dates for the central geographic zone, where most of Russia's population resides, were shortened by two months in 2017 without any reasons provided (now they are worse than those for the northern zone), summer insolation requirements and prohibition of all-year shading were cancelled. The above listed regulatory easements change the emphasis from the human health improving factor (as in the 1982 version) to the factor "causing health-improving effect on human habitat" (as in the 2001 version), which is essentially limited to the bactericidal effect. Apparently, the logic of social development implies that human species has changed sufficiently over the previous 50 years to cancel its mechanisms of self-protection and self-regulation that had been forming for millions of years. However, it is not true. Vulnerability of a modern city to highly contagious infections is directly proportional to development density, i.e. the volume of non-insolate facades and territories, and population density, i.e. just the number of hand grasps per one door handle. In this context, construction of non-residential apartments, which are in most cases used for residence, but are not compliant with any regulatory requirements to residential premises, including sanitary and epidemiological requirements, and not providing any social infrastructure including medical institutions, is a very questionable trend.

The COVID-19 pandemic poses a question whether contemporary cities are safe enough to ignore the natural factors of human protection and its artificial habitat which are justified by evolution, life and science [10].

6. CONCLUSIONS

The role of sunlight transformed by the atmosphere is not less important in human life. The standards of its utilisation, which is more large-scale than utilisation of insolation, are also cut off by the two authorities issuing them, namely, the Ministry of Construction and the Ministry of Healthcare of the Russian Federation, from time to time although it does not attract attention of the society for some reasons. In the last editions of the natural illumination standards, the reference point for the most of indoor spaces is relocated from the depth to the centre with the same rather poor standard value daylight factor. It is obvious that illuminance in indoor spaces becomes much lower, which will require utilisation of additional artificial illumination being not capable to replace daylight neither in terms of quality nor in terms of quantity, over the most part of a year.

The basics of the Russian standards of natural lighting and insolation were established in the hard years after WWII when, nevertheless, the return to peaceful life could not be imagined without a comprehensive solution of the problems of safety and quality of life in cities being reconstructed. The government planned and subsidised comprehensive studies in the field of sanitary and hygienic safety of environment, in particular, determination of lighting and climatic parameters necessary for productive life. Dedicated organisations and high-level scientists engaged in different spheres such as light engineering, hygiene, architecture participated in the re-

search programmes. The first sanitary standards of natural lighting and insolation were developed and put into effect on the basis of the evidence base. Unfortunately, that generation of independently thinking scientists with high levels of professionalism and scientific potential has passed away, the institutes and laboratories engaged in always topical works in the field of public health have been either closed or assigned new functions, and the following generation of specialists responsible for the fate of hygiene as a scientific discipline is represented more by government officials than by well-known scientists, which made it possible to adopt legal and regulatory easements under pressure of the interests of the construction industry [9]. For instance, it is impossible to understand the motivation of decreasing the standard requirements of insolation for the central geographic zone of the Russian Federation adopted by the Chief Sanitary Inspector A. Yu. Popova without any scientific research, justifications, discussions in the professional community and more in disregard of its opinion, just 'supported by the Moscow Investors Club'. Anna Yurievna did not reply to the open letter [10] addressed to her.

It is to be added that the mankind has just two proven means of combating infections like COVID-19 before the start of industrial manufacturing of efficient vaccines and introduction of efficient treatment methods: restrictive quarantine measures and the sunlight. And the more a contemporary city has of the latter, the less strict and destructive can be the former.

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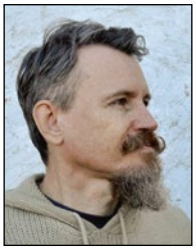

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