

Editorial

Public Health Issues of Recreational Waters: Perspectives for Innovation and Advanced Management

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This Special Issue offers new perspectives on innovation in managing water for recreational uses, in facilities for sport, playtime, rehabilitation, health, and wellness. The recreational use of waters signifies a technological challenge for hygiene and an opportunity for promoting health by providing physical activity in safe aquatic environments. Public health issues focus on water managing and surveillance not only at the pool level but also along all the pipeline plant in buildings or associated facilities, including those based on the use of coastal/fresh or SPA waters. Innovation plays a major role in handling, monitoring, treating water through the development, improvement or evaluation of novel methods, devices, procedures, strategies, guidelines aimed to improve the quality and safety of water. Technical advancements in the field are characterized by an intense progress within a very multidisciplinary setting, where several types of expertise interact, such as hygiene, medicine, biology, chemistry, sociology, engineering, physics, informatics, and epidemiology. This special issue consists of papers covering a wide range of research topics in a perspective of One Health, including questions related to (i) biological risks and microbial diversity of water, also in relation to specific water treatments [1], (ii) evaluation and monitor of chemical risks and disinfection by-products (DBP) [2–4], (iii) new perspectives for the design of water buildings in aquatic environments [5] and (iv) health promotion, wellness and water-based therapies within a larger cultural frame [6].

Aburto-Medina et al. [1] focus on the microbial community from water taken from the borehole, pre-filter water (chlorinated, cold and post-bathing water) and post-filter water at a commercial Australian natural hot spring bathing facility. Bathing environments, such as balneotherapy facilities are not sterile and natural spring waters may harbor natural microbial populations that may include potential pathogens. The detection of changes in the microbial community plays an essential role in providing indications for a correct management of the bathing water. The new perspectives achieved by the metagenomic approach can support surveillance and adequate selection of treatments individualized for each type of water. This aspect is relevant to enhance the effectiveness of management in different aquatic environments and to improve the comprehension of the impact of chemicals on the microbial community, reducing the specific selection of pathogens and avoiding the production of unnecessary disinfection by-product with their implications for health and environment as well as for the quality of the natural spring water.

Monitoring of disinfection by-products (DBP) represents a key issue to contain chemical risks, while maintaining high disinfection standards. Falk et al. [2] focus on this issue and in their study intends to determine the minimum concentration of free chlorine (FC) a cyanuric acid (CYA) without affecting the risk of pathogenic gastrointestinal diseases due to different pathogens such as *Giardia* or *Cryptosporidium*. By developing a dedicated model, they considered the rates of pathogen introduction into pool water, disinfection, turbulent diffusive transport, and pathogen uptake by swimmers in order to evaluate the risk to develop an infectious disease. Findings were compared to the acceptable risk to develop a gastrointestinal illness for untreated recreational waters, as drafted by U.S. Environmental Protection Agency (EPA). These specific results and in general the modelling and study on



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this way can be useful to support the update of law and regulations by identifying and updating the available threshold values and best fitting sampling points. The concentration of combined chlorine determines if there is a threat due to DBPs, and the evaluation of the distribution of free and combined chlorine concentrations should take in account also seasonality in the use and of the water flow systems. Wyczarska-Kokot et al. [3] have determined the most reliable sampling point for assessing the quality of water and its suitability for swimming. Their study is based on the distribution of free and combined chlorine contents in specific areas of the pool. Such approach aimed to identify the pool areas with the worst water quality, providing indications for surveillance and optimization of internal controls.

The chemical risk can be contained both with new threshold values and surveillance, but it needs also the development of new devices that can be rapid and portable. In this special issue Sciuto et al. [4] have reported a new technology to assay mercury (Hg^{2+}) in water. The pollution of water reserves from inorganic elements, such as mercury Hg^{2+} or other heavy metals, still represents a present issue for different water sources and a classical public health question to address. However, Hg^{2+} assay have some limitations in terms of bulky instruments and the cost and time required for the analysis. Sciuto et al. [4] have developed a miniaturizable and high-throughput bioluminescence sensor for Hg^{2+} detection in water, which combines the specificity of a living bacterial Hg^{2+} reporter cell, used as sensing element, with the performance of a silicon photomultiplier, used as optical detector. The proposed system can lay the basis for further studies and validations to develop a rapid and portable technology that can be used in field, providing remote monitoring, too.

Innovation plays a major role in handling, monitoring, treating water through the development of new devices and models, but also in the improvement or evaluation of novel procedures and strategies for the design of aquatic recreational areas. Shyu et al. [5] have investigated 50 riverside sites by Comfortable Water Environment Rest Assessment Form, involving a multidisciplinary team of experts. The investigations revealed several factors that could contribute to improve the value of riverside recreational sites, such as the availability of more exercise tools and equipment for physical activity, highlighting the strategic relevance of the overall design planning, starting from the high-quality perception at the facility entrance. Shyu et al. [5] approached the general question and after considering specific cases and interviews, also provided a practical guide for designing service facilities along riverside recreational places. Future projects for realizing buildings and equipped facilities on riverside recreational sites could take advantage from these considerations, increasing the benefits for those areas and finally contributing to improve the well-being of residents and visitors, also supporting a drive force of ideas and investments in recreational sites.

Water is in the center of any One Health perspective, representing a dynamic cross-roads between humans, living beings and environment. The recreational use of waters represents a balance between technological challenges for hygiene and opportunities for promoting health. Indeed, the aquatic facilities represent places where it is possible to socialize, practice sport, rehabilitation, adapted physical activities, and wellness. SPA waters represent a worldwide diffused environment for wellness, that is founded on new technologies and studies, but also on the reach traditions from different ancient cultures. However, the potential benefits of traditional balneotherapies are often lacking established medical evidences regarding effects and mechanisms, requiring further studies. Wangchuk et al. [6] revised the different water therapies practiced in Bhutan and their health benefits, by an overall and multidisciplinary approach based on recent scientific literature and knowledge from ancient textbooks. The analysis also involves the collection of patients' health records and interviews of physicians and data from clinical trials. Wangchuk et al. [6] listed and studied main characteristics of different hot springs, mineral, and holy spring waters in Bhutan. The wide perspective opens to new enticing scenarios, showing the need for systematic evidence-based studies.

The One Health perspective enhances a positive and sustainable role for the recreational uses of water. COVID-19 pandemic impacted dramatically on the recreational use of waters, imposing the development of additional safety measures and the diffusion of a novel culture regarding the use of water for health, rehabilitation, adapted physical activities or even for sport events [7]. The availability of results from ongoing studies and the establishment of a common scientific background can provide tools for prompt response to novel health threats but also can support the introduction of technical advancements in continuity with the well routed tradition in the field of recreational waters. This Special Issue harbors a wide perspective for approaching the beauty of water as a recreational tool and provides hints for updating potentials, managing opportunities and improve policy making.

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