



COVID-19

A Theme Series on Emerging Technologies for Use in the Study, Diagnosis and Treatment of Patients with COVID-19

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SARS-CoV-2, the virus that causes COVID-19, has overwhelmed worldwide healthcare systems, having infected over 2 million people in the US alone at the time of this writing. The direct cost of COVID-19 care is staggering, as is the enormous global economic impact of the disease. In addition to a safe and effective vaccine, safe and effective antiviral and disease mitigation treatments are desperately needed to prevent COVID-19 or reduce clinical decompensation and death from severe COVID-19 pneumonia. The cellular and molecular bioengineering community has a history of innovative approaches to address pressing biomedical challenges. As a voice for this community, in this issue of *Cellular & Molecular Bioengineering*, we have compiled a series of commentaries and reviews that reflect how the biomedical engineering community continues to contribute to fields that have become central to understanding, treating, and managing the COVID-19 pandemic. This special issue is anchored by a comprehensive review from Maria Tsikala Vafea, Eleftherios Mylonakis, and colleagues of innovative technological advances being applied to address the current pandemic.

While the majority of COVID-19 patients have a mild illness, a minority of patients require hospitalization for severe viral pneumonia, and many further deteriorate due to systemic cytokine release, thrombotic obstruction of pulmonary vessels, respiratory failure, thromboembolism, metabolic and multiple

organ failure, septic shock, and death. Despite current supportive care, COVID-19 is now among the most frequent causes of natural death, at mortality rates up to 65 per 100,000 lives, with case fatality ratios up to 15% among the most affected countries. Opportunities for technologies to intervene in COVID-19 disease progression are highlighted by Jasmine Shirazi, Jason Gleghorn, and colleagues, with additional commentary on exploring confounding risks from cancer by Nidhi Jyotsana and Michael R. King. In addition to non-selective antiviral and antibacterial agents, many ill patients also receive empiric anticoagulation and off-label therapies without evidence of survival benefit. Consensus on the best treatment approach will likely change as data continue to accumulate. Model systems that may be useful for basic research and preclinical applications of COVID-19-related technologies are reviewed with a focus on animal models (Jhinuk Basu Mullick and Chelsey S. Simmons) and in the context of acute kidney injury (Holly Ryan and Chelsey S. Simmons).

With our limited understanding of COVID-19, rapid and accurate diagnostics are central to unraveling the detrimental impact of SARS-CoV-2 on pathophysiology. Effective assays require not only quantitative measurements of up- or down-regulated molecular responses at the cellular and organ level but also continuous monitoring of genetic sequences over a long period of post-infection time. Current methods of processing samples are complex, time-consuming, and costly, but continuous monitoring of cellular and molecular responses is necessary to understand the development of short-term and long-term symptoms and impacts of drugs or medications targeting specific

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abnormal functions. In this issue, Amogha Tadimety, John X.J. Zhang, and colleagues review state-of-the-art biosensor technologies that promise to reduce complexity and resources required to diagnose COVID-19, while HHS Lakshmanan, Owen J.T. McCarty and colleagues review technologies to monitor coagulation.

Health systems worldwide face the daunting task of serving millions of patients with acute complications and long term alterations of immunological and genetic responses in an already overloaded healthcare system. The cellular and molecular bioengineering community, a preexisting network of scientists, engineers, clinicians, and public health experts, remains well poised to contribute preclinical model systems, diagnostic assays, predictive analytics, and engineered therapies to pandemic-fighting efforts.

AUTHOR CONTRIBUTIONS

CS, OJTM, and AT wrote and approved the final version of the manuscript.

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CONFLICT OF INTEREST

The authors CS, OJTM and AT declare no conflict of interest.

HUMAN AND ANIMAL STUDIES

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