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Preface

Advances in the engineering applied to medicine have led to significant strides in diagnosing diseases, assisted in the recovery from pathological conditions, and have prolonged human lives. Critical reviews of a diversity of themes in biomedical engineering are represented in articles in the current issue of *Critical Reviews in Bioengineering*. They deal with diagnosis of gastrointestinal pathologies, mechanical ventilation, and modeling of biomedical processes.

Gastrointestinal (GI) diseases form a significant portion of internal medicine practice. The major role played by GI microbiota is well recognized in several pathologies.[1,2] Major parts of the GI tract are sampled primarily through invasive methodologies. Images transmitted from the endoscopic capsules developed nearly 15 years ago provided a new technological breakthrough in GI diagnosis.[3] Current methods of collecting digestive fluids involve invasive procedures primarily through tethered endoscopic devices.[4,5] The paper by Amoako-Tuffour et al.[6] reviews technological challenges and potential solutions in developing ingestible gastrointestinal sampling devices.

The autonomic nervous system has a major role in maintaining homeostasis and is implicated in various diseases. The contraction and relaxation of the lower esophageal sphincter is vagally mediated, and patients with gastroesophageal reflux disease (GERD) have altered autonomic nervous system function. Obese patients have increased incidence of GERD. Current research on GERD and obesity has been advanced by a number of tools including sensors, novel imaging modalities, and signal processing.[7,8] The review by Devendran et al.[9] examines physiological studies of GERD and obesity and proposes the hypothesis that autonomic imbalance in sympathovagal stimulation in the lower esophageal sphincter is an important factor contributing to increased prevalence of GERD symptoms in obese individuals. Further studies are warranted to answer some of the questions raised by their hypothesis.

In the intensive care unit, mechanical ventilation is a critical procedure used to save patients' lives. The objective of the respiratory therapist is to move toward discontinuation of mechanical ventilation (i.e., weaning) at the earliest. Weaning outcome is an excellent prognostic indicator of morbidity and mortality. However, the decision to wean a patient from ventilator is a critical one and is fraught with difficulties because of a lack of standardization. Weaning involves several steps, starting with a fully supported mechanically ventilated patient and leading to a spontaneously breathing patient, including extubation. The paper by Alam et al.[10] uses Jubran and Tobin's[11] weaning framework as the basis to discuss the steps or stages of weaning and the complexities involved within and between the stages. The paper initially discusses modalities of mechanical ventilation, their controlling parameters, and physiological conditions under which they are programmed. They review several studies that model and automate the weaning process. The paper concludes that, even though automated weaning modes have potential, they are infrequently used and are not as practical as the evidence-based protocol model.

Diffusion in magnetic resonance imaging is usually modeled single exponential decay $exp(-bD)$, where b is the pulse sequence controlled parameter and D is the diffusion coefficient (square millimeters per second). Diffusion tensor imaging and diffusion kurtosis imaging often are used to derive markers that characterize the tissue under study. In their paper, Ingo et al.[12] combine continuous-time random walk theory with the diffusion equation to identify fractional model order parameters and an entropy measure, which serve as markers to characterize tissue microstructure and complexity in the underlying anatomy.[13,14]

Nanoparticles are objects whose size varies from 1 to 100 nm. Magnetic nanoparticles are currently being used for biosensing and as contrast agents in medicine.[15] With applications ranging from direct imaging of particles to magnetic resonance imaging contrast, magnetic nanoparticles have garnered considerable interest,[15,16] In specialized applications such as magnetic particle imaging, one needs precise information about particle dynamics for their efficacious use in clinical settings.[17] Reeves and Weaver[18] review mathematical modeling of relaxation time in response to externally applied magnetic fields. Such models are described by Brownian and Néel relaxation mechanisms. The authors also provide a series of mathematical techniques to solve equations arising out of theoretical models.

Articles included in the present issue review the technological and engineering challenges faced by investigators and suggest potential solutions for the development of medical devices and tools to improve the diagnosis of diseases and the treatment of patients. The mathematical models and theoretical underpinnings of specific issues are reviewed.

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