Journal of Engineering and Science in Medical Diagnostics and Therapy

Editorial

From Bench to Clinic

Translational research is an essential component of the scope of the *ASME Journal of Engineering and Science in Medical Diagnostics and Therapy*. Turning insights from multidisciplinary research into diagnostic or therapeutic methods and tools/procedures is the optimum goal of the journal. This issue includes a range of research which fulfils these objectives.

Starting from the last word of the issue title "Clinic," two of the papers published in this issue focus on the clinic operating room and the planning and management of clinical heterogeneity. Operating rooms consume the largest cost in hospitals which impacts on staffing and finance. Elective surgery scheduling, uncertainty in surgical and recovery times, and related facilities and resources contribute significantly to operating room performance. These factors are all considered as major challenges when developing operating rooms. Thus, efficient management and schedules are essential to minimize the cost and improve the performance. The first paper "Tactical operating room planning based on system transient performance control" used a manufacturing system analytical approach, to model a peri-operative process. The uncertain surgical and recovery duration is quantified probabilistically and incorporated in a Markov chain model with multistate geometrical machines [1,2]. Model predictive control to pace patient release into the operating room is then applied to control system transient performance. This paper presents a guidance protocol with suggestions to improve operating theater performance in regards to planning recovery and surgery times.

In medical practice and research, a reference range is derived using statistical and not clinical principles. Classically, it would be derived from the local healthy population and matched in age, gender, and other characteristics to the patients under investigation. However, it is often not realized that the application of whole population derived reference ranges to complex pathologies that comprise patient subgroups may be problematic. This is because recruiting suitable controls requires discarding a certain percent at each end of the range. The review paper "Managing clinical heterogeneity: An argument for benefit based action limits" provides examples of how subgroups can be identified in diverse pathologies and how better management can be achieved using evidence-based action limits rather than reference ranges. The authors' clinical experience of problems arising from using the wrong reference ranges for the clinical situation helps to identify subgroups which will often enable clinicians to derive specific action limits for treatment. This will lead to customized management and a potentially effective research route to study complex pathologies.

In the operating room, anaesthesia is the first tool used to create a temporarily induced barrier between the patient and the surrounding environment. Volatile anaesthetics have been shown to reduce lung resistance through dilation of constricted airways. The paper "Targeted versus continuous delivery of volatile anaesthetics during cholinergic bronchoconstriction" compares the changes in lung resistance, elastance, and anatomic dead space during pharmacologically induced bronchoconstriction with intravenous methacholine. It also compares the following treatments with targeted anaesthetic delivery to dead space and continuous anaesthetic delivery throughout inspiration. The paper demonstrates that the diffusion of inhaled anaesthetics from airway lumen to smooth muscle yields significant bronchodilation in vivo. As a result, systemic recirculation is not necessary to reduce lung resistance and elastance during sustained bronchoconstriction.

The implementation of simple lab experiments to create effective clinical tools is emphasized in three of the papers in this issue. The paper, "A study on long-term in vitro reliability of intracochlear PZT micro-actuators" examines the effectiveness of the use of a PZT micro-actuator integrated with cochlear implant electrode array for acoustic stimulation. This is a treatment method which implements acoustic emission to translate lab testing to direct therapy method. On the other hand, tissue characterization has been attempted in two other papers. The paper "An analytical model of tumours with higher permeability than surrounding tissues for ultrasound elastography imaging" analyses a poroelastic mathematical model of tumor tissue in a cylindrical coordinate system, where the permeability of the tumor tissue is assumed to be higher than the surrounding normal tissue. The results indicate that the proposed model is accurate and closely resembles the finite element analysis. The availability of this model and its solutions can be helpful for ultrasound elastography applications such as for extracting the mechanical parameters of the tumor and normal tissue and, in general, to study the impact of poroelastic material properties in the assessment of tumors. Further, the elastography technique is implemented in the other paper, "Finite element based optimization of human fingertip optical elastography," by applying an acoustic emission technique to the fingertip to quantitatively map soft tissue viscoelastic properties.

Tissue characterization is essential for imaging, diagnostics, and therapy for many diseases. Three papers in this issue are published on this topic. "Heterogeneous versus homogeneous material considerations in determining the modal frequencies of long tibia bones" uses modeling as well as experimental validation to demonstrate that using heterogeneous material properties influences the modal frequencies for bones. However, the paper "Dynamic tensile behaviour of fibre bundles isolated from spinal nerve roots: Effects of anatomical site and loading rate on mechanical strength" investigates the mechanical properties of a neural fiber bundle. It demonstrates that the fiber bundle isolated from the lumbar spinal level is weaker in mechanical strength compared to that from the cervical and thoracic spinal level, and the

mechanical response of the fiber bundle is insensitive to strain rate. On the other hand an instrument-assisted soft tissue manipulation is a form of manual therapy which is performed with rigid cast tools. Neither the applied force during the manipulation process, nor the angle of treatment and strokes frequency has been quantified which contribute to the overall recovery process. A quantifiable soft tissue manipulation represents an advancement in the manipulation process. The paper "Skin modelling analysis of a force sensing instrument-assisted soft tissue manipulation device" proposes a novel mechatronic device that measures force during the manipulation process with localized pressures, similar to traditional, nonmechatronic manipulation devices that are frequently used to treat soft tissue dysfunctions. We hope you find this issue enjoyable and find useful practical outcomes for clinical applications.

References

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