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Plasma Medicine

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Plasma Medicine

Recent demonstrations of plasma technology in the treatment of living cells, tissues, and organs are creating a new field at the intersection of plasma science and technology with biology and medicine - *Plasma Medicine*. This fascinating new field poses numerous technological challenges and brings to the forefront many fundamental questions regarding the mechanisms of interaction between living organisms and plasma. In order to create a forum that brings together plasma scientists, medical professionals, biologists, and biochemists, a new conference was organized: The *First International Conference on Plasma Medicine*, ICPM-1. This event took place in Corpus Christi, TX, from October 15 to 18, 2007. The main goals of ICPM were to develop a common language that experts in the various relevant fields can all understand, to better define key challenges and open questions, and to move toward their effective solutions.

The technical program of ICPM-1 included 19 invited papers, 23 contributed oral presentations, and 19 poster papers. The authors of these contributions were subsequently invited to submit their full manuscripts to a *Special Issue* of *Plasma Processes and Polymers* (PPP) dedicated to *Plasma Medicine*. The submitted papers underwent the usual rigorous refereeing process that PPP requires for all its manuscript published. The result is an excellent collection of accepted papers found in this issue of PPP, articles which cover many aspects of the interaction of plasma with both prokaryotic and eukaryotic cells.

The Guest Editors would like to express their gratitude for the help and support they received from the editorial team of *Plasma Processes and Polymers*, especially from Sandra Kalveram, who conducted the logistics of the refereeing process with high efficiency. Our thanks also go to the authors who submitted their papers to this issue and to the referees whose reviews and feedback helped to improve the manuscripts.

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Foreword

The Information Age has fundamentally changed the approach to medicine. Most technologies we are using today in Medicine are Industrial Age technologies, mainly mechanical instruments, some electronic instruments and monitors, and numerous chemical-based drugs and materials. The Information Age is totally different, and was captured best by Nicholas Negroponte in his book "Being Digital"[1] where he states that the defining characteristic of the Information Age is replacing physical objects with non-physical entities - "it's bits and bytes instead of atoms". For Medicine the expression of this would be to say "It is no longer blood and guts, but bits and bytes".

We have just begun the transition into the Information Age by moving to an electronic medical record, networking with telemedicine (rather than having people everywhere), and using electrocoagulation or lasers instead of scissors and scalpels. In short, replacing supplies and instruments with information and energy. This concept has an enormous advantage, because today's large diagnostic and therapeutic systems that are currently separate tools, used at different places and scheduled for different times can now miniaturized, integrated and used in real time at the patient bedside. One current example of this application of energy would be ultrasound. Diagnostic ultrasound can be coupled with high-intensity-focused-ultrasound (HIFU) into a small, hand-held instrument. Using the Doppler, internal hemorrhage can be diagnosed, and activating the HIFU can coagulate the tissues and stop the bleeding - all from outside the body in real time at the patient bedside.

Another analogy for information and energy sharing is that networking of the information makes the entire patient care episode and the medical system an integrated entity. For example, when a labeled supply, such as a sponge or disposable scissors is used, the system automatically bills the patient, orders new supplies for the floor or room and sends a request to the central supply to order a replacement from the vendor - all immediately and efficiently.

Likewise with plasma medicine, the promise is to replace numerous physical objects with energy. Instead of using alcohol, iodine or merthiolate to

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sterilize supplies, the application of plasma energy can achieve the same results (sterilization) without physical supplies. No more need for ordering, waiting for delivery, maintaining inventory, distribution throughout the hospital, storage until use, and re-ordering when utilized. In a handheld plasma instrument, it may be possible to attain the same sterility without the huge logistical chain and cost. Plasma sterilization would be available whenever needed, at the point of care and in real time, without the need to reorder more supplies. This dramatically improves the delivery, efficiency, cost effectiveness, and safety of patient care.

On a more speculative note, it might also be possible to continuously sterilize supplies, instruments and equipment while they are being used. If a plasma could be distributed over the surface of an instrument continuously while operating, there would be no need to sterilize instruments or run quality checks in the factory but rather they could be shipped non-sterile at incredible cost savings. Every day there is a significant loss of supply usage because the supply or disposable instrument gets out of date or contaminated before or during a procedure, requiring opening of a new sterile replacement, thereby increasing the cost for the procedure. Finally, it may be possible to monitor the instrument by measuring the change in the plasma characteristics.

This *Special Issue* represents one of the first attempts to describe and understand the potential use of plasma applied to medicine. The preliminary success in treating cutaneous leishmaniasis, which is not treatable with topical medicines and requires surgical excision, demonstrates the potential of plasma medicine. Certainly, many other applications beyond those speculated above will be discovered, while some of them will be proven to be ineffective - that is the hard science. However, the basic hypothesis is sound: replacement of physical objects with energy can significantly improve the quality, efficiency, safety, and cost of healthcare. What now remains is the discovery and validation of these potential opportunities for the application of plasma in medicine.

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[1] N. Negroponte, "*Being Digital*", Vintage Books, New York 1996.

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