Metrology for therapeutic ultrasound
the right dose for every patient

**Vision**

The establishment of a global metrology infrastructure for ultrasound exposure and dose to tissue that will enable more effective and safer treatments across the spectrum of conditions from strains and minor fractures through to life threatening cancers.

- Ultrasound is the established treatment of choice for kidney stones, many soft tissue injuries and a range of surgical applications including cataracts.
- The market for ultrasound ablation equipment in the EU was worth £460 million in 2009; £970 million by 2019.
- New therapeutic uses have emerged: more than 60,000 prostate cancer treatments using HIFU without surgery or radiotherapy.
- Patients and doctors assume that treatments are based on a good understanding of the required dose in tissue (as in radiotherapy) but no such metrological infrastructure exists.
- Treatments are inconsistent: harm can result from over-treatment or under-treatment.
- Valuable new treatments are not taken up because their outcomes are too uncertain.

This project will develop the metrological infrastructure (definitions, validated measurement and modelling methods) for traceable dosimetry to improve the quality of life for patients. It will benefit the medical manufacturing industry, and give healthcare providers optimised treatment planning methods.

**Ultrasound therapies**

Lithotripsy, soft tissue physiotherapy and phacoemulsification during cataract surgery are long-established but still rather variable. Many promising new uses need metrology to take them from a few enthusiastic champions into mainstream practice where they can deliver maximum benefit: some are highlighted below. Others include treatment of atrial fibrillation, ultrasound-induced haemostasis, the treatment of stroke in conjunction with clot-busting drugs, and intravascular HIFU.

Enhanced bone healing: low intensity pulsed ultrasound (LIPUS) shows a 30% reduction in the time to regain full weight bearing, which is a reduction of about 40 days. Before we used ultrasound I would expect to see this kind of injury healing with some difficulty, and some of them don’t heal at all. Even if they do heal, it can take between six and 12 months and patients have ongoing pain during that time." Angus Maclean, Orthopaedic Surgeon.

Targeted drug delivery: with ultrasound it is possible to direct drugs to specific organs and stimulate uptake, even opening the blood brain barrier. "When you encapsulate a drug in nanoparticles, you can target it to the tumour. This is because the blood vessels in tumors are much more permeable than in normal tissues. Then we hope to open the door to treating Parkinson’s disease, epilepsy and brain tumors." Neal Kassell, MD.

**Need**

Reliable and appropriate definitions of dose parameters, and traceable methods for determining these quantities, are vital to ensure treatments can be planned in detail and therapeutic benefit maximised.

- The number of potentially valuable uses of ultrasound for therapy is increasing, some using very high pressures (>100 atm) and energy densities (>1kW/cm^2).
- There are no standardised and traceable dose quantities for medical ultrasound (either therapeutic or diagnostic), meaning that treatment parameters cannot be translated from one patient to another or from one type of equipment to another.
- The ‘amount’ of ultrasound required cannot be calculated and the ‘amount’ delivered cannot be measured making it impossible to determine dose-response curves and to arrive at robust, personalised treatment plans.
- Without harmonised standards, manufacturers do not have a clear and unified regulatory route to market in EU or globally.
- Non-medical human exposure (eg in the context of cosmetic surgery) is increasing and is unregulated.

**Impact**

The outputs of this project will lead to improved equipment, clinical procedures and regulations, bringing health and financial benefits to all the stakeholder groups.

For patients:
- Improved therapies, leading to better disease management and improved quality of life.
- Less invasive cancer treatments, with fewer side-effects and shorter recovery times;
- More informed patient management.

For doctors and healthcare providers:
- Increased range of reliable therapies available;
- Enhanced information guiding equipment procurement and underpinning patient care;
- Access to treatment planning tools;
- Reduced healthcare costs.

For manufacturers and regulators:
- Easier to bring new modalities to market;
- More homogenous global regulatory and purchasing requirements;
- Access to validated phantoms and dose standards.

**Team**

Our consortium of partners and collaborators is centred on Europe but global in reach. It includes all the major stakeholders: metrologists, regulators, medical researchers, clinicians, academics, industry, and international societies.

Modern medicine is a global industry. The critical size of this project has brought in important partners and collaborators to give a well-balanced consortium which will speed the process of gaining international consensus. The inclusion of ICR and FDA as unfunded partners brings clinical and regulatory expertise. The collaboration and support of industry like Smith & Nephew, Enraf Nonius and Philips Medical Systems is also important. Participation within key international committees and the inclusion of these important international societies as collaborators will ensure that the outputs are widely and rapidly disseminated for the benefit of the community as a whole.

**Equipped for success**

The UltraSight programme is an initiative to maximise the potential of the project and ensure its success. It brings together relevant stakeholders, including end-users, patients, quality and safety experts, to discuss and implement recommendations for patient safety and the establishment of a global metrology infrastructure for medical ultrasound.

**WP1: Quantities & Definitions**

How can ‘dose’ be defined for therapeutic ultrasound?

WP2: Laboratory standards

Equipment

WP3: Modelling methods

WP4: Transfer standards

WP5: Transfer standards

WP6: Clinical application

Clinicians

Regulations

Treated patients

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