Engymetry-a New Method and a New System for Nuclear Medicine Examinations with Clinical Examples

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Subject and purpose of engymetry is the introduction of a new low cost approach to medical applications of radiopharmaceuticals without expensive stationary imaging equipment. Engymetry means continuous measurement of function "nearby" (=engys) as opposed to telemetry. Nuclear radiation fields carrying pathophysiological signals emitted by patients are registered continuously in loco, in situ, by various small radiation sensors attached to or in the body. The detected signals are displayed and stored in a wearable CMOS data acquisition unit. The topic is treated in 4 sections.

1) Data acquisition: The new battery-powered engymetric system consists of different wearable radiation detectors (Geiger-Müller, CdTe, Silicon-avalanche, Crystal-photodiode) and a small multichannel signal storage unit for the time-activity histograms of tracer studies. Washin, accumulation, metabolism, and washout of radiopharmaceuticals from various parts of the body can be monitored continuously. The system is especially suited to register and analyse slowly changing functions.

2) Information processing: A concept for personal computing as "alternative" data processing for physicians and other non-computer specialists is developed. A software system for interactive analysis of engymetric biomedical signals (engygrams) in dialog with an inexpensive personal computer (Apple II) or a hand-held-computer (Epson HX-20) is introduced. Topics treated include traditional time function arithmetic, sophisticated data analysis from indicator dilution theory, and external extensibility of the dialog system by new programs. Implemented operations such as Fourier transforms, (de) convolution, (cross) correlation, curve fitting with exponentials, cubic splines, gamma variates, lagged normal density functions are described. Applications regard e.g. substance extraction by organs (dual isotope method), local and global Xe-133 clearance, perfusion studies, compartmental analysis.

3) Clinical applications: Different classes of engymetric application procedures with results from a variety of clinical fields are discussed. The fields regard thrombosis, chronic venous insufficiency, compartment syndrome, radiocardiography, renography, regional blood flow, tumor detection, lymph kinetics, oviduct patency control, hematology, blood distribution changes, cerebrospinal fluid dynamics, peripheral arterial disease. More than 450 patients have been examined. As compared to expensive conventional nuclear medicine imaging procedures low cost engymetry is unrestricted in time of measurement and independent of the environment of the patients who need not be immobilised. It can be conducted over short and long times (sec-min-

hours-days), during any physical activity (divers, pilots), at home, during surgery, at intensive care units, during pharmaceutical interventions etc. The continuous engymetric measurements "nearby" reduce radioindicator dose and radiation burden substantially. Low dose beta- and positron-emitters have been used successfully. Cardiac left-to-right-shunt determination after C $(0\text{–}15)_2$ bolus inhalation for example is compared to the result by a positron camera.

4) Further applications: The engymetric principle opens up a wide field of novel function studies using gamma- and beta-emitting radioindicators with short or long half life mainly in biology, physiology, pharmacology, nuclear medicine, veterinary medicine, and general research. Possible further applications are discussed.

The engymetric equipment is now commercially available.