A novel daily routine method of quantification and denoising in ^{99m}Tc-Mag3 renography.

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Aim: To overcome the presence of high level of Poisson noise in fast dynamic renal acquisition which hinders images analysis and interpretation.

Material and methods: To subdue the noise problem, a method based on fitting and filtering time activity curves (TAC) in Legendre space is proposed. The signal in time domain is transformed to a space domain where noise and signal are mapped into different subspaces. A "cut off" is applied onto the set and an inverse Legendre transform lead to a denoised TAC. This method was used to extract the usual functional information in ^{99m}Tc-Mag3 renography. We used a renal database (http://www.dynamicrenalstudy.org) which contains Monte-Carlo (MC) simulated studies and real patients' data for a total of 70 different studies. The MC studies provided Gold Standard with different levels of injected activity, renal clearance and noise in the anterior and posterior views. The relative kidney function (integral method), time to maximum of uptake (TM) and half emptying time (T1/2) were computed using a homemade software written in Python.
The results were compared to the ground-truth (MC data) and to the values obtained with a state-of-the-art commercial software (Hermes) currently used in clinical practice for nuclear image analysis. For each parameter (TM, T1/2) a parametric image at voxel level was also obtained.

Results: When pooling all data, slope (R^2) of the linear regression between Hermes and Legendre was: 0.97 (0.99) for uptake, 0.92 (0.78) for TM, 0.26 (0.10) for T1/2 (MC). Furthermore Mean (SD) for the Bland-Altman analysis was: 0.23 (0.93) for uptake, 0.09 (1.11) for TM, -2.05 (2.30) for T1/2 (MC). In case of high level of noise, the Legendre method held up performing and remained accurate (to the 10s frame temporal resolution) while the commercial software delivered TM and T1/2 values with sometimes difference exceeding the minute.
The same analysis has been performed at pixel level and led to the generation of TM and T1/2 parametric images that reflected the regional dependence of each parameter.

Conclusions: The Legendre method revealed not only to be accurate, routinely applicable and very robust in presence of high level of noise but a major breakthrough is the possibility to also generate parametric image at pixel level thanks to a fast and congruent fitting and a considerable noise removal.