Application for QIBA Project Funding

Title of Proposal: Beyond Confounders: Addressing Sources of Measurement Variability and Error in Shear Wave Elastography		
QIBA Committee/Subgroup: US SWS		
NIBIB Task Number(s) which this project addresses:		
Project Coordinator or Lead Investigator Information: Lead PI: Anthony Samir, MD, MPH Co-PI: Manish Dhyani, MD		
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Institution/Company: Massachusetts General Hospital		
Amount Requested:		

Project Description

It is well established that liver fibrosis severity correlates with liver stiffness, which can be non-invasively estimated by quantifying liver parenchymal shear wave speed (SWS) [1-6]. The capacity of liver SWS estimates to distinguish between F0-F3 and cirrhotic liver has been shown to be excellent, with an estimated area under the receiver operating characteristic (AUROC) curve of 0.98 [7].

Important challenges remain. Hepatic shear wave speed estimates are considerably less accurate for making the distinction between the clinically relevant intermediate METAVIR fibrosis grades of F1 and F2 [7-9]. Furthermore, substantial variation is noted in clinical practice: (1) inter-system variation limits comparability of measurements obtained on different SWS measurement systems, (2) measurement-to-measurement variation necessitates the acquisition of multiple measurements, and the performance of statistical procedures – such as taking median values – to eliminate the influence of outlier measurements. There are several reasons for this, some of which are inherent to the biology of liver fibrosis, and others predicated on our lack of knowledge of measurement system properties. The proposed work focuses on these measurement system properties:

1. **The effect on SWS of acoustic radiation force attenuation secondary to measurement depth.** Acoustic force is progressively attenuated with increasing tissue depth. The US technical subcommittee group has addressed this knowledge limitation in phantoms. We propose to validate this phantom work by performing SWS measurements in a group of patients of known liver fibrosis stage at varying depths.
2. **The effect of region of interest placement relative to the acoustic radiation force focus point.** We propose to perform SWS estimates at varying distance from the central focus of the acoustic radiation force to determine the effect of this on the measured SWS in a group of patients of known liver fibrosis stage.
3. **The effect of operator compressive force on shear wave speed measurements.** It has been claimed that transducer compressive force has little impact on liver SWS if measurements are performed intercostally. However, data substantiating this assertion is limited, and large compressive effects have been observed in other organs, including the kidneys [10]. Anecdotally, in interventional radiology practice it is entirely possible to displace the liver by compression over the intercostal spaces, raising the possibility that this is a source of measurement variability.
4. **The effect of acquisition parameters on SWS.** Multiple parameters (Annexure 2) are known to affect estimated SWS. The relative importance of these parameters at different liver fibrosis stages is poorly

understood. We propose to obtain measurement parameters from QIBA vendor partners. The QIBA US technical group to will use these to construct SWS estimation simulations, which will be compared with RF data acquired in human subjects.