Quality control in a longitudinal multi center Alzheimer's Disease study

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Introduction

InnoMed, (Innovative Medicines in Europe) is an Integrated Project funded by the European Union Sixth Framework program and is designed (i) to create knowledge to predict benefit and risk of new therapies in the drug development process (ii) to manage and organize data to predict benefit and risk of new therapies (iii) to make drug discovery more efficient and reduce drop out risks. InnoMed is divided into two parts, namely AddNeuroMed and PredTox. While AddNeuroMed will develop and validate novel surrogate markers based upon in vitro and in vivo models in animals and humans, using Alzheimer's Disease as a testing platform (1), PredTox will deliver new biomarkers of toxicity and greater understanding of mechanisms of toxicity. Within AddNeuroMed, the neuroimaging work package aims to (A) perform a multi center MRI study similar to a drug trial (B) combine MRI data with other biomarkers and clinical data, and (C) establish routines for MRI data collection and storage, MR quality control and site feed back. Here we describe the image quality control routines applied in the multi centre MRI study and present the results from the first 24 months of imaging.

Method

MR images were collected from patients with Alzheimer disease, mild cognitive impairment or normal control subjects at six European MRI centers (Kings College London, University of Kuopio, University of Perugia, University of Thessaloniki, University of Lodz and University of Toulouse).Sagittal MP-RAGE and axial PD/T2 weighted TSE images were acquired using three different 1.5T MR systems (GE, Siemens, Picker). In all cases birdcage head coils were employed. Immediately after acquisition, the images were reviewed at each MRI acquisition site to ensure (A) complete brain and skull coverage (B) exclusion of wrap-around effecting the brain (C) exclusion of motion artefacts, (D) exclusion of intensity non-homogeneity (E), assure adequate gray/white matter contrast. Image acquisition was instantly repeated if these QC requirements were not met.

Thereafter, data was transferred in DICOM format to the data coordination centre (DCC) at the Karolinska Institute. Data management, workflow control and image quality control utilised the Loris database system developed at McConnell Brain Imaging Centre, McGill University, Montreal (3). At the DCC imaging parameters (e.g. TR, TE, slice thickness etc.) were automatically verified and file names assigned during database uploading and inconsistencies regarding the DICOM header meta information reported to the acquisition sites for correction. The second level of QC, performed manually by two experts ensured inter-site consistency. In addition to the manual quality control, measurements of signal to noise ratio and geometric distortions were carried out using the ADNI phantom. Moreover, a human volunteer was scanned at each site and the data processed to give automated cortical and sub-cortical volumes (3).

Results

During the first 24 months 601 patient datasets were acquired and uploaded to the database. 97% of the 3D -T1 weighted images passed QC and could be used for volume estimations. 84% of the PD/T2 weighted images passed QC. The main reasons for failing to gain a pass were movement artefacts (95%) or insufficient brain coverage (<5%). Quantitative phantom measurements of signal to noise ratio, uniformity and geometric distortion were acceptable at each site. Human phantom measurements of whole brain (coefficient of variation = 1.7%) and cortical thickness (CV = 1.4%) showed excellent agreement between the different acquisition sites.

Conclusion

Data has been successfully collected for a multi-site Alzheimer's disease MRI-study. Quality control and quality assurance were performed on a routine basis both, at the six data collection centers and the DCC. The feature-set of the database system covers the entire process from image acquisition, storage and quality control to data querying for analysis. Quality control statistics showed that the performance of the participating sites is very high; 97 % of all T1 images passed QC. Phantom measurements and human phantom whole brain volume and cortical thickness measurements showed excellent inter-site agreement.

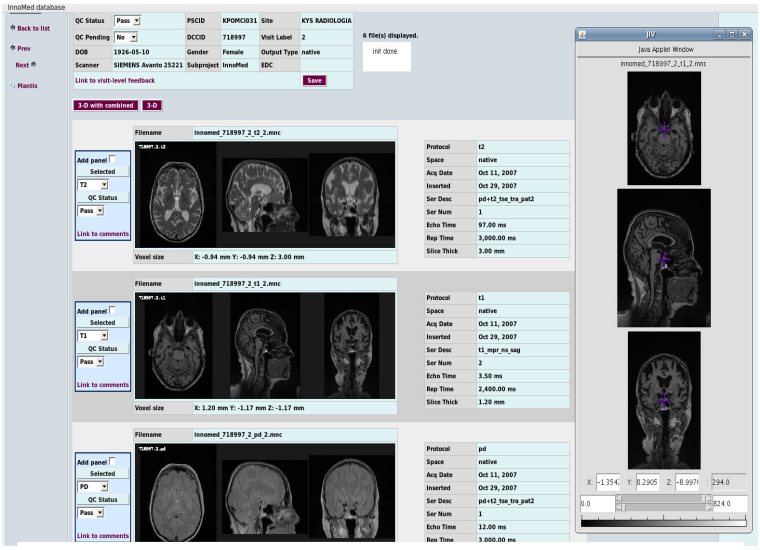

Fig1. Quality control interface for the AddNeuroMed database. Image type, quality control status and acquisition parameters are shown.

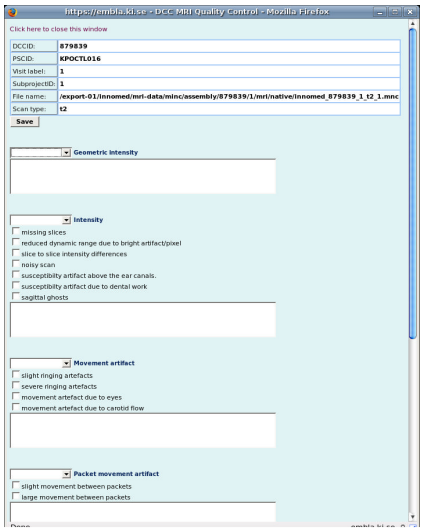

Fig2. Examples of quality control parameters stored for each image type.

References:

(1) Lovestone S, Francis, P., Strandgaard K., on behalf of the AddNeuroMed collaborative group. Biomarkers for disease modification trials – the innovative medicines initiative and AddNeuroMed ; The Journal of Nutrition, Health & Aging Volume 11, Number 4, 2007

(2) SG Mueller, MW Weiner, LJ Thal, RC Petersen, CR Jack, W Jagust, JQ Trojanowski, AW Toga, L Beckett, Ways toward an early diagnosis in Alzheimer's disease : The Alzheimer's Disease Neuroimaging Initiative (ADNI), Alzheimers Dement, 1(1), 55-66, 2005

(3) Evans AC; Brain Development Cooperative Group.The NIH MRI study of normal brain development. Neuroimage. 2006 Mar; 30(1):184-202. Epub 2006 Jan 11.PMID: 16376577