Cost-Effectiveness Analysis Of AI-Assisted Radiological Assessment In Patients With Relapsing Remitting Multiple Sclerosis In The UK

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INTRODUCTION

- Since many of the pathological events in the brain of people with Multiple Sclerosis (PwMS) remain clinically silent in the short term, magnetic resonance imaging (MRI) is a standard tool to detect silent disease activity, particularly in order to evaluate disease modifying treatment response and inform clinical decisions about Disease Modifying Treatment (DMT)[1].
- However, current evaluation of brain MRI scans, in a clinical setting, relies on visual inspection, the sensitivity and accuracy of which are limited by human and technical factors[2-6].
- AI-derived software for medical image quantification offers potential to improve accuracy, efficiency, and thereby timely DMT decisions which may improve outcomes[7-10].
- ico**brain ms**[11-13] is a software for medical image quantification providing automatic labelling, visualization and volumetric quantification of white matter lesions and brain volume in PwMS from serial sets of MRI scans. The technology summarizes clinically relevant findings in structured electronic reports and provides annotated images highlighting changes that indicate disease activity and, thus, suboptimal DMT response. Both reports and annotated images complement the visual assessment of MRI scans, thereby assisting radiologists, neurologists and other health care professionals in clinical decision-making, for example, DMT switching.

OBJECTIVE

- **To provide an initial evaluation of the cost-effectiveness of AI-assisted MRI assessment in the MS clinical decision-making pathway in the UK**
- **To identify key drivers of cost-effectiveness to inform research and decision about the use of AI-assisted MRI assessment in PwMS.**

METHODS

- A cohort Markov model based on the National Health Service (NHS) Treatment Algorithm for Multiple Sclerosis Disease-modifying Therapies was developed[14]. The model compares the current clinical decision-making pathway using visual inspection only of MRI head to assess disease activity with AI-assisted MRI assessment.
- The model simulates both treatment course and disease progression of PwMS on different treatment options. The structure of the model is depicted in **Figure 1**.
- PwMS failing on a first-line DMT (non-responders) can switch to a second-line DMT. Upon failure on a second-line DMT, patients will receive a third-line DMT option.
- If treatment failure is not detected, patients move to a suboptimal treatment line characterised by faster disease progression and higher relapse rate. Patients may also discontinue any DMT at any stage.
- The model uses ‘at least one relapses’ or ‘two or more new lesions’ in the previous year as criteria of treatment failure and treatment switch.
- Annual rates of disease activity (i.e. relapses and new lesions) and the sensitivity of the MRI assessment tool (Visual vs AI-assisted) are used to estimate the transition probabilities between treatment options.
- To estimate the model input parameters, we used published data, as well as unpublished data, and assumptions based on expert opinion. More details about model input parameters and assumptions are in the supplemental materials (accessible also via the QR code below).

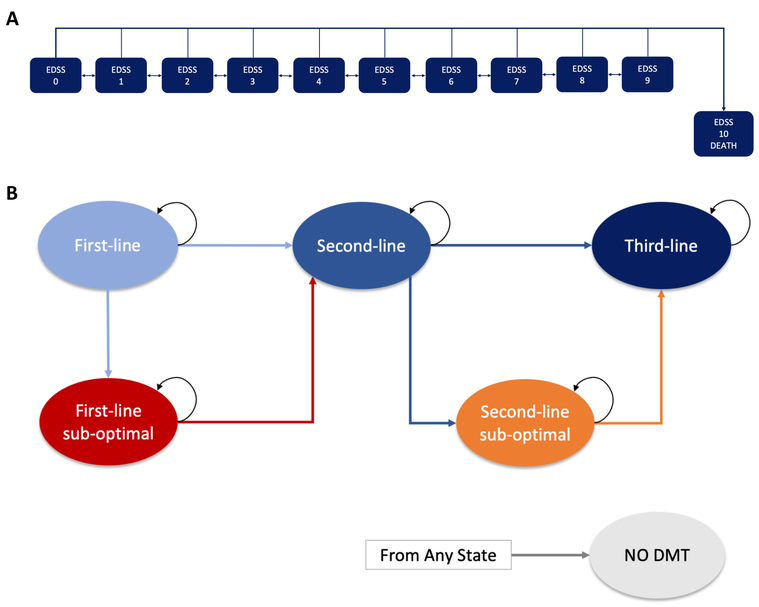

Figure 1 Two-layers model structure A. The first layer uses the common model structure simulating the disease progression of PwMS using health states based on EDSS score from 0 to 10 (death). At each cycle, patients can move forward or backward or stay in the same EDSS state. They can move to the “Death” state from any states.
B. The second layer models the treatment course of the patient across DMT lines according to the clinical decision rules. Patients can move from one DMT line to the other according to specified criteria of treatment failure while on the current DMT.

RESULTS

- For the base case, we used sensitivity estimates of 50% and 80% for the visual and AI-assisted assessments respectively, meaning that the visual assessment detected 50%, while the AI-assisted assessment 80% of the silent MRI activity.
- The AI-assisted MRI assessment was cost-effective at a willingness to pay threshold of £20,000 per QALY, with an **ICER of £5,871**. The incremental QALYs gain was **0.08** and the incremental costs **£469** per patient over a time-horizon of 20 years.

Probabilistic Sensitivity Analysis (PSA)

- The probabilistic sensitivity analysis results were consistent with the base case results. AI-assisted MRI assessment had a good probability (**76.5-85.4%)** of being cost-effective at conventional thresholds (GBP 20,000 and GBP 30,000 per QALY gained). Whereas it had a **30.3%** probability of being dominant.

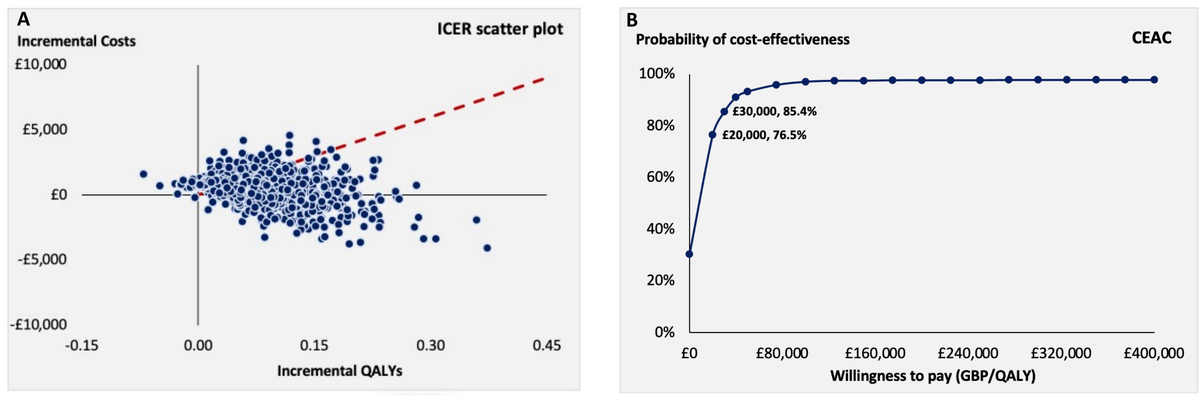

Figure 2 PSA results A. ICER scatter plot. Red dashed line indicates £20,000 cost-effectiveness threshold **B.** Cost-effectiveness acceptability curve

Deterministic Sensitivity Analysis

- Results of the deterministic analysis were expressed in terms of Net Health Benefit (NHB) (**Figure 3).** The most sensitive parameters were 1) the sensitivity of both visual and AI-assisted radiological assessment, 2) the efficacy of the first-line DMT on the EDSS progression of non-responders and the EDSS progression rate of non-responders, 3) The efficacy on EDSS and the cost of the third line DMT.

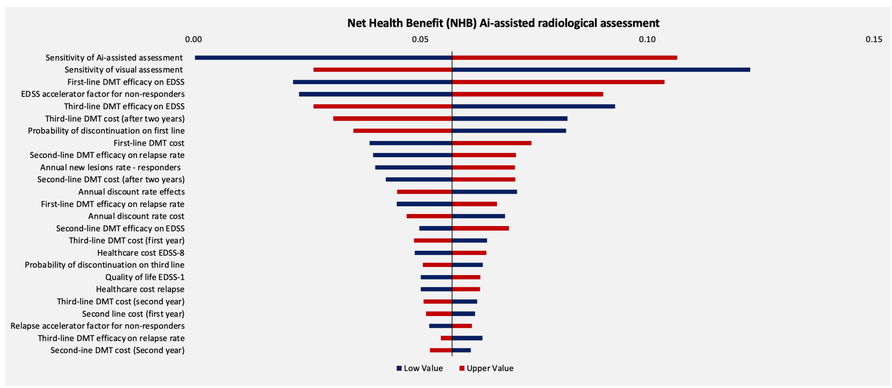

Figure 3 Tornado diagram. Deterministic sensitivity analysis, AI-assisted vs visual assessment based on incremental net health benefit (positive values equate to health gains for AI-assisted assessment at the £20,000 threshold)

CONCLUSIONS

- AI-assisted MRI assessment using a tool such as ico**brain ms** can inform DMT decisions in PwMS to switch earlier to more effective DMT, with the intention to prevent or slow down disability worsening and disease progression.
- The results of our initial evaluation show that AI-assisted MRI assessment is cost-effective from a health care perspective in the MS care pathway in the UK.
- Our model is useful to identify key drivers of cost-effectiveness to inform future research. For example, it is important to further investigate the efficacy of AI-assisted radiological assessment in detecting silent disease activity and inform clinical decision early compared to visual radiological assessment performed by radiologists with different experience and level of sub-specialization, and in different subpopulations of PwMS (e.g. active vs highly active). This may help to obtain more precise estimates of efficacy, and to reduce uncertainties around the model outputs.

Suppl. Materials

References

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