

## **Electronic Supplementary Material**

### **ESM Methods**

#### **Hidden Markov model detailed description**

Parameter estimates for the hidden Markov model – Q matrix, emission matrix, covariate effect parameters and initial state probabilities – are shown in ESM Tables 3, 4, 5 and 6. Starting values for the emission matrix probabilities were set to encourage the fitting algorithm to find a model in which hidden states 1 to 4 correspond roughly to the four reported states. To constrain the model so that parameters would be identifiable and the fitting algorithm would converge in a reasonable time, we specified a number of restrictions as follows:

- (1) instantaneous transitions occur only between adjacent states, and that state 4 (“refer”) is an absorbing state. This does not disallow transition to non-adjacent states between examinations, as more than one transition can occur within an interval.
- (2) mismatches between the observed state and the ‘true’ hidden state occur only for adjacent states
- (3) for each covariate the effect parameters (rate ratios) are equal for the three possible up transitions to worse states (1-2, 2-3, 3-4), and equal for the two possible down transitions to less severe states (2-1, 3-2).