New models for handling correlated underdispersed Likert pain scores

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Background

Pain intensity assessment

- Rating scales,
- From 0 (no pain) to 10 (worst possible pain),
- Among 11 scores with the Likert Scale.

11-point ordered categorical data modelling

- Models adapted to fit and simulate non negative [0,10] integer values[1],
- Models taking into account serial correlation between observations (psychological tendency to report same or similar score as previously done).

Objective ➔ To develop model(s) for 11-point pain data

Methods

Data

- Likert pain scores from placebo arm of a clinical study,
- Collected from 231 patients suffering from painful distal diabetic neuropathy,
- Consisted of daily diary entries over 18 weeks.

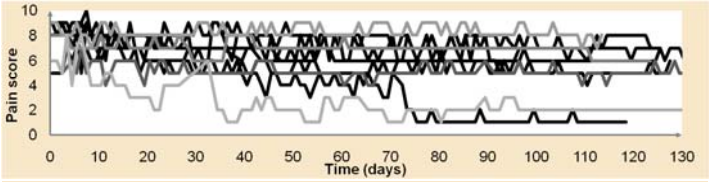

Figure 1: *Profiles of the time course of the pain scores for 8 representative patients.*

Models

- Generalized Poisson model[2] right-truncated at 11 (LAPLACE -2LL in NONMEM VI):

$$P(Y_i = y) = \frac{\lambda_i(1-\delta_i)\times\left(\lambda_i(1-\delta_i)+y\delta_i\right)^{y-1}\times e^{-\left(\lambda_i(1-\delta_i)+y\delta_i\right)}/\,y!}{\sum_{n=0}^{10}P(n)}$$

Open 1st order Markov elements incorporated, inflating the probabilities of subsequent scores to be equal, ±1, ±2 or ±3 to the preceding one.

- Compared to a continuous model logit transformed (FOCEI in NONMEM VI):

$$Y = 10\times\frac{e^{\ln\left(\frac{\lambda_i}{1-\lambda_i}\right)+\varepsilon}}{1+e^{\ln\left(\frac{\lambda_i}{1-\lambda_i}\right)+\varepsilon}}$$

Auto-correlation in time introduced for the residual error model, correlating ε_s with an AR1 model.

Results

Time course of the mean score

- Described with an exponential placebo function:

$$\lambda = Baseline\times\left(1-\mathrm{E\,max}\times\left(1-e^{\left(-\ln(2)/T\frac{1}{2}*time\right)}\right)\right)$$

Estimates were 6.13 & 6.27 Likert scores for Baseline, 22.4 & 16.9 % for Emax and 38.4 & 29.4 days for T½, with the generalized Poisson & the continuous model, respectively.

- Evaluated with a Visual Predictive Check[3] (VPC) :

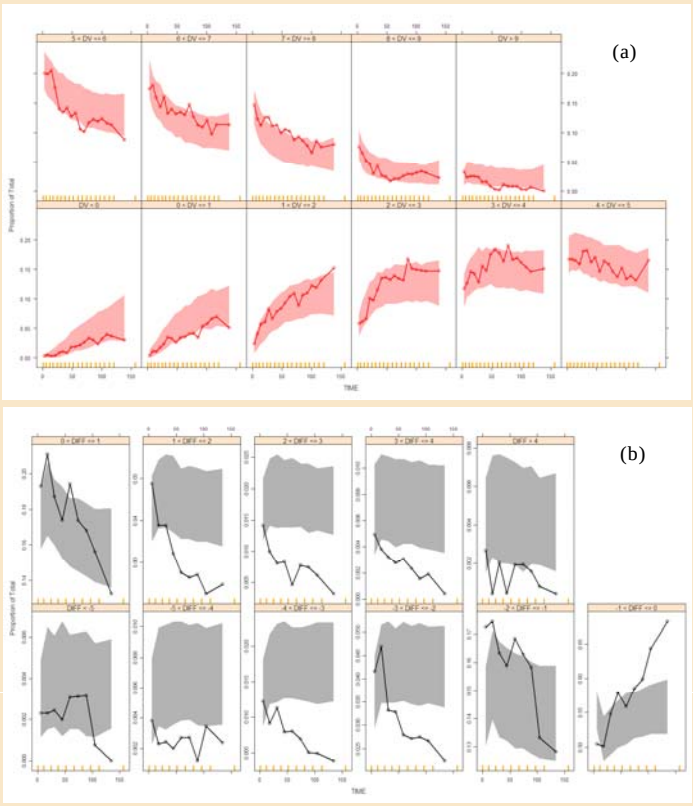

Figure 2: *Categorical VPCs of the Likert scores (a) and the differences between subsequent [S_n-S_{n-1}] scores (b) versus time (days) comparing proportions of the observations (lines) and 95 % confidence interval of 500 simulations (areas) performed with the generalized Poisson model.*

Transitions between scores

- Estimates were $P(S_n=S_{n-1})$ = 76 %, $T\frac{1}{2}_{correlation}$ = 0.75 days.

Conclusions

➔ 2 models to describe observed Likert scores.
➔ Novel features to handle serial correlation.

References

1 Plan *et al.* Eleven ordered categories data: which modelling options? *PAGE* 2009.
2 Yang *et al.* Testing approaches for overdispersion in poisson regression versus the generalized poisson model. *Biometrical journal* 2007.
3 Karlsson & Holford. A Tutorial on Visual Predictive Checks. *PAGE* 2008.

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