Generalized Mixed Linear Models
Practical 1

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Post-operative sore throat study

The aim of a study carried out at the Royal Berkshire Hospital, Reading, in 2004 was to investigate the incidence of sore throat in patients who had undergone orthopaedic, gynaecological, genitourinary or general surgery. Of particular interest was whether the occurrence of a sore throat was affected by the method used to deliver anaesthetic gas, and patients were allocated to one of three types of airway device, namely the laryngeal mask airway (LMA), the endo-tracheal tube (ETT), and the traditional face mask (FM). The decision on which of the three types of device to use for a particular patient was made by the consultant anaesthetist, and there were 12 anaesthetists involved.

The response variable was binary and concerned whether or not a patient experienced a sore throat in the 24 hour period following the operation. The values of certain explanatory variables were also recorded, including the age and sex of the patient, the duration of surgery, and, for LMA and ETT, whether or not the throat was lubricated before the airway was inserted.

The following eight variables are contained in the datafile **sorethroat.dta**.

PATIENT	Patient number (1 - 947)
AGE	Age of patient in years
SEX	Sex of patient (0 = male, 1 = female)
DURATION	Duration of surgery in minutes
AIRWAY	Type of airway used (LMA, ETT or FM)
LUBRIC	Lubrication used in inserting mask (0 = no, 1 = yes, . = n/a)
CONSULT	Consultant anaesthetist (1 - 12)
SORE	Occurrence of sore throat (0 = no, 1 = yes)

1. How do the three types of airway compare in terms of the incidence of post-operative sore throat?

2. Is there any evidence that the probability that a consultant selects the face mask (FM) is dependent upon the age and sex of the patient or the duration of surgery?

Solution

Evidently, we need to evaluate the risks of FM(1), LMA(0) and ETT(2). We choose LMA as reference (arbitrary). We get the following. Clearly, FM has the highest preventive effect.

```
Logistic regression                                     Number of obs   =        947
                                                        LR chi2(2)      =      26.23
                                                        Prob > chi2     =     0.0000
Log likelihood = -392.27112                             Pseudo R2       =     0.0324

------------------------------------------------------------------------------
        sore | Odds Ratio   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      airway |
          1  |   .1008403   .0726669    -3.18   0.001     .0245611    .4140202
          2  |   1.681319   .4974374     1.76   0.079     .9414826    3.002533
             |
       _cons |   .1944444   .0189319   -16.82   0.000     .1606643     .235327
------------------------------------------------------------------------------
```

But how is this influenced by other covariate such as gender and age?

```
Logistic regression                                     Number of obs   =        947
                                                        LR chi2(4)      =      47.52
                                                        Prob > chi2     =     0.0000
Log likelihood = -381.62451                             Pseudo R2       =     0.0586

------------------------------------------------------------------------------
        sore | Odds Ratio   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      airway |
          1  |   .0941757   .0679809    -3.27   0.001     .0228822    .3875968
          2  |   1.830303   .5528838     2.00   0.045     1.012508    3.308624
             |
         age |   1.000994   .0061108     0.16   0.871     .9890885    1.013043
         sex |   2.538882   .5415277     4.37   0.000     1.671424    3.856546
       _cons |   .0977297   .0341282    -6.66   0.000     .0492922    .1937649
------------------------------------------------------------------------------
```

We see that gender is important, but not age. We also look at the effect of including duration:

```
Logistic regression                                     Number of obs   =        947
                                                        LR chi2(4)      =      48.25
                                                        Prob > chi2     =     0.0000
Log likelihood = -381.26135                             Pseudo R2       =     0.0595

------------------------------------------------------------------------------
        sore | Odds Ratio   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      airway |
          1  |   .0872864   .0634804    -3.35   0.001     .0209844    .3630753
          2  |    1.97484   .6217158     2.16   0.031     1.065511    3.660208
             |
         sex |   2.554164   .5449203     4.40   0.000     1.681313    3.880156
    duration |   .9966394    .003946    -0.85   0.395     .9889354    1.004403
       _cons |   .1151237   .0266415    -9.34   0.000     .0731447    .1811951
------------------------------------------------------------------------------
```

There is no effect of duration. Finally, we look at the consultant effect. This is more difficult as there are many consultants. Hence we need to perform a proper model evaluation.

```
Logistic regression                                     Number of obs   =        942
                                                        LR chi2(13)     =      54.18
                                                        Prob > chi2     =     0.0000
Log likelihood = -377.46249                             Pseudo R2       =     0.0670

------------------------------------------------------------------------------
        sore | Odds Ratio   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      airway |
          1  |   .1055685   .0774471    -3.06   0.002     .0250655    .4446233
          2  |   1.909648   .6425182     1.92   0.055     .9875493    3.692731
             |
         sex |   2.425342   .5360854     4.01   0.000     1.572634    3.740402
             |
  consultant |
          2  |   1.403994    .605088     0.79   0.431     .6032782    3.267479
          3  |   .7801426    .490758    -0.39   0.693     .2273607    2.676902
          4  |   1.103781   .4592449     0.24   0.812     .4883457    2.494814
          5  |    .739868   .3498967    -0.64   0.524     .2928235    1.869401
          6  |    1.05312   .4526899     0.12   0.904     .4535067    2.445524
          7  |   1.760576   .7683945     1.30   0.195      .748432    4.141497
          8  |   .7921757    .417397    -0.44   0.658     .2820485    2.224945
          9  |   1.194777   .5105239     0.42   0.677     .5170962    2.760592
         10  |   1.362303   .5826169     0.72   0.470      .589169    3.149978
         11  |   1.002999   .6385044     0.00   0.996     .2880247    3.492781
         12  |          1  (empty)
             |
       _cons |   .0937726   .0343965    -6.45   0.000     .0456929    .1924437
------------------------------------------------------------------------------
```

In this model, we see many specific consultant's effects, none of them is significant. But is there an overall consultant effect?

- We see that the log-likelihood is -377.46249 (AIC = 782.925, BIC= 850.797) for this model, whereas the model without consultant effect has log-likelihood of -381.63776 (AIC = 771.2755, BIC = 773.5353).
- The likelihood ratio statistic is -377.46249-(-381.63776) = 8.35062 which is not significant on a chi-square scale of 11 df (consultant 12 has no estimable effect).
- This is not the best way of dealing with categorical variables with many categories and we need to take this up again when discussing random effects.

Finally, we look at the question of FM selection and how this is affected by age and gender.

```
Logistic regression                               Number of obs   =        947
                                                  LR chi2(2)      =       3.40
                                                  Prob > chi2     =     0.1827
Log likelihood = -326.09469                       Pseudo R2       =     0.0052

------------------------------------------------------------------------------
          FM | Odds Ratio   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         age |   1.009157   .0068659     1.34   0.180     .9957895    1.022704
         sex |   1.344045   .2977323     1.33   0.182     .8706749    2.074778
       _cons |   .0658002    .025568    -7.00   0.000     .0307239    .1409221
------------------------------------------------------------------------------
```

We see that there is no age- or gender effect, but this result is heavily confounded by the consultant's effect as the next analysis shows.

```
Logistic regression                               Number of obs   =        651
                                                  LR chi2(8)      =      91.45
                                                  Prob > chi2     =     0.0000
Log likelihood = -240.23214                       Pseudo R2       =     0.1599

------------------------------------------------------------------------------
          FM | Odds Ratio   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         age |   1.020834   .0082594     2.55   0.011     1.004774    1.037152
         sex |   .7555842   .2001989    -1.06   0.290     .4495203    1.270037
             |
  consultant |
           2 |   .6357229   .3307346    -0.87   0.384      .229314    1.762402
           3 |          1  (empty)
           4 |   .3228287   .1981049    -1.84   0.065     .0969682    1.074768
           5 |   4.703393    1.96275     3.71   0.000     2.075872    10.65668
           6 |          1  (empty)
           7 |          1  (empty)
           8 |          1  (empty)
           9 |   4.219144   1.663601     3.65   0.000     1.948037    9.138008
          10 |   .2630869   .1791228    -1.96   0.050     .0692721    .9991717
          11 |   .2858109   .3071024    -1.17   0.244      .034791     2.34796
          12 |          1  (empty)
             |
       _cons |   .0518732   .0296399    -5.18   0.000     .0169268    .1589687
------------------------------------------------------------------------------
```

However, we see also see that this form of analysis has reached its limits since many individual consultant's effects are not estimable and, hence, this form of analysis suffers under loss of power.