

RBCT

Torgerson et al

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```
library(glmmTMB)
library(MuMIn)
library(rstanarm)
```

```
## Loading required package: Rcpp
## This is rstanarm version 2.21.3
## - See https://mc-stan.org/rstanarm/articles/priors for changes to default priors!
## - Default priors may change, so it's safest to specify priors, even if equivalent to the defaults.
## - For execution on a local, multicore CPU with excess RAM we recommend calling
##   options(mc.cores = parallel::detectCores())
##
## Attaching package: 'rstanarm'
## The following object is masked from 'package:MuMIn':
##
##   loo
```

```
library(bridgesampling)
library(DHARMA)
```

```
## This is DHARMA 0.4.5. For overview type '?DHARMA'. For recent changes, type news(package = 'DHARMA')
```

```
library(readxl)
library(ggplot2)
```

```
#Load the data
```

```
rbctconf <- read_excel("rbctconf.xlsx", sheet = "Sheet1")
```

```
#short piece of code to make sure the reference level
#of variable exactly aligns with the analysis in Nature, 2006
rbctconf$Triplet<-relevel(factor(rbctconf$Triplet), ref="J")
rbctconf$Treatment<-relevel(factor(rbctconf$Treatment), ref="Survey-only")
```

```
#Model from 2006 paper
```

```
rs1<-glm(Incidence~Treatment+Triplet+log(Hist3yr)+log(Baseline), poisson, data=rbctconf)
```

```
summary(rs1)
```

```
##
## Call:
```

```

## glm(formula = Incidence ~ Treatment + Triplet + log(Hist3yr) +
##     log(Baseline), family = poisson, data = rbctconf)
##
## Deviance Residuals:
##      Min       1Q   Median       3Q      Max
## -0.85321  -0.54680  -0.00241   0.47137   0.88688
##
## Coefficients:
##              Estimate Std. Error z value Pr(>|z|)
## (Intercept)    -0.36167    0.93212  -0.388  0.69801
## TreatmentProactive -0.20661    0.07287  -2.835  0.00458 **
## TripletA        -0.26894    0.23410  -1.149  0.25064
## TripletB         0.15640    0.16604   0.942  0.34621
## TripletC         0.43196    0.16141   2.676  0.00745 **
## TripletD        -0.30400    0.19043  -1.596  0.11041
## TripletE        -0.02578    0.17511  -0.147  0.88298
## TripletF        -0.15938    0.18547  -0.859  0.39017
## TripletG         0.48182    0.19488   2.472  0.01342 *
## TripletH        -0.24769    0.18918  -1.309  0.19044
## TripletI        -0.50242    0.19730  -2.546  0.01088 *
## log(Hist3yr)     1.24144    0.21255   5.841  5.2e-09 ***
## log(Baseline)     0.04678    0.24805   0.189  0.85042
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for poisson family taken to be 1)
##
##      Null deviance: 167.3255  on 19  degrees of freedom
## Residual deviance:   5.6596  on  7  degrees of freedom
## AIC: 142.29
##
## Number of Fisher Scoring iterations: 4
AICc(rs1)

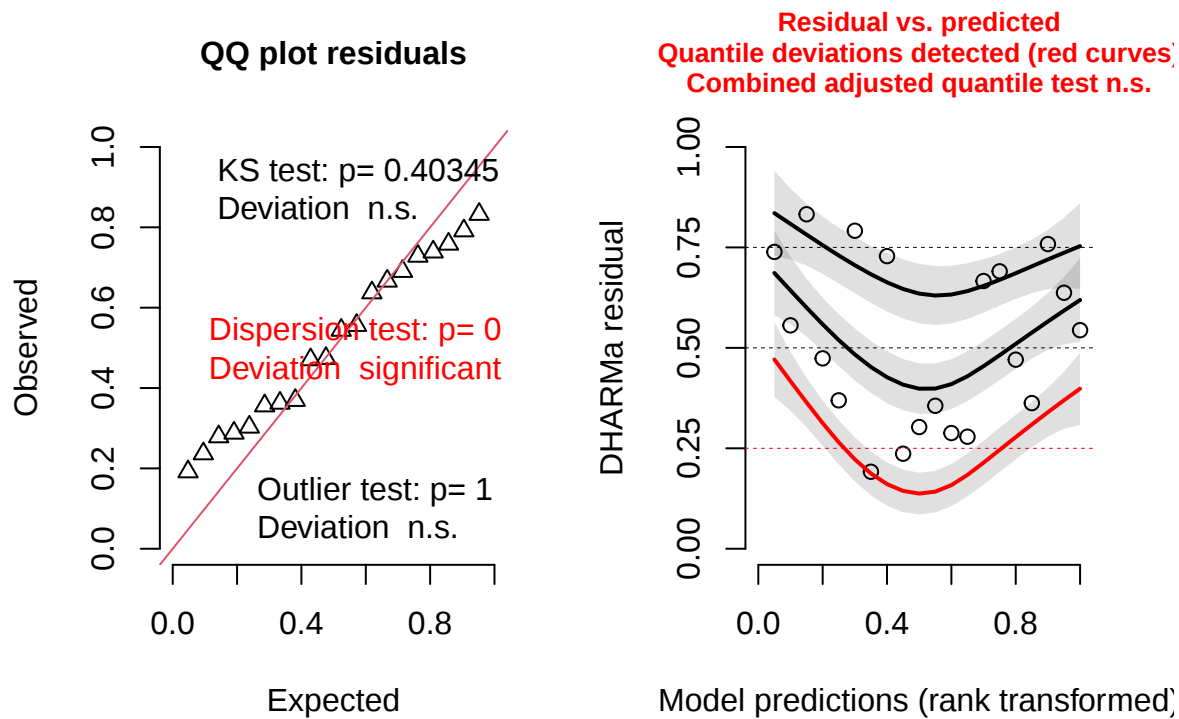
## [1] 202.9587

# This is model 1 in the text and gives the results in Table 1,
#and in the additional material of the 2006 paper.
# Post hoc analysis of model 1, and other (non quasi) models

plot(simulateResiduals(rs1))

```

DHARMa residual



#This gives figure 1 in the text

Model 2 in the text

```
rs2<-glm(Incidence~Treatment+Triplet+log(Hist3yr)+offset(log(Baseline)), quasipoisson, data=rbctconf)
```

```
summary(rs2)
```

```
##
## Call:
## glm(formula = Incidence ~ Treatment + Triplet + log(Hist3yr) +
##      offset(log(Baseline)), family = quasipoisson, data = rbctconf)
##
## Deviance Residuals:
##      Min       1Q   Median       3Q      Max
## -2.25722  -0.28151   0.01045   0.22610   2.90309
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  -3.4083259  0.8244394  -4.134  0.00328 **
## TreatmentProactive -0.1464174  0.1169442  -1.252  0.24592
## TripletA        0.3275810  0.2851203   1.149  0.28378
## TripletB        0.2144111  0.2709480   0.791  0.45157
## TripletC        0.2447265  0.2525308   0.969  0.36088
## TripletD       -0.0039618  0.2843936  -0.014  0.98923
## TripletE        0.2051618  0.2675414   0.767  0.46520
## TripletF       -0.3955031  0.2831510  -1.397  0.20001
## TripletG       -0.0004596  0.2510366  -0.002  0.99858
## TripletH       -0.0478847  0.2924001  -0.164  0.87398
## TripletI       -0.2774756  0.3087597  -0.899  0.39507
```

```

## log(Hist3yr)          0.7407251  0.2634804   2.811  0.02280 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for quasipoisson family taken to be 2.686752)
##
## Null deviance: 119.882 on 19 degrees of freedom
## Residual deviance: 20.128 on 8 degrees of freedom
## AIC: NA
##
## Number of Fisher Scoring iterations: 4
#Model 3 in the text
rs3<-glmmTMB(Incidence~Treatment+Triplet+log(Hist3yr)+log(Baseline),family=genpois, data=rbctconf)

summary(rs2)

##
## Call:
## glm(formula = Incidence ~ Treatment + Triplet + log(Hist3yr) +
##      offset(log(Baseline)), family = quasipoisson, data = rbctconf)
##
## Deviance Residuals:
##      Min       1Q   Median       3Q      Max
## -2.25722  -0.28151   0.01045   0.22610   2.90309
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    -3.4083259   0.8244394  -4.134  0.00328 **
## TreatmentProactive -0.1464174   0.1169442  -1.252  0.24592
## TripletA         0.3275810   0.2851203   1.149  0.28378
## TripletB         0.2144111   0.2709480   0.791  0.45157
## TripletC         0.2447265   0.2525308   0.969  0.36088
## TripletD        -0.0039618   0.2843936  -0.014  0.98923
## TripletE         0.2051618   0.2675414   0.767  0.46520
## TripletF        -0.3955031   0.2831510  -1.397  0.20001
## TripletG        -0.0004596   0.2510366  -0.002  0.99858
## TripletH        -0.0478847   0.2924001  -0.164  0.87398
## TripletI        -0.2774756   0.3087597  -0.899  0.39507
## log(Hist3yr)      0.7407251   0.2634804   2.811  0.02280 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for quasipoisson family taken to be 2.686752)
##
## Null deviance: 119.882 on 19 degrees of freedom
## Residual deviance: 20.128 on 8 degrees of freedom
## AIC: NA
##
## Number of Fisher Scoring iterations: 4
AICc(rs2)

## [1] NA

```

```
#Model 3a in the text
rs3a<-glmmTMB(Incidence~log(Hist3yr)+log(Baseline),family=genpois, data=rbctconf)

summary(rs3a)
```

```
## Family: genpois ( log )
## Formula: Incidence ~ log(Hist3yr) + log(Baseline)
## Data: rbctconf
##
##      AIC      BIC    logLik deviance df.resid
##    157.7    161.7     -74.9    149.7      16
##
##
## Dispersion parameter for genpois family (): 2.63
##
## Conditional model:
##           Estimate Std. Error z value Pr(>|z|)
## (Intercept)  -2.4021     0.9581  -2.507  0.0122 *
## log(Hist3yr)   0.9352     0.1938   4.825 1.40e-06 ***
## log(Baseline)  0.6569     0.1650   3.982 6.83e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
AICc(rs3a)
```

```
## [1] 160.3831
```

```
#Model 3b in the text
all.modelall2<-dredge(rs3,options(na.action = na.fail))
```

```
## Warning in eval(.expr_beta_arg): invalid value for 'beta' : the argument is
## taken to be "none"
```

```
## Fixed terms are "cond((Int))" and "disp((Int))"
```

```
final.models2=get.models(all.modelall2,cumsum(weight<=0.95))
table.final2=model.avg(final.models2)
summary(table.final2)
```

```
##
## Call:
## model.avg(object = final.models2)
##
## Component model call:
## glmmTMB(formula = Incidence ~ <16 unique rhs>, data = rbctconf, family
##       = genpois, ziformula = ~0, dispformula = ~1)
##
## Component models:
##      df logLik  AICc delta weight
## 12      4 -74.86 160.38  0.00  0.75
## 123     5 -74.22 162.72  2.33  0.23
## 2       3 -80.40 168.30  7.92  0.01
## 23      4 -79.50 169.67  9.28  0.01
## 1       3 -83.40 174.31 13.93  0.00
## 13      4 -83.04 176.74 16.36  0.00
## (Null)  2 -86.04 176.78 16.40  0.00
## 3       3 -85.46 178.42 18.04  0.00
```

```

## 234    13 -52.65 191.98 31.59    0.00
## 24     12 -62.09 192.75 32.36    0.00
## 124    13 -61.56 209.79 49.41    0.00
## 4      11 -79.26 213.52 53.14    0.00
## 14     12 -73.76 216.09 55.71    0.00
## 1234   14 -52.60 217.20 56.81    0.00
## 34     12 -78.50 225.58 65.20    0.00
## 134    13 -72.96 232.60 72.21    0.00
##
## Term codes:
## cond(log(Baseline))  cond(log(Hist3yr))      cond(Treatment)      cond(Triplet)
##                      1                      2                      3                      4
##
## Model-averaged coefficients:
## (full average)
##               Estimate Std. Error Adjusted SE z value Pr(>|z|)
## cond((Int))      -2.309e+00  1.057e+00   1.129e+00  2.045  0.04081 *
## cond(log(Baseline))  6.387e-01  1.887e-01   2.005e-01  3.186  0.00144 **
## cond(log(Hist3yr))   9.379e-01  1.976e-01   2.135e-01  4.394  1.11e-05 ***
## cond(TreatmentProactive) -2.967e-02  7.444e-02   7.768e-02  0.382  0.70253
## cond(TripletA)      -4.954e-08  1.290e-04   1.327e-04  0.000  0.99970
## cond(TripletB)       2.638e-08  7.881e-05   8.424e-05  0.000  0.99975
## cond(TripletC)       7.907e-08  1.954e-04   1.973e-04  0.000  0.99968
## cond(TripletD)      -5.343e-08  1.376e-04   1.410e-04  0.000  0.99970
## cond(TripletE)      -4.975e-09  4.809e-05   5.629e-05  0.000  0.99993
## cond(TripletF)      -2.069e-08  7.205e-05   7.837e-05  0.000  0.99979
## cond(TripletG)       8.535e-08  2.097e-04   2.115e-04  0.000  0.99968
## cond(TripletH)      -4.401e-08  1.170e-04   1.212e-04  0.000  0.99971
## cond(TripletI)      -9.105e-08  2.253e-04   2.279e-04  0.000  0.99968
##
## (conditional average)
##               Estimate Std. Error Adjusted SE z value Pr(>|z|)
## cond((Int))      -2.30876    1.05703    1.12872  2.045  0.040809 *
## cond(log(Baseline))  0.65281    0.16479    0.17843  3.659  0.000254 ***
## cond(log(Hist3yr))   0.93906    0.19498    0.21109  4.449  8.6e-06 ***
## cond(TreatmentProactive) -0.12388    0.10708    0.11631  1.065  0.286852
## cond(TripletA)      -0.28666    0.11887    0.14039  2.042  0.041169 *
## cond(TripletB)       0.15263    0.11245    0.13330  1.145  0.252202
## cond(TripletC)       0.45750    0.10783    0.12638  3.620  0.000295 ***
## cond(TripletD)      -0.30914    0.11808    0.13967  2.213  0.026877 *
## cond(TripletE)      -0.02878    0.11204    0.13231  0.218  0.827788
## cond(TripletF)      -0.11972    0.12531    0.14560  0.822  0.410930
## cond(TripletG)       0.49384    0.10305    0.12231  4.038  5.4e-05 ***
## cond(TripletH)      -0.25465    0.11972    0.14212  1.792  0.073179 .
## cond(TripletI)      -0.52681    0.12756    0.15145  3.479  0.000504 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

model.avg(object = final.models2)

##
## Call:
## model.avg(object = final.models2)
##
## Component models:

```

```
## '12'      '123'      '2'      '23'      '1'      '13'      '(Null)' '3'
## '234'     '24'       '124'     '4'      '14'      '1234'    '34'      '134'
##
## Coefficients:
##      cond((Int)) cond(log(Baseline)) cond(log(Hist3yr))
## full      -2.308765      0.6386521      0.9379255
## subset    -2.308765      0.6528074      0.9390614
##      cond(TreatmentProactive) cond(TripletA) cond(TripletB) cond(TripletC)
## full      -0.02966757 -4.954329e-08 2.637875e-08 7.906988e-08
## subset    -0.12387556 -2.866606e-01 1.526291e-01 4.575033e-01
##      cond(TripletD) cond(TripletE) cond(TripletF) cond(TripletG)
## full      -5.342789e-08 -4.974584e-09 -2.069192e-08 8.534944e-08
## subset    -3.091371e-01 -2.878326e-02 -1.197248e-01 4.938373e-01
##      cond(TripletH) cond(TripletI)
## full      -4.401043e-08 -9.104859e-08
## subset    -2.546472e-01 -5.268129e-01
#Model 4 in the text
rs4<-glmmTMB(Incidence~Treatment+Triplet+
              log(Hist3yr)+offset(log(hdyrsrisk)), family=genpois,data=rbctconf)
summary(rs4)
```

```
## Family: genpois ( log )
## Formula:
## Incidence ~ Treatment + Triplet + log(Hist3yr) + offset(log(hdyrsrisk))
## Data: rbctconf
##
##      AIC      BIC    logLik deviance df.resid
##    156.7    169.7    -65.4    130.7        7
##
##
## Dispersion parameter for genpois family (): 1.05
##
## Conditional model:
##      Estimate Std. Error z value Pr(>|z|)
## (Intercept)   -4.46387    0.51442  -8.677 < 2e-16 ***
## TreatmentProactive -0.14686    0.07310  -2.009 0.044550 *
## TripletA       -0.33736    0.17784  -1.897 0.057827 .
## TripletB       -0.63445    0.16898  -3.755 0.000174 ***
## TripletC       -0.46422    0.15755  -2.946 0.003215 **
## TripletD        0.05311    0.17742   0.299 0.764677
## TripletE       -0.40196    0.16705  -2.406 0.016120 *
## TripletF       -0.97294    0.17656  -5.510 3.58e-08 ***
## TripletG       -0.51586    0.15667  -3.293 0.000992 ***
## TripletH       -0.54741    0.18653  -2.935 0.003339 **
## TripletI       -0.28745    0.19257  -1.493 0.135511
## log(Hist3yr)    0.74027    0.16433   4.505 6.64e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
AICc(rs4)
```

```
## [1] 217.404
```

```
#Model 4a
rs4a<-glmmTMB(Incidence~log(Hist3yr)+offset(log(hdyrsrisk)), family=genpois,data=rbctconf)
```

```

summary(rs4a)

## Family: genpois ( log )
## Formula: Incidence ~ log(Hist3yr) + offset(log(hdyrsrisk))
## Data: rbctconf
##
##      AIC      BIC    logLik deviance df.resid
##    166.6    169.6    -80.3    160.6      17
##
## Dispersion parameter for genpois family (): 3.96
##
## Conditional model:
##              Estimate Std. Error z value Pr(>|z|)
## (Intercept)  -4.6754      0.6689  -6.989 2.76e-12 ***
## log(Hist3yr)   0.6399      0.2025   3.161 0.00157 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

AICc(rs4a)

## [1] 168.1069

#Model 4b
all.modelall2<-dredge(rs4,options(na.action = na.fail))

## Warning in eval(.expr_beta_arg): invalid value for 'beta' : the argument is
## taken to be "none"

## Fixed terms are "cond((Int))" and "disp((Int))"

final.models2=get.models(all.modelall2,cumsum(weight<=0.95))
table.final2=model.avg(final.models2)
summary(table.final2)

##
## Call:
## model.avg(object = final.models2)
##
## Component model call:
## glmmTMB(formula = Incidence ~ <16 unique rhs>, data = rbctconf, family
##       = genpois, ziformula = ~0, dispformula = ~1)
##
## Component models:
##      df logLik   AICc delta weight
## 12      3 -80.30 168.11  0.00   0.37
## 1       3 -80.40 168.30  0.20   0.33
## 13      4 -79.50 169.67  1.56   0.17
## 123     4 -80.02 170.71  2.61   0.10
## 2       2 -84.81 174.33  6.22   0.02
## 23      3 -84.33 176.16  8.05   0.01
## (Null)  2 -86.04 176.78  8.67   0.00
## 3       3 -85.46 178.42 10.32   0.00
## 134     13 -52.65 191.98 23.87   0.00
## 14      12 -62.09 192.75 24.64   0.00
## 24      11 -73.84 202.69 34.58   0.00

```

```

## 124    12 -67.26 203.09 34.98    0.00
## 4      11 -79.26 213.52 45.41    0.00
## 234    12 -73.01 214.60 46.49    0.00
## 1234   13 -65.37 217.40 49.30    0.00
## 34     12 -78.50 225.58 57.47    0.00
##
## Term codes:
##          cond(log(Hist3yr)) cond(offset(log(hdyrsrisk)))
##                  1                  2
##          cond(Treatment)      cond(Triplet)
##                  3                  4
##
## Model-averaged coefficients:
## (full average)
##          Estimate Std. Error Adjusted SE z value Pr(>|z|)
## cond((Int))      -1.897e+00  2.760e+00  2.777e+00  0.683  0.4946
## cond(log(Hist3yr))  7.920e-01  3.201e-01  3.336e-01  2.374  0.0176 *
## cond(TreatmentProactive) -4.304e-02  1.023e-01  1.065e-01  0.404  0.6860
## cond(TripletA)     -1.166e-06  6.266e-04  6.447e-04  0.002  0.9986
## cond(TripletB)      6.099e-07  3.891e-04  4.153e-04  0.001  0.9988
## cond(TripletC)      1.847e-06  9.492e-04  9.586e-04  0.002  0.9985
## cond(TripletD)     -1.250e-06  6.681e-04  6.851e-04  0.002  0.9985
## cond(TripletE)     -1.235e-07  2.399e-04  2.792e-04  0.000  0.9996
## cond(TripletF)     -5.047e-07  3.745e-04  4.037e-04  0.001  0.9990
## cond(TripletG)      1.993e-06  1.019e-03  1.028e-03  0.002  0.9985
## cond(TripletH)     -1.044e-06  5.730e-04  5.937e-04  0.002  0.9986
## cond(TripletI)     -2.142e-06  1.093e-03  1.105e-03  0.002  0.9985
##
## (conditional average)
##          Estimate Std. Error Adjusted SE z value Pr(>|z|)
## cond((Int))      -1.8968      2.7600      2.7774  0.683 0.494633
## cond(log(Hist3yr))  0.8163      0.2928      0.3079  2.651 0.008027 **
## cond(TreatmentProactive) -0.1552      0.1426      0.1532  1.013 0.310883
## cond(TripletA)     -0.2860      0.1204      0.1419  2.016 0.043838 *
## cond(TripletB)      0.1496      0.1214      0.1411  1.060 0.289245
## cond(TripletC)      0.4530      0.1254      0.1418  3.194 0.001402 **
## cond(TripletD)     -0.3066      0.1244      0.1452  2.111 0.034774 *
## cond(TripletE)     -0.0303      0.1148      0.1349  0.225 0.822315
## cond(TripletF)     -0.1238      0.1381      0.1570  0.788 0.430434
## cond(TripletG)      0.4886      0.1267      0.1430  3.417 0.000634 ***
## cond(TripletH)     -0.2560      0.1222      0.1445  1.772 0.076379 .
## cond(TripletI)     -0.5254      0.1301      0.1538  3.415 0.000638 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

model.avg(object = final.models2)

##
## Call:
## model.avg(object = final.models2)
##
## Component models:
## '12'    '1'    '13'    '123'    '2'    '23'    '(Null)' '3'
## '134'   '14'   '24'   '124'   '4'    '234'   '1234'   '34'
##

```

```

## Coefficients:
##      cond((Int)) cond(log(Hist3yr)) cond(TreatmentProactive) cond(TripletA)
## full      -1.896854      0.7919597      -0.04303815  -1.166232e-06
## subset    -1.896854      0.8163398      -0.15520178  -2.859893e-01
##      cond(TripletB) cond(TripletC) cond(TripletD) cond(TripletE)
## full      6.099495e-07  1.847351e-06 -1.250216e-06 -1.235489e-07
## subset    1.495749e-01  4.530166e-01 -3.065841e-01 -3.029727e-02
##      cond(TripletF) cond(TripletG) cond(TripletH) cond(TripletI)
## full     -5.046909e-07  1.992651e-06 -1.044149e-06 -2.142371e-06
## subset   -1.237628e-01  4.886478e-01 -2.560515e-01 -5.253629e-01

#Model 4c in the text
rs4c<-glmmTMB(Incidence~Treatment+Triplet+log(Hist3yr)+log(hdyrsrisk), family=genpois,data=rbctconf)

summary(rs4c)

## Family: genpois ( log )
## Formula:
## Incidence ~ Treatment + Triplet + log(Hist3yr) + log(hdyrsrisk)
## Data: rbctconf
##
##      AIC      BIC    logLik deviance df.resid
##    133.2    147.1     -52.6    105.2        6
##
##
## Dispersion parameter for genpois family (): 0.28
##
## Conditional model:
##      Estimate Std. Error z value Pr(>|z|)
## (Intercept)    -0.39270    0.62459  -0.629 0.529523
## TreatmentProactive -0.20663    0.03861  -5.351 8.74e-08 ***
## TripletA         -0.30730    0.09189  -3.344 0.000825 ***
## TripletB          0.10805    0.13476   0.802 0.422653
## TripletC          0.39164    0.14236   2.751 0.005940 **
## TripletD         -0.30837    0.10398  -2.966 0.003020 **
## TripletE         -0.06112    0.09613  -0.636 0.524907
## TripletF         -0.19525    0.14068  -1.388 0.165178
## TripletG          0.45426    0.15540   2.923 0.003465 **
## TripletH         -0.26343    0.09355  -2.816 0.004861 **
## TripletI         -0.52058    0.10436  -4.988 6.10e-07 ***
## log(Hist3yr)      1.24342    0.10868  11.441 < 2e-16 ***
## log(hdyrsrisk)    0.04384    0.13139   0.334 0.738653
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

AICc(rs4c)

## [1] 217.1978

#Model 4d in the text
rs4d<-glmmTMB(Incidence~log(Hist3yr)+log(hdyrsrisk), family=genpois,
              data=rbctconf)

summary(rs4d)

## Family: genpois ( log )

```

```

## Formula:          Incidence ~ log(Hist3yr) + log(hdyrsrisk)
## Data: rbctconf
##
##      AIC      BIC    logLik deviance df.resid
##    151.5    155.5    -71.8    143.5      16
##
##
## Dispersion parameter for genpois family (): 1.89
##
## Conditional model:
##           Estimate Std. Error z value Pr(>|z|)
## (Intercept) -2.13664    0.71509  -2.988  0.00281 **
## log(Hist3yr)  0.82669    0.16096   5.136 2.81e-07 ***
## log(hdyrsrisk) 0.51201    0.09616   5.325 1.01e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

AICc(rs4d)

## [1] 154.2039

#Model 4e in the text
all.modelall2<-dredge(rs4c,options(na.action = na.fail))

## Warning in eval(.expr_beta_arg): invalid value for 'beta' : the argument is
## taken to be "none"

## Fixed terms are "cond((Int))" and "disp((Int))"

final.models2=get.models(all.modelall2,cumsum(weight<=0.95))
table.final2=model.avg(final.models2)
summary(table.final2)

##
## Call:
## model.avg(object = final.models2)
##
## Component model call:
## glmmTMB(formula = Incidence ~ <16 unique rhs>, data = rbctconf, family
##       = genpois, ziformula = ~0, dispformula = ~1)
##
## Component models:
##      df logLik   AICc delta weight
## 12      4 -71.77 154.20  0.00    0.7
## 123     5 -70.79 155.87  1.66    0.3
## 2       3 -80.40 168.30 14.10    0.0
## 23      4 -79.50 169.67 15.46    0.0
## 1       3 -81.50 170.50 16.29    0.0
## 13      4 -80.88 172.42 18.22    0.0
## (Null)  2 -86.04 176.78 22.58    0.0
## 3       3 -85.46 178.42 24.22    0.0
## 234     13 -52.65 191.98 37.77    0.0
## 24      12 -62.09 192.75 38.54    0.0
## 124     13 -61.56 209.79 55.59    0.0
## 4       11 -79.26 213.52 59.31    0.0
## 14      12 -73.76 216.09 61.89    0.0
## 1234    14 -52.60 217.20 62.99    0.0

```

```

## 34      12 -78.50 225.58 71.38    0.0
## 134     13 -72.96 232.60 78.39    0.0
##
## Term codes:
## cond(log(hdyrsrisk))    cond(log(Hist3yr))    cond(Treatment)
##              1              2              3
##      cond(Triplet)
##              4
##
## Model-averaged coefficients:
## (full average)
##              Estimate Std. Error Adjusted SE z value Pr(>|z|)
## cond((Int))          -2.105e+00  7.143e-01  7.726e-01  2.724  0.00645 **
## cond(log(hdyrsrisk))   5.085e-01  9.632e-02  1.041e-01  4.884  1.0e-06 ***
## cond(log(Hist3yr))     8.293e-01  1.603e-01  1.735e-01  4.779  1.8e-06 ***
## cond(TreatmentProactive) -3.851e-02  7.588e-02  7.867e-02  0.490  0.62445
## cond(TripletA)        -2.105e-09  2.659e-05  2.735e-05  0.000  0.99994
## cond(TripletB)         1.121e-09  1.624e-05  1.736e-05  0.000  0.99995
## cond(TripletC)         3.359e-09  4.028e-05  4.067e-05  0.000  0.99993
## cond(TripletD)        -2.270e-09  2.836e-05  2.907e-05  0.000  0.99994
## cond(TripletE)        -2.114e-10  9.912e-06  1.160e-05  0.000  0.99999
## cond(TripletF)        -8.791e-10  1.485e-05  1.615e-05  0.000  0.99996
## cond(TripletG)         3.626e-09  4.323e-05  4.359e-05  0.000  0.99993
## cond(TripletH)        -1.870e-09  2.411e-05  2.499e-05  0.000  0.99994
## cond(TripletI)        -3.868e-09  4.644e-05  4.697e-05  0.000  0.99993
##
## (conditional average)
##              Estimate Std. Error Adjusted SE z value Pr(>|z|)
## cond((Int))          -2.10479    0.71435    0.77265  2.724  0.006447 **
## cond(log(hdyrsrisk))   0.50902    0.09512    0.10302  4.941  8.00e-07 ***
## cond(log(Hist3yr))     0.82955    0.15970    0.17299  4.795  1.60e-06 ***
## cond(TreatmentProactive) -0.12687    0.08809    0.09579  1.324  0.185362
## cond(TripletA)        -0.28667    0.11884    0.14037  2.042  0.041124 *
## cond(TripletB)         0.15261    0.11247    0.13332  1.145  0.252334
## cond(TripletC)         0.45749    0.10787    0.12642  3.619  0.000296 ***
## cond(TripletD)        -0.30914    0.11809    0.13967  2.213  0.026880 *
## cond(TripletE)        -0.02880    0.11204    0.13231  0.218  0.827715
## cond(TripletF)        -0.11974    0.12534    0.14563  0.822  0.410961
## cond(TripletG)         0.49383    0.10309    0.12235  4.036  5.43e-05 ***
## cond(TripletH)        -0.25466    0.11972    0.14212  1.792  0.073166 .
## cond(TripletI)        -0.52681    0.12756    0.15145  3.479  0.000504 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

model.avg(object = final.models2)

##
## Call:
## model.avg(object = final.models2)
##
## Component models:
## '12'      '123'      '2'        '23'        '1'        '13'        '(Null)' '3'
## '234'      '24'        '124'      '4'        '14'        '1234'      '34'      '134'
##
## Coefficients:

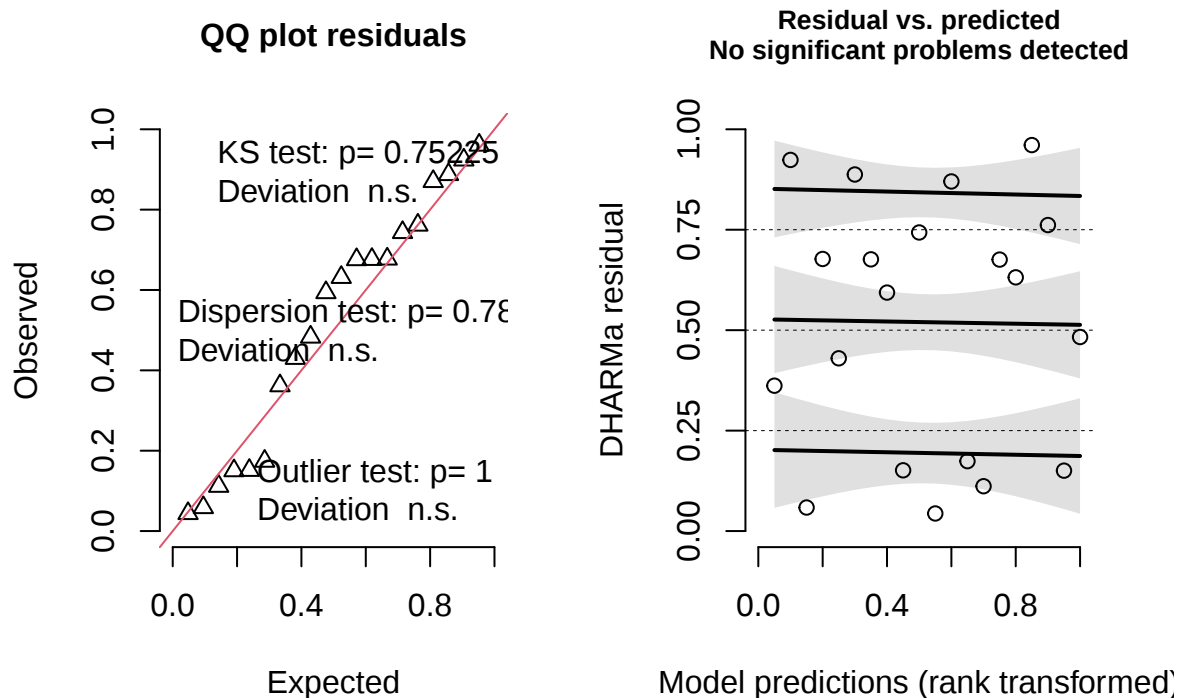
```

```
##      cond((Int)) cond(log(hdyrsrisk)) cond(log(Hist3yr))
## full      -2.104793      0.5085481      0.8293050
## subset    -2.104793      0.5090170      0.8295464
##      cond(TreatmentProactive) cond(TripletA) cond(TripletB) cond(TripletC)
## full      -0.03851175 -2.104788e-09  1.120488e-09  3.358923e-09
## subset    -0.12687190 -2.866743e-01  1.526116e-01  4.574887e-01
##      cond(TripletD) cond(TripletE) cond(TripletF) cond(TripletG)
## full      -2.269704e-09 -2.114209e-10 -8.791171e-10  3.625719e-09
## subset    -3.091360e-01 -2.879574e-02 -1.197367e-01  4.938267e-01
##      cond(TripletH) cond(TripletI)
## full      -1.869717e-09 -3.867909e-09
## subset    -2.546573e-01 -5.268131e-01
```

```
#post hoc analysis
```

```
plot(simulateResiduals(rs4d))
```

DHARMA residual



```
#This gives figure 2 in the text
```

```
#Model 5 in the text
```

```
rs5<-lm(Incidence/hdyrsrisk~Treatment+Triplet+log(Hist3yr), data=rbctconf)
```

```
summary(rs5)
```

```
##
## Call:
## lm(formula = Incidence/hdyrsrisk ~ Treatment + Triplet + log(Hist3yr),
##     data = rbctconf)
##
## Residuals:
```

```
##           Min           1Q       Median           3Q           Max
## -0.031619 -0.003847  0.000000  0.003847  0.031619
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)    -0.012492   0.060197  -0.208   0.8408
## TreatmentProactive -0.004699   0.008993  -0.523   0.6154
## TripletA       -0.018472   0.021692  -0.852   0.4192
## TripletB       -0.043502   0.021956  -1.981   0.0829 .
## TripletC       -0.035699   0.020134  -1.773   0.1141
## TripletD        0.023001   0.020971   1.097   0.3046
## TripletE       -0.027780   0.020625  -1.347   0.2149
## TripletF       -0.059544   0.020119  -2.960   0.0182 *
## TripletG       -0.038922   0.020122  -1.934   0.0891 .
## TripletH       -0.030720   0.020140  -1.525   0.1657
## TripletI       -0.023273   0.020201  -1.152   0.2825
## log(Hist3yr)    0.038445   0.019078   2.015   0.0786 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.02011 on 8 degrees of freedom
## Multiple R-squared:  0.8152, Adjusted R-squared:  0.5611
## F-statistic: 3.209 on 11 and 8 DF,  p-value: 0.05445
```

```
AICc(rs5)
```

```
## [1] -31.16628
```

```
#Model 5a in the text
```

```
rs5a<-lm(Incidence/hdyrsrisk~log(Hist3yr), data=rbctconf)
```

```
summary(rs5a)
```

```
##
## Call:
## lm(formula = Incidence/hdyrsrisk ~ log(Hist3yr), data = rbctconf)
##
## Residuals:
##           Min           1Q       Median           3Q           Max
## -0.038556 -0.024733 -0.001586  0.019927  0.047031
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)   -0.08077    0.06357  -1.271   0.2200
## log(Hist3yr)   0.05107    0.01976   2.584   0.0187 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.02663 on 18 degrees of freedom
## Multiple R-squared:  0.2706, Adjusted R-squared:  0.2301
## F-statistic: 6.678 on 1 and 18 DF,  p-value: 0.01871
```

```
AICc(rs5a)
```

```
## [1] -82.87219
```

```

#Model 5b in the text
all.modelall2<-dredge(rs5,options(na.action = na.fail))

## Warning in eval(.expr_beta_arg): invalid value for 'beta' : the argument is
## taken to be "none"

## Fixed term is "(Intercept)"

final.models2=get.models(all.modelall2,cumsum(weight<=0.95))
table.final2=model.avg(final.models2)
summary(table.final2)

##
## Call:
## model.avg(object = final.models2)
##
## Component model call:
## lm(formula = Incidence/hdyrsrisk ~ <8 unique rhs>, data = rbctconf)
##
## Component models:
##      df logLik   AICc delta weight
## 1      3  45.19 -82.87  0.00  0.69
## 12     4  45.27 -79.87  3.00  0.16
## (Null) 2  42.03 -79.36  3.52  0.12
## 2      3  42.10 -76.70  6.17  0.03
## 3     11  54.57 -54.14 28.73  0.00
## 13     12  58.58 -48.59 34.28  0.00
## 23     12  54.81 -41.05 41.82  0.00
## 123    13  58.92 -31.17 51.71  0.00
##
## Term codes:
## log(Hist3yr)      Treatment      Triplet
##              1              2              3
##
## Model-averaged coefficients:
## (full average)
##              Estimate Std. Error Adjusted SE z value Pr(>|z|)
## (Intercept)    -5.557e-02  8.314e-02  8.624e-02  0.644  0.519
## log(Hist3yr)     4.334e-02  2.587e-02  2.683e-02  1.615  0.106
## TreatmentProactive -8.738e-04  5.704e-03  6.092e-03  0.143  0.886
## TripletA        -1.293e-09  1.487e-05  1.683e-05  0.000  1.000
## TripletB        -1.140e-08  2.289e-05  2.421e-05  0.000  1.000
## TripletC        -1.600e-08  2.848e-05  2.954e-05  0.001  1.000
## TripletD         1.459e-08  2.672e-05  2.785e-05  0.001  1.000
## TripletE        -8.117e-09  1.915e-05  2.070e-05  0.000  1.000
## TripletF        -2.587e-08  4.221e-05  4.294e-05  0.001  1.000
## TripletG        -1.717e-08  3.003e-05  3.104e-05  0.001  1.000
## TripletH        -1.217e-08  2.361e-05  2.488e-05  0.000  1.000
## TripletI        -8.344e-09  1.933e-05  2.086e-05  0.000  1.000
##
## (conditional average)
##              Estimate Std. Error Adjusted SE z value Pr(>|z|)
## (Intercept)    -0.055570  0.083142  0.086238  0.644  0.5193
## log(Hist3yr)     0.051062  0.019854  0.021299  2.397  0.0165 *
## TreatmentProactive -0.004681  0.012509  0.013453  0.348  0.7279

```

```

## TripletA      -0.003040  0.022597  0.025624  0.119  0.9056
## TripletB      -0.026780  0.022668  0.025691  1.042  0.2972
## TripletC      -0.037605  0.022191  0.025244  1.490  0.1363
## TripletD       0.034293  0.022406  0.025445  1.348  0.1777
## TripletE      -0.019076  0.022317  0.025361  0.752  0.4519
## TripletF      -0.060792  0.022187  0.025240  2.409  0.0160 *
## TripletG      -0.040343  0.022188  0.025241  1.598  0.1100
## TripletH      -0.028598  0.022192  0.025245  1.133  0.2573
## TripletI      -0.019610  0.022208  0.025260  0.776  0.4376
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

model.avg(object = final.models2)

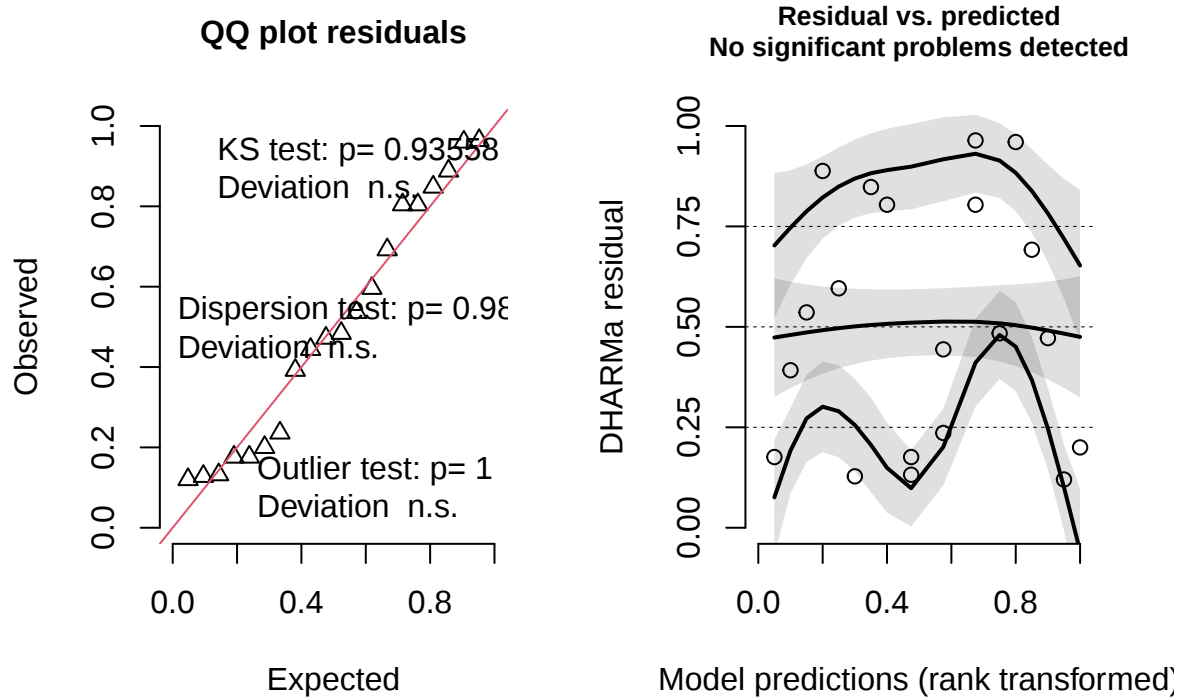
##
## Call:
## model.avg(object = final.models2)
##
## Component models:
## '1'      '12'      '(Null)' '2'      '3'      '13'      '23'      '123'
##
## Coefficients:
##      (Intercept) log(Hist3yr) TreatmentProactive      TripletA      TripletB
## full   -0.05557001  0.04333949      -0.0008737708 -1.293408e-09 -1.139451e-08
## subset -0.05557001  0.05106212      -0.0046809081 -3.039795e-03 -2.677963e-02
##      TripletC      TripletD      TripletE      TripletF      TripletG
## full   -1.600073e-08 1.459159e-08 -8.116786e-09 -2.586643e-08 -1.716567e-08
## subset -3.760525e-02 3.429345e-02 -1.907624e-02 -6.079183e-02 -4.034312e-02
##      TripletH      TripletI
## full   -1.216806e-08 -8.343886e-09
## subset -2.859763e-02 -1.960998e-02

#post hoc analysis

plot(simulateResiduals(rs5a))

```

DHARMa residual



#This gives figure 3 in the text

#Model 6 in the text

```
perturb <- read_excel("perturb.xlsx")
perturb$Triplet<-relevel(factor(perturb$Triplet), ref="J")
perturb$Treatment<-relevel(factor(perturb$Treatment), ref="Survey-only")

rs6<-glm(Incidence~Treatment+Triplet+log(Hist3yr)+log(Baseline),
         poisson, data=perturb)

summary(rs6)
```

```
##
## Call:
## glm(formula = Incidence ~ Treatment + Triplet + log(Hist3yr) +
##      log(Baseline), family = poisson, data = perturb)
##
## Deviance Residuals:
##      Min       1Q   Median       3Q      Max
## -1.07254  -0.51256  -0.00993   0.45459   0.94001
##
## Coefficients:
##              Estimate Std. Error z value Pr(>|z|)
## (Intercept)    1.87929    0.98260   1.913  0.05580 .
## TreatmentProactive  0.25310    0.10083   2.510  0.01207 *
## TripletA        -0.27471    0.26640  -1.031  0.30245
## TripletB         0.67142    0.17204   3.903 9.51e-05 ***
## TripletC         0.33289    0.18395   1.810  0.07034 .
```

```

## TripletD          -0.33151    0.28116   -1.179    0.23837
## TripletE          0.10470    0.20659    0.507    0.61229
## TripletF          0.12297    0.21294    0.577    0.56362
## TripletG          0.24100    0.20903    1.153    0.24894
## TripletH          0.31090    0.20272    1.534    0.12513
## TripletI         -0.56201    0.26726   -2.103    0.03548 *
## log(Hist3yr)       0.29362    0.09797    2.997    0.00273 **
## log(Baseline)      0.10807    0.22944    0.471    0.63762
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for poisson family taken to be 1)
##
## Null deviance: 108.3610 on 19 degrees of freedom
## Residual deviance: 7.4481 on 7 degrees of freedom
## AIC: 135.36
##
## Number of Fisher Scoring iterations: 4
AICc(rs6)

## [1] 196.0238
#Model 6a in the text
rs6a<-glmmTMB(Incidence~Treatment+Triplet+log(Hist3yr)+
              offset(log(hdyrsrisk)),family=genpois,data=perturb)

summary(rs6a)

## Family: genpois ( log )
## Formula:
## Incidence ~ Treatment + Triplet + log(Hist3yr) + offset(log(hdyrsrisk))
## Data: perturb
##
##      AIC      BIC    logLik deviance df.resid
##      150      163     -62      124         7
##
##
## Dispersion parameter for genpois family (): 1.11
##
## Conditional model:
##      Estimate Std. Error z value Pr(>|z|)
## (Intercept)  -2.87216    0.28990  -9.907  <2e-16 ***
## TreatmentProactive  0.09493    0.09725   0.976   0.3290
## TripletA       -0.31860    0.22401  -1.422   0.1549
## TripletB       -0.13601    0.18320  -0.742   0.4578
## TripletC       -0.42375    0.19305  -2.195   0.0282 *
## TripletD        0.37845    0.23834   1.588   0.1123
## TripletE       -0.21437    0.20389  -1.051   0.2931
## TripletF       -0.46373    0.21996  -2.108   0.0350 *
## TripletG       -0.55056    0.20557  -2.678   0.0074 **
## TripletH        0.13117    0.19517   0.672   0.5015
## TripletI       -0.07469    0.24811  -0.301   0.7634
## log(Hist3yr)    0.11657    0.09243   1.261   0.2072
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

AICc(rs6a)

## [1] 210.7029
#Model 6b in the text
rs6b<-glmmTMB(Incidence~offset(log(hdyrsrisk)),family=genpois, data=perturb)

## Warning in (function (start, objective, gradient = NULL, hessian = NULL, : NA/
## NaN function evaluation
summary(rs6b)

## Family: genpois ( log )
## Formula: Incidence ~ offset(log(hdyrsrisk))
## Data: perturb
##
##      AIC      BIC   logLik deviance df.resid
##    149.2    151.2    -72.6    145.2      18
##
##
## Dispersion parameter for genpois family (): 3.04
##
## Conditional model:
##           Estimate Std. Error z value Pr(>|z|)
## (Intercept) -2.74879    0.07308  -37.61  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

AICc(rs6b)

## [1] 149.9424
#Model 6c
all.modelall2<-dredge(rs6a,options(na.action = na.fail))

## Warning in eval(.expr_beta_arg): invalid value for 'beta' : the argument is
## taken to be "none"
## Fixed terms are "cond((Int))" and "disp((Int))"
## Warning in (function (start, objective, gradient = NULL, hessian = NULL, : NA/
## NaN function evaluation
final.models2=get.models(all.modelall2,cumsum(weight<=0.95))

## Warning in (function (start, objective, gradient = NULL, hessian = NULL, : NA/
## NaN function evaluation
table.final2=model.avg(final.models2)
summary(table.final2)

##
## Call:
## model.avg(object = final.models2)
##
## Component model call:
## glmmTMB(formula = Incidence ~ <16 unique rhs>, data = perturb, family =
##      genpois, ziformula = ~0, dispformula = ~1)
##

```

```

## Component models:
##      df logLik   AICc delta weight
## 2      2 -72.62 149.94  0.00   0.43
## 12     3 -71.47 150.45  0.50   0.34
## 23     3 -72.59 152.68  2.73   0.11
## 123    4 -71.03 152.73  2.78   0.11
## (Null) 2 -77.58 159.86  9.91   0.00
## 1      3 -76.32 160.15 10.21   0.00
## 13     4 -75.32 161.30 11.35   0.00
## 3      3 -77.37 162.23 12.29   0.00
## 24    11 -62.96 180.92 30.98   0.00
## 4      11 -63.36 181.72 31.78   0.00
## 14     12 -59.24 187.05 37.11   0.00
## 134    13 -51.23 189.13 39.19   0.00
## 34     12 -61.90 192.37 42.43   0.00
## 124    12 -62.49 193.55 43.61   0.00
## 234    12 -62.80 194.18 44.23   0.00
## 1234   13 -62.02 210.70 60.76   0.00
##
## Term codes:
##      cond(log(Hist3yr)) cond(offset(log(hdyrsrisk)))
##                      1                      2
##      cond(Treatment)      cond(Triplet)
##                      3                      4
##
## Model-averaged coefficients:
## (full average)
##      Estimate Std. Error Adjusted SE z value Pr(>|z|)
## cond((Int))      -2.907e+00  6.235e-01  6.294e-01  4.618  3.9e-06 ***
## cond(log(Hist3yr))  7.923e-02  1.172e-01  1.212e-01  0.654  0.513
## cond(TreatmentProactive) 1.896e-02  7.966e-02  8.416e-02  0.225  0.822
## cond(TripletA)     -2.967e-08  1.181e-04  1.280e-04  0.000  1.000
## cond(TripletB)     3.860e-08  1.987e-04  2.028e-04  0.000  1.000
## cond(TripletC)    -1.342e-08  1.655e-04  1.712e-04  0.000  1.000
## cond(TripletD)     2.585e-09  1.793e-04  1.872e-04  0.000  1.000
## cond(TripletE)    -9.108e-09  1.012e-04  1.112e-04  0.000  1.000
## cond(TripletF)    -4.993e-08  1.746e-04  1.814e-04  0.000  1.000
## cond(TripletG)    -3.941e-08  1.924e-04  1.977e-04  0.000  1.000
## cond(TripletH)     3.324e-08  1.226e-04  1.303e-04  0.000  1.000
## cond(TripletI)    -4.140e-08  1.783e-04  1.870e-04  0.000  1.000
##
## (conditional average)
##      Estimate Std. Error Adjusted SE z value Pr(>|z|)
## cond((Int))      -2.90686    0.62352    0.62941  4.618  3.9e-06 ***
## cond(log(Hist3yr))  0.17592    0.11606    0.12490  1.408  0.159
## cond(TreatmentProactive) 0.08564    0.15150    0.16212  0.528  0.597
## cond(TripletA)    -0.20905    0.23359    0.26779  0.781  0.435
## cond(TripletB)     0.27200    0.45184    0.46461  0.585  0.558
## cond(TripletC)    -0.09455    0.42901    0.44454  0.213  0.832
## cond(TripletD)     0.01822    0.47564    0.49674  0.037  0.971
## cond(TripletE)    -0.06418    0.26081    0.28825  0.223  0.824
## cond(TripletF)    -0.35184    0.30159    0.32867  1.070  0.284
## cond(TripletG)    -0.27773    0.42853    0.44546  0.623  0.533
## cond(TripletH)     0.23428    0.22588    0.25437  0.921  0.357

```

```
## cond(TripletI)          -0.29172    0.37257    0.40159    0.726    0.468
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
model.avg(object = final.models2)
```

```
##
## Call:
## model.avg(object = final.models2)
##
## Component models:
## '2'      '12'      '23'      '123'      '(Null)' '1'      '13'      '3'
## '24'      '4'      '14'      '134'      '34'      '124'      '234'      '1234'
##
## Coefficients:
##          cond((Int)) cond(log(Hist3yr)) cond(TreatmentProactive) cond(TripletA)
## full      -2.906856          0.07923304          0.01896063 -2.966526e-08
## subset    -2.906856          0.17591936          0.08564357 -2.090518e-01
##          cond(TripletB) cond(TripletC) cond(TripletD) cond(TripletE)
## full      3.859813e-08 -1.341715e-08  2.584808e-09 -9.107516e-09
## subset    2.720019e-01 -9.455095e-02  1.821521e-02 -6.418088e-02
##          cond(TripletF) cond(TripletG) cond(TripletH) cond(TripletI)
## full     -4.992736e-08 -3.941153e-08  3.324458e-08 -4.139683e-08
## subset   -3.518393e-01 -2.777340e-01  2.342754e-01 -2.917244e-01
```

```
#Model 7
rbct_allbreakdowns <- read_excel("rbct-allbreakdowns.xlsx")
rbct_allbreakdowns$Triplet<-relevel(factor(rbct_allbreakdowns$Triplet), ref="J")
rbct_allbreakdowns$Treatment<-relevel(factor(rbct_allbreakdowns$Treatment), ref="Survey-only")
rs7<-glm(Incidence~Treatment+Triplet+log(Hist3yr)+log(Baseline),quasipoisson, data=rbct_allbreakdowns)

summary(rs7)
```

```
##
## Call:
## glm(formula = Incidence ~ Treatment + Triplet + log(Hist3yr) +
##      log(Baseline), family = quasipoisson, data = rbct_allbreakdowns)
##
## Deviance Residuals:
##      Min       1Q   Median       3Q      Max
## -1.73868  -0.48053  -0.00895   0.50661   2.18503
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    -1.14735     1.19621  -0.959  0.3694
## TreatmentProactive -0.08281     0.08923  -0.928  0.3843
## TripletA         0.20783     0.25706   0.808  0.4454
## TripletB         0.16854     0.19550   0.862  0.4172
## TripletC         0.21106     0.19890   1.061  0.3239
## TripletD        -0.15656     0.22378  -0.700  0.5067
## TripletE         0.25219     0.19686   1.281  0.2410
## TripletF        -0.20472     0.21974  -0.932  0.3825
## TripletG        -0.14892     0.23113  -0.644  0.5399
## TripletH        -0.02507     0.21947  -0.114  0.9123
## TripletI        -0.19182     0.22665  -0.846  0.4253
```

```

## log(Hist3yr)          0.57475    0.22413    2.564    0.0373 *
## log(Baseline)        0.68024    0.30352    2.241    0.0600 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for quasipoisson family taken to be 2.353964)
##
## Null deviance: 168.79 on 19 degrees of freedom
## Residual deviance: 16.23 on 7 degrees of freedom
## AIC: NA
##
## Number of Fisher Scoring iterations: 4

#Model 7a
rs7a<-glmmTMB(round(Incidence/0.85)~Treatment+Triplet+log(Hist3yr)+log(hrдыrsrisk),family=genpois, data=
summary(rs7a)

## Family: genpois ( log )
## Formula:          round(Incidence/0.85) ~ Treatment + Triplet + log(Hist3yr) +
##           log(hrдыrsrisk)
## Data: rbct_allbreakdowns
##
##      AIC      BIC    logLik deviance df.resid
##    169.3    183.3     -70.7    141.3        6
##
##
## Dispersion parameter for genpois family (): 0.979
##
## Conditional model:
##           Estimate Std. Error z value Pr(>|z|)
## (Intercept)   -1.67851    0.87908  -1.909 0.056211 .
## TreatmentProactive -0.08107    0.05308  -1.527 0.126666
## TripletA       -0.24879    0.12407  -2.005 0.044930 *
## TripletB       -0.41399    0.19594  -2.113 0.034618 *
## TripletC       -0.27470    0.20025  -1.372 0.170126
## TripletD       -0.12548    0.13654  -0.919 0.358109
## TripletE       -0.16442    0.14293  -1.150 0.249984
## TripletF       -0.59681    0.19668  -3.034 0.002410 **
## TripletG       -0.50722    0.20407  -2.485 0.012937 *
## TripletH       -0.36522    0.14731  -2.479 0.013164 *
## TripletI       -0.20438    0.13415  -1.524 0.127629
## log(Hist3yr)    0.57239    0.13317   4.298 1.72e-05 ***
## log(hrдыrsrisk)  0.67793    0.18083   3.749 0.000178 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

AICc(rs7a)

## [1] 253.3444

#Model 7b
rs7b<-glmmTMB(round(Incidence/0.85)~log(Hist3yr)+log(hrдыrsrisk),
              family=genpois, data=rbct_allbreakdowns)

summary(rs7b)

```

```

## Family: genpois ( log )
## Formula:      round(Incidence/0.85) ~ log(Hist3yr) + log(hrдыrsrisk)
## Data: rbct_allbreakdowns
##
##      AIC      BIC    logLik deviance df.resid
##    165.2    169.2    -78.6    157.2      16
##
##
## Dispersion parameter for genpois family (): 2.17
##
## Conditional model:
##           Estimate Std. Error z value Pr(>|z|)
## (Intercept)  -0.54874    0.57630  -0.952   0.341
## log(Hist3yr)   0.63235    0.13815   4.577 4.71e-06 ***
## log(hrдыrsrisk) 0.41247    0.08293   4.974 6.56e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

AICc(rs7b)

## [1] 167.871

#Model 7c
all.modelall2<-dredge(rs7a,options(na.action = na.fail))

## Warning in eval(.expr_beta_arg): invalid value for 'beta' : the argument is
## taken to be "none"

## Fixed terms are "cond((Int))" and "disp((Int))"
final.models2=get.models(all.modelall2,cumsum(weight<=0.95))
table.final2=model.avg(final.models2)
summary(table.final2)

##
## Call:
## model.avg(object = final.models2)
##
## Component model call:
## glmmTMB(formula = round(Incidence/0.85) ~ <16 unique rhs>, data =
##   rbct_allbreakdowns, family = genpois, ziformula = ~0, dispformula = ~1)
##
## Component models:
##      df logLik   AICc delta weight
## 12      4 -78.60 167.87  0.00   0.79
## 123     5 -78.12 170.52  2.65   0.21
## 2       3 -86.51 180.52 12.65   0.00
## 1       3 -86.70 180.91 13.04   0.00
## 23      4 -85.82 182.32 14.45   0.00
## 13      4 -86.29 183.26 15.38   0.00
## (Null)  2 -92.87 190.45 22.58   0.00
## 3       3 -92.20 191.90 24.03   0.00
## 14     12 -77.30 223.17 55.30   0.00
## 24     12 -77.99 224.54 56.67   0.00
## 124    13 -71.78 230.23 62.36   0.00
## 4      11 -87.95 230.91 63.04   0.00
## 134    13 -76.24 239.14 71.27   0.00

```

```

## 234    13 -77.18 241.04 73.17    0.00
## 34     12 -87.08 242.72 74.85    0.00
## 1234   14 -70.67 253.34 85.47    0.00
##
## Term codes:
##      cond(log(Hist3yr)) cond(log(hrdyrsrisk))      cond(Treatment)
##              1              2              3
##      cond(Triplet)
##              4
##
## Model-averaged coefficients:
## (full average)
##              Estimate Std. Error Adjusted SE z value Pr(>|z|)
## cond((Int))      -5.247e-01  5.854e-01  6.323e-01  0.830    0.407
## cond(log(Hist3yr))  6.295e-01  1.410e-01  1.522e-01  4.137 3.51e-05 ***
## cond(log(hrdyrsrisk)) 4.115e-01  8.426e-02  9.097e-02  4.523 6.10e-06 ***
## cond(TreatmentProactive) -1.567e-02  4.563e-02  4.789e-02  0.327    0.743
## cond(TripletA)      -1.989e-13  2.676e-07  2.915e-07  0.000    1.000
## cond(TripletB)      -1.723e-13  5.586e-07  5.759e-07  0.000    1.000
## cond(TripletC)      -2.176e-14  6.184e-07  6.324e-07  0.000    1.000
## cond(TripletD)      -1.967e-13  3.314e-07  3.528e-07  0.000    1.000
## cond(TripletE)      -2.873e-14  3.585e-07  3.774e-07  0.000    1.000
## cond(TripletF)      -3.955e-13  6.845e-07  6.982e-07  0.000    1.000
## cond(TripletG)      -3.159e-13  6.629e-07  6.779e-07  0.000    1.000
## cond(TripletH)      -3.408e-13  4.724e-07  4.899e-07  0.000    1.000
## cond(TripletI)      -2.941e-13  3.544e-07  3.758e-07  0.000    1.000
##
## (conditional average)
##              Estimate Std. Error Adjusted SE z value Pr(>|z|)
## cond((Int))      -0.52474    0.58535    0.63231  0.830    0.407
## cond(log(Hist3yr))  0.63077    0.13828    0.14967  4.214 2.5e-05 ***
## cond(log(hrdyrsrisk)) 0.41210    0.08277    0.08960  4.600 4.2e-06 ***
## cond(TreatmentProactive) -0.07449    0.07425    0.08074  0.923    0.356
## cond(TripletA)      -0.16582    0.17941    0.20818  0.797    0.426
## cond(TripletB)      -0.14368    0.48939    0.50582  0.284    0.776
## cond(TripletC)      -0.01814    0.56439    0.57718  0.031    0.975
## cond(TripletD)      -0.16398    0.25432    0.27730  0.591    0.554
## cond(TripletE)      -0.02395    0.32650    0.34377  0.070    0.944
## cond(TripletF)      -0.32972    0.53092    0.54565  0.604    0.546
## cond(TripletG)      -0.26334    0.54497    0.56020  0.470    0.638
## cond(TripletH)      -0.28412    0.32457    0.34555  0.822    0.411
## cond(TripletI)      -0.24516    0.21121    0.24012  1.021    0.307
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

model.avg(object = final.models2)

##
## Call:
## model.avg(object = final.models2)
##
## Component models:
## '12'    '123'    '2'      '1'      '23'      '13'      '(Null)' '3'
## '14'    '24'    '124'    '4'      '134'    '234'    '34'      '1234'
##

```

```

## Coefficients:
##      cond((Int)) cond(log(Hist3yr)) cond(log(hdyrsrisk))
## full      -0.5247448      0.6295046      0.4114704
## subset    -0.5247448      0.6307654      0.4121032
##      cond(TreatmentProactive) cond(TripletA) cond(TripletB) cond(TripletC)
## full      -0.01567253 -1.989004e-13 -1.723352e-13 -2.175951e-14
## subset    -0.07448827 -1.658243e-01 -1.436767e-01 -1.814102e-02
##      cond(TripletD) cond(TripletE) cond(TripletF) cond(TripletG)
## full      -1.966831e-13 -2.872937e-14 -3.954925e-13 -3.158718e-13
## subset    -1.639757e-01 -2.395182e-02 -3.297241e-01 -2.633439e-01
##      cond(TripletH) cond(TripletI)
## full      -3.407907e-13 -2.940621e-13
## subset    -2.841189e-01 -2.451610e-01

#Bayesian Analysis
#2006 paper
library(rstanarm)
library(bridgesampling)
rs<-stan_glm(Incidence~Treatment+A+B+C+D+E+F+G+H+I+log(Hist3yr)+log(Baseline),prior_intercept=normal(0,
diagnostic_file = file.path(tempdir(), "df.csv"),refresh=0)

#Marginal Likelihood
bridge<-bridge_sampler(rs)

## Iteration: 1
## Iteration: 2
## Iteration: 3
## Iteration: 4
## Iteration: 5

bridge

## Bridge sampling estimate of the log marginal likelihood: -116.1562
## Estimate obtained in 5 iteration(s) via method "normal".

#most parsimonious (overdispersed) Poisson model
rs1B<-stan_glm.nb(Incidence~Treatment+log(hdyrsrisk)+log(Hist3yr),
                  prior_intercept=normal(0,10), prior=normal(0,10),
                  data=rbctconf,diagnostic_file =file.path(tempdir(),"df.csv"),refresh=0)

summary(rs1B, probs=c(0.025,0.5,0.975), digits=3)

##
## Model Info:
## function:      stan_glm.nb
## family:        neg_binomial_2 [log]
## formula:       Incidence ~ Treatment + log(hdyrsrisk) + log(Hist3yr)
## algorithm:     sampling
## sample:        4000 (posterior sample size)
## priors:        see help('prior_summary')
## observations:  20
## predictors:    4
##
## Estimates:
##              mean    sd    2.5%   50%   97.5%
## (Intercept)   -2.073  1.674 -5.297 -2.067  1.147

```

```

## TreatmentProactive      -0.152  0.205 -0.557 -0.154  0.247
## log(hdyrsrisk)          0.484  0.206  0.081  0.482  0.881
## log(Hist3yr)            0.891  0.360  0.172  0.896  1.600
## reciprocal_dispersion  6.190  2.040  2.850  5.939 10.652
##
## Fit Diagnostics:
##      mean    sd      2.5%   50%   97.5%
## mean_PPD 45.978  7.309 33.299 45.300 62.200
##
## The mean_ppd is the sample average posterior predictive distribution of the outcome variable (for de
##
## MCMC diagnostics
##      mcse  Rhat  n_eff
## (Intercept)      0.026 1.001 4180
## TreatmentProactive 0.003 1.000 4084
## log(hdyrsrisk)     0.003 1.001 4065
## log(Hist3yr)       0.006 1.000 3573
## reciprocal_dispersion 0.033 0.999 3784
## mean_PPD          0.124 1.000 3470
## log-posterior      0.045 1.001 1527
##
## For each parameter, mcse is Monte Carlo standard error, n_eff is a crude measure of effective sample
#And with the herd years at risk set as an offset
rs1aB<-stan_glm.nb(Incidence~Treatment+log(hdyrsrisk)+log(Hist3yr),prior_intercept=normal(0,10), prior=
diagnostic_file =file.path(tempdir(),"df.csv"),refresh=0)

summary(rs1aB, probs=c(0.025,0.5,0.975), digits=3)

##
## Model Info:
## function:      stan_glm.nb
## family:        neg_binomial_2 [log]
## formula:       Incidence ~ Treatment + log(hdyrsrisk) + log(Hist3yr)
## algorithm:     sampling
## sample:        4000 (posterior sample size)
## priors:        see help('prior_summary')
## observations:  20
## predictors:    4
##
## Estimates:
##      mean    sd      2.5%   50%   97.5%
## (Intercept)      -2.110  1.611 -5.390 -2.088  0.986
## TreatmentProactive -0.156  0.205 -0.567 -0.153  0.250
## log(hdyrsrisk)     0.486  0.205  0.070  0.489  0.876
## log(Hist3yr)       0.897  0.347  0.192  0.901  1.578
## reciprocal_dispersion 6.281  2.129  2.833  6.074 11.231
##
## Fit Diagnostics:
##      mean    sd      2.5%   50%   97.5%
## mean_PPD 45.777  7.070 33.700 45.050 61.150
##
## The mean_ppd is the sample average posterior predictive distribution of the outcome variable (for de
##
## MCMC diagnostics

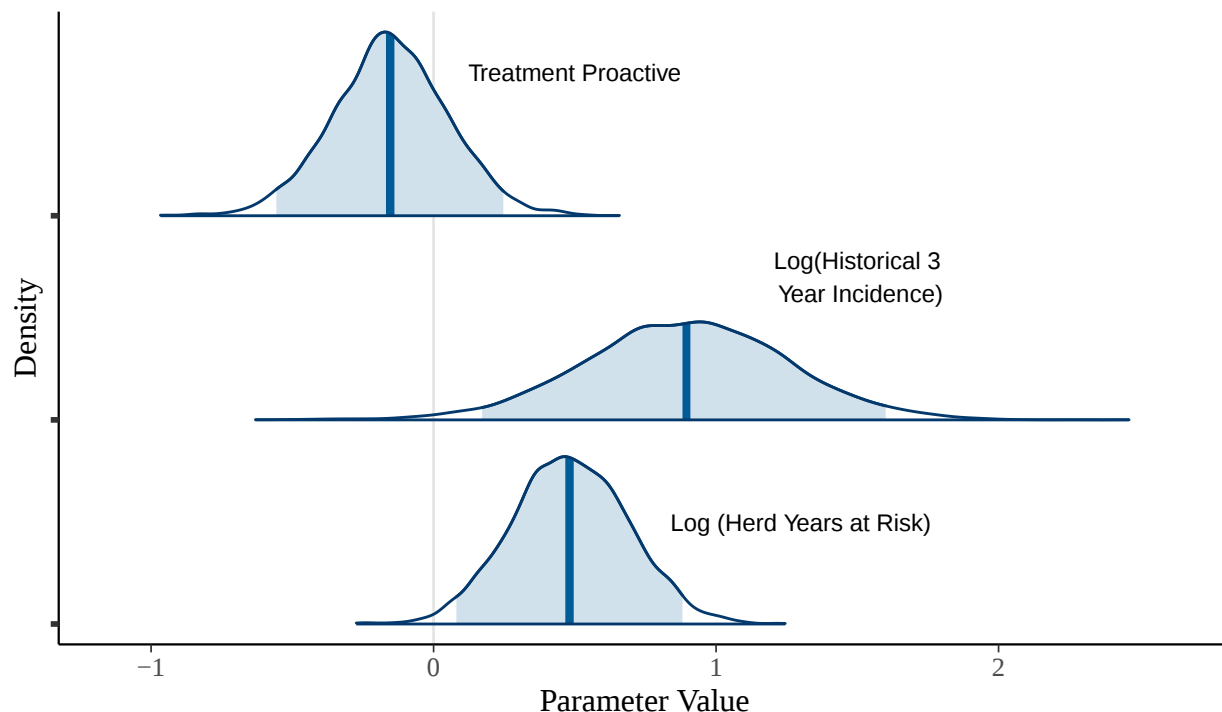
```

```
##               mcse Rhat n_eff
## (Intercept)    0.025 1.000 4007
## TreatmentProactive 0.003 1.000 3613
## log(hdyrsrisk)    0.003 1.000 3818
## log(Hist3yr)      0.005 1.000 4276
## reciprocal_dispersion 0.038 1.000 3131
## mean_PPD         0.120 1.000 3461
## log-posterior     0.050 1.005 1297
##
## For each parameter, mcse is Monte Carlo standard error, n_eff is a crude measure of effective sample
```

```
#Upper panel Figure 4 in the text
title <- paste(" Posterior distributions")
subheader <- paste("with medians and 95% intervals")
plot(rs1B, plotfun="areas",prob=0.95, pars=c("TreatmentProactive", "log(Hist3yr)", "log(hdyrsrisk)"))+
  labs(y="Density", x="Parameter Value")+
  ggtitle(bquote(atop(bold(. (title)), atop(. (subheader), ""))))+
  theme(plot.title = element_text(hjust = 0.5))+
  theme(axis.text.y=element_blank()+
  annotate("text", x=.5, y=3.7,size=3, label= "Treatment Proactive")+
  annotate("text", x=1.5, y=2.7,size=3, label= "Log(Historical 3\n Year Incidence)")+
  annotate("text", x=1.3, y=1.5,size=3, label= "Log (Herd Years at Risk)")
```

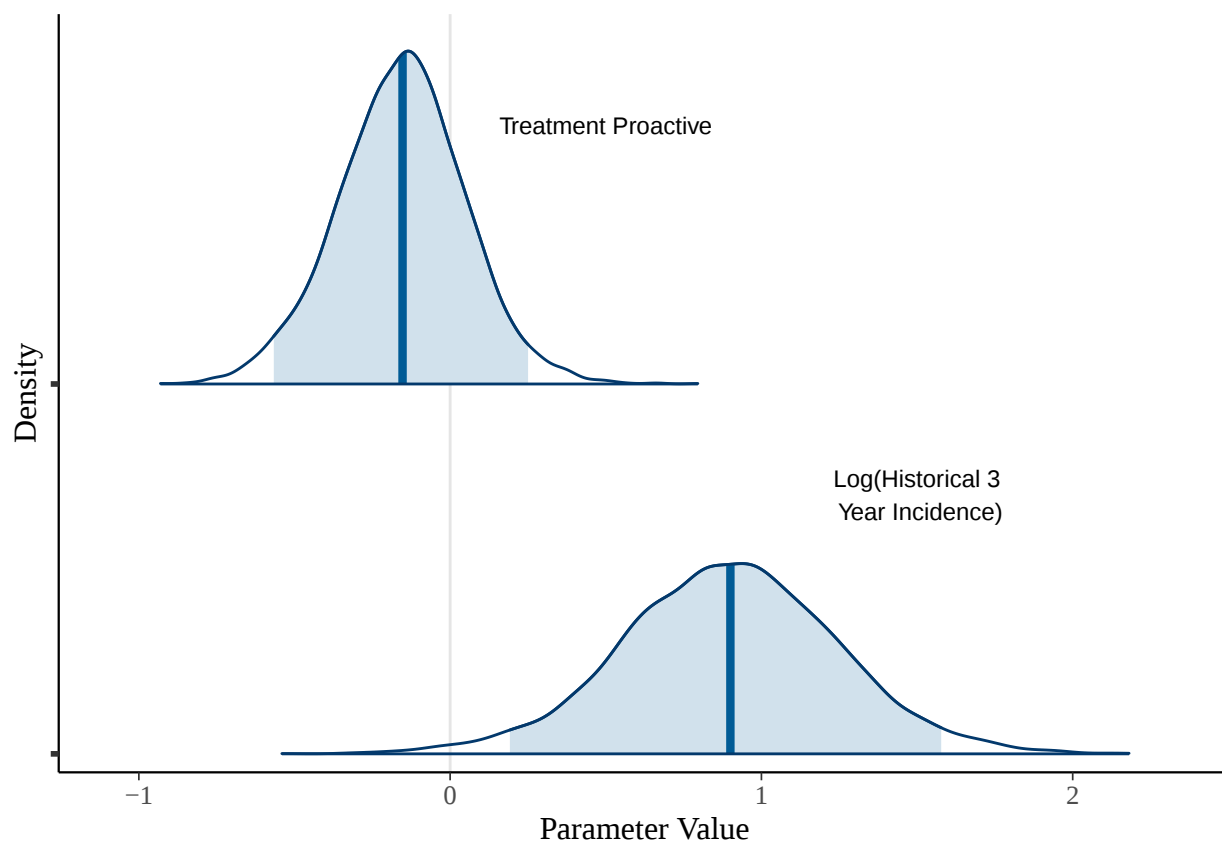
Posterior distributions

with medians and 95% intervals



```
#Lower panel figure 4
plot(rs1aB, plotfun="areas",prob=0.95, pars=c("TreatmentProactive", "log(Hist3yr)"))+
  labs(y="Density", x="Parameter Value")+
  theme(axis.text.y=element_blank()+
  annotate("text", x=.5, y=2.7,size=3, label= "Treatment Proactive")+
```

```
annotate("text", x=1.5, y=1.7, size=3, label= "Log(Historical 3\n Year Incidence)")
```



```
bridge1<-bridge_sampler(rs1B)
```

```
## Iteration: 1
## Iteration: 2
## Iteration: 3
## Iteration: 4
## Iteration: 5
```

```
bridge1
```

```
## Bridge sampling estimate of the log marginal likelihood: -98.54878
## Estimate obtained in 5 iteration(s) via method "normal".
```

```
#Removal of treatment as a covariate further improves model
```

```
#support compared to the Nature model
```

```
rs2B<-stan_glm.nb(Incidence~log(hdyrsrisk)+log(Hist3yr),
                  prior_intercept=normal(0,10), prior=normal(0,10),
                  data=rbctconf,diagnostic_file = file.path(tempdir(), "df.csv"),refresh=0)
```

```
#Comparison of most parsimonious (overdispersed) Poisson model
```

```
#in terms of Bayes factor
```

```
bridge2<-bridge_sampler(rs2B)
```

```
## Iteration: 1
## Iteration: 2
## Iteration: 3
```

```
## Iteration: 4
```

```
## Iteration: 5
```

```
bayes_factor(bridge2, bridge1)
```

```
## Estimated Bayes factor in favor of x1 over x2: 35.71934
```