```
# TFI analysis
model {
# Population (disecrete time) model - 2 year higher rate
# PID incidence and ct GP re-infection rate ratio informative priors
Y[1:10] ~ dmnorm(mu[], Omega[ , ])
for (ag in 1:4) {
 log(lambda.PID[ag]) <- Y[ag]
 EF[ag] <- Y[ag+5] * Y[ag+5]
 }
logit(psi) <- Y[5]
log(eta1) <- Y[10]

# WBDEV call
for (ag in 1:4) {
 input1[ag] <- lambda.PID[ag]
 input1[ag+6] <- EF[ag]
 }
input1[5] <- psi
input1[6] <- eta1

philap ~ dbeta(12,16)
input1[11] <- philap

for (i in 1:29) {
 input2[i] <- N[i+15]
 }

solution[1:609] <- cumulativePIDlap(input1[1:11],input2[1:29])


# number of previous PIDs [n,a] n = number: 0,1,2,3; a = age-group
for (i in 1:4) {
 numPIDs[2,i] <- solution[i]
 numPIDs[3,i] <- solution[i+4]
 numPIDs[4,i] <- solution[i+8]
 numPIDsnct[2,i] <- solution[i+12]
 numPIDsnct[3,i] <- solution[i+16]
 numPIDsnct[4,i] <- solution[i+20]
 }

# number of previous PIDs in women aged 44, n = number: 0,1,2,3;
num44[2] <- solution[58]
num44[3] <- solution[87]
num44[4] <- solution[116]

num44nct[2] <- solution[145]
num44nct[3] <- solution[174]
num44nct[4] <- solution[203]



# population denominators  - 2002
N1619 <- sum(N[16:19])
N2024 <- sum(N[20:24])
N2534 <- sum(N[25:34])
N3544 <- sum(N[35:44])
N1644 <- sum(N[16:44])
N1617 <- sum(N[16:17])
N1820 <- sum(N[18:20])
N2124 <- sum(N[21:24])
N2529 <- sum(N[25:29])
```

```
N3044 <- sum(N[30:44])
N1819 <- sum(N[18:19])
N3034 <- sum(N[30:34])


# Distribution of PID severity - 2002
# hospital
r.HESPID[1] ~ dbin(HESPID[1],N1619)
r.HESPID[2] ~ dbin(HESPID[2],N2024)
r.HESPID[3] ~ dbin(HESPID[3],N2534)
r.HESPID[4] ~ dbin(HESPID[4],N3544)

# priors
for (a in 1:4) {
 HESPID[a] ~ dbeta(1,1)
 }

# kc60
r.kc602008[1] ~ dbin(kc602008[1],N1619)
r.kc602008[2] ~ dbin(kc602008[2],N2024)
r.kc602008[3] ~ dbin(kc602008[3],N2534)
r.kc602008[4] ~ dbin(kc602008[4],N3544)

# priors
for (a in 1:4) {
 kc602008[a] ~ dbeta(1,1)
 }

# data by age not available until 2008
# 13421 / 12117 is the ratio of totals for 2002 and GUMCAD data for
# 2008
# assumes GUMCAD data representative of all kc60
# assumes age distribution is the same in 2002 as 2008
for (a in 1:4) {
 kc60[a] <- kc602008[a] * 13421 / 12117
 }

# GPRD
r.GPRDPID[1] ~ dbin(GPRDPID[1],N1619)
r.GPRDPID[2] ~ dbin(GPRDPID[2],N2024)
r.GPRDPID[3] ~ dbin(GPRDPID[3],N2534)
r.GPRDPID[4] ~ dbin(GPRDPID[4],N3544)

# priors
for (a in 1:4) {
 GPRDPID[a] ~ dbeta(1,1)
 }

# Distribution
for (a in 1:4) {
pmin[a] <- kc60[a] + max(HESPID[a],GPRDPID[a])
pmax[a] <- kc60[a] + HESPID[a] + GPRDPID[a]
X[a] ~ dunif(pmin[a],pmax[a])
      hospdiag[a] <- psi * HESPID[a] / X[a]
      milddiag[a] <- 1 - hospdiag[a] - undiag[a]
      undiag[a] <- (1 - psi)
      }


# proportion with PIDs by each age, severity, and number
# all PID
```

```
# n = 1
for (s in 1:3) {
 for (a in 1:4) {
  PIDcat[1,s,a] <- 1 - (PIDcat[2,s,a] + PIDcat[3,s,a] +
PIDcat[4,s,a])
  }
 PIDcat44[1,s] <- 1 - (PIDcat44[2,s] + PIDcat44[3,s] + PIDcat44[4,s])

 }

# n = 2-4
for (n in 2:4) {
 for (a in 1:4) {
  PIDcat[n,1,a] <- numPIDs[n,a] * undiag[a]
  PIDcat[n,2,a] <- numPIDs[n,a] * milddiag[a]
  PIDcat[n,3,a] <- numPIDs[n,a] * hospdiag[a]
  }
 PIDcat44[n,1] <- num44[n] * undiag[4]
 PIDcat44[n,2] <- num44[n] * milddiag[4]
 PIDcat44[n,3] <- num44[n] * hospdiag[4]
 }


# non-CT related PID
# n = 1
for (s in 1:3) {
 for (a in 1:4) {
  PIDcatnct[1,s,a] <- 1 - (PIDcatnct[2,s,a] + PIDcatnct[3,s,a] +
                           PIDcatnct[4,s,a])
  }
 PIDcat44nct[1,s] <- 1 - (PIDcat44nct[2,s] + PIDcat44nct[3,s] +
                          PIDcat44nct[4,s])
 }

# n = 2-4
for (n in 2:4) {
 for (a in 1:4) {
  PIDcatnct[n,1,a] <- numPIDsnct[n,a] * undiag[a]
  PIDcatnct[n,2,a] <- numPIDsnct[n,a] * milddiag[a]
  PIDcatnct[n,3,a] <- numPIDsnct[n,a] * hospdiag[a]
  }
 PIDcat44nct[n,1] <- num44nct[n] * undiag[4]
 PIDcat44nct[n,2] <- num44nct[n] * milddiag[4]
 PIDcat44nct[n,3] <- num44nct[n] * hospdiag[4]
 }

# Probability of TFI given PID by age, severity, number of PIDs-
# Westrom
# Likelihood
for (a in 1:2) {
 for (s in 1:3) {
  onePIDsev[a,s] <- p[a,s,1]
  r.onePIDsev[a,s] ~ dbin(onePIDsev[a,s],n.onePIDsev[a,s])
  }
 twoPID[a] <- (p[a,1,2] * n.onePIDsev[a,1] +
              p[a,2,2] * n.onePIDsev[a,2] +
              p[a,3,2] * n.onePIDsev[a,3]) / sum(n.onePIDsev[a, ])
 r.twoPID[a] ~ dbin(twoPID[a],n.twoPID[a])
 threePID[a] <- (p[a,1,3] * n.onePIDsev[a,1] +
                p[a,2,3] * n.onePIDsev[a,2] +
                p[a,3,3] * n.onePIDsev[a,3]) / sum(n.onePIDsev[a, ])
```

```
 r.threePID[a] ~ dbin(threePID[a],n.threePID[a])
 }

# model
for (a in 1:2) {
 for (s in 1:3) {
  for (n in 1:3) {
   logit(p[a,s,n]) <- beta0 + beta1[a] + beta2[s] + beta3[n]
   PIDtoTFI[n+1,a,s] <- p[a,s,n]
   }
  }
 }

for (a in 1:2) {
 onePID[a] <- (onePIDsev[a,1] * n.onePIDsev[a,1] +
               onePIDsev[a,2] * n.onePIDsev[a,2] +
               onePIDsev[a,3] * n.onePIDsev[a,3]) /
              sum(n.onePIDsev[a, ])
 }

# priors
beta0 ~ dnorm(0,0.0001)

beta1[1] <- 0
beta1[2] ~ dnorm(0,0.0001)

beta2[1] <- 0
beta2[2] ~ dnorm(0,0.0001)
beta2[3] ~ dnorm(0,0.0001)

beta3[1] <- 0
beta3[2] ~ dnorm(0,0.0001)
beta3[3] ~ dnorm(0,0.0001)

# RESIDUAL DEVIANCE
for (a in 1:2) {
 for (s in 1:3) {
  dev1[a,s] <- 2 * (r.onePIDsev[a,s] * log(r.onePIDsev[a,s] /
                   (onePIDsev[a,s] * n.onePIDsev[a,s])) +
                   (n.onePIDsev[a,s] - r.onePIDsev[a,s]) *
                   log((n.onePIDsev[a,s] - r.onePIDsev[a,s]) /
                   (n.onePIDsev[a,s] - (n.onePIDsev[a,s] *
                    onePIDsev[a,s]))))
  }

 dev2[a] <- 2 * (r.twoPID[a] * log(r.twoPID[a] /
                (twoPID[a] * n.twoPID[a])) +
                (n.twoPID[a] - r.twoPID[a]) *
                 log((n.twoPID[a] - r.twoPID[a]) /
                     (n.twoPID[a] - (n.twoPID[a] * twoPID[a]))))

 dev3[a] <- 2 * (r.threePID[a] * log(r.threePID[a] /
                (threePID[a] * n.threePID[a])) +
                (n.threePID[a] - r.threePID[a]) *
                 log((n.threePID[a] - r.threePID[a]) /
                     (n.threePID[a] - (n.threePID[a] *
threePID[a]))))
 }
sumdev1 <- sum(dev1[ , ])
sumdev2 <- sum(dev2[])
sumdev3 <- sum(dev3[])
```

```
sumdev.tot <- sumdev1 + sumdev2 + sumdev3


# Progression probabilities by age, diagnostic status, and number
# progress[n,s,a] n: number of PIDs 0,1,2,3+,
# 1: undiagnosed (mild),
# 2: diagnosed outside of Hospital (mild),
# 3: hospital diagnosed(overall Westrom)
# a: age<=29, 30+

# model 1
for (n in 1:3) {
 for (a in 1:2) {
      PIDtoTFI2[n,1,a] <- (PIDtoTFI[2,a,1] * n.onePIDsev[a,1] +
                           PIDtoTFI[2,a,2] * n.onePIDsev[a,2] +
                           PIDtoTFI[2,a,3] * n.onePIDsev[a,3]) /
                          sum(n.onePIDsev[a, ])
      PIDtoTFI2[n,2,a] <- (PIDtoTFI[2,a,1] * n.onePIDsev[a,1] +
                           PIDtoTFI[2,a,2] * n.onePIDsev[a,2] +
                           PIDtoTFI[2,a,3] * n.onePIDsev[a,3]) /
                          sum(n.onePIDsev[a, ])
      PIDtoTFI2[n,3,a] <- (PIDtoTFI[2,a,1] * n.onePIDsev[a,1] +
                           PIDtoTFI[2,a,2] * n.onePIDsev[a,2] +
                           PIDtoTFI[2,a,3] * n.onePIDsev[a,3]) /
                          sum(n.onePIDsev[a, ])
            }
      }

# model 2
#for (n in 1:3) {
# for (a in 1:2) {
#  PIDtoTFI2[n,1,a] <- PIDtoTFI[2,a,1]
#  PIDtoTFI2[n,2,a] <- (PIDtoTFI[2,a,1] * n.onePIDsev[a,1] +
#                       PIDtoTFI[2,a,2] * n.onePIDsev[a,2] +
#                       PIDtoTFI[2,a,3] * n.onePIDsev[a,3]) /
#                      sum(n.onePIDsev[a, ])
#  PIDtoTFI2[n,3,a] <- (PIDtoTFI[2,a,1] * n.onePIDsev[a,1] +
#                       PIDtoTFI[2,a,2] * n.onePIDsev[a,2] +
#                       PIDtoTFI[2,a,3] * n.onePIDsev[a,3]) /
#                      sum(n.onePIDsev[a, ])
#  }
# }


# model 3
#for (n in 1:3) {
# for (a in 1:2) {
#  PIDtoTFI2[n,1,a] <- PIDtoTFI[2,a,1]
#  PIDtoTFI2[n,2,a] <- PIDtoTFI[2,a,1]
#  PIDtoTFI2[n,3,a] <- (PIDtoTFI[2,a,1] * n.onePIDsev[a,1] +
#                       PIDtoTFI[2,a,2] * n.onePIDsev[a,2] +
#                       PIDtoTFI[2,a,3] * n.onePIDsev[a,3]) /
#                      sum(n.onePIDsev[a, ])
#  }
# }


# model 4
#for (n in 1:3) {
# for (a in 1:2) {
#  A[n,a] ~ dunif(0,PIDtoTFI[2,a,1])
```

```
#  PIDtoTFI2[n,1,a] <- A[n,a]
#  PIDtoTFI2[n,2,a] <- PIDtoTFI[2,a,1]
#  PIDtoTFI2[n,3,a] <- (PIDtoTFI[2,a,1] * n.onePIDsev[a,1] +
#                       PIDtoTFI[2,a,2] * n.onePIDsev[a,2] +
#                       PIDtoTFI[2,a,3] * n.onePIDsev[a,3]) /
#                      sum(n.onePIDsev[a, ])
#  }
# }


# model 5
#for (n in 1:3) {
# for (a in 1:2) {
#  PIDtoTFI2[n,1,a] <- 0
#  PIDtoTFI2[n,2,a] <- PIDtoTFI[2,a,1]
#  PIDtoTFI2[n,3,a] <- (PIDtoTFI[2,a,1] * n.onePIDsev[a,1] +
#                       PIDtoTFI[2,a,2] * n.onePIDsev[a,2] +
#                       PIDtoTFI[2,a,3] * n.onePIDsev[a,3]) /
#                      sum(n.onePIDsev[a, ])
#  }
# }

# TFIs by age
# all PID
for (n in 2:4) {
 for (s in 1:3) {
  TFIs[n,s,1] <- PIDcat[n,s,1] * PIDtoTFI2[n-1,s,1]
  TFIs[n,s,2] <- PIDcat[n,s,2] * PIDtoTFI2[n-1,s,1]
  TFIs[n,s,3] <- PIDcat[n,s,3] *
                (PIDtoTFI2[n-1,s,1] * N2529 + PIDtoTFI2[n-1,s,2] *
N3034) /
                 N2534
  TFIs[n,s,4] <- PIDcat[n,s,4] * PIDtoTFI2[n-1,s,2]
  TFI44[n,s] <- PIDcat44[n,s] * PIDtoTFI2[n-1,s,2]
  }
 }
for (a in 1:4) {
 TFIbyage[a] <- sum(TFIs[2:4 , ,a])
 }
TFI44tot <- sum(TFI44[2:4 , ])
TFIbyage.tot <- (TFIbyage[1] * sum(N[16:19]) +
                 TFIbyage[2] * sum(N[20:24]) +
                 TFIbyage[3] * sum(N[25:34]) +
                 TFIbyage[4] * sum(N[35:44])) /
                sum(N[16:44])

# non-CT related PID
for (n in 2:4) {
 for (s in 1:3) {
  TFIsnct[n,s,1] <- PIDcatnct[n,s,1] * PIDtoTFI2[n-1,s,1]
  TFIsnct[n,s,2] <- PIDcatnct[n,s,2] * PIDtoTFI2[n-1,s,1]
  TFIsnct[n,s,3] <- PIDcatnct[n,s,3] *
                   (PIDtoTFI2[n-1,s,1] * N2529 + PIDtoTFI2[n-1,s,2] *
                    N3034) / N2534
  TFIsnct[n,s,4] <- PIDcatnct[n,s,4] * PIDtoTFI2[n-1,s,2]
  TFI44nct[n,s] <- PIDcat44nct[n,s] * PIDtoTFI2[n-1,s,2]
  }
 }

for (a in 1:4) {
 TFIbyagenct[a] <- sum(TFIsnct[2:4 , ,a])
```

```
 }
TFI44totnct <- sum(TFI44nct[2:4 , ])
TFIbyagenct.tot <- (TFIbyagenct[1] * sum(N[16:19]) +
                    TFIbyagenct[2] * sum(N[20:24]) +
                    TFIbyagenct[3] * sum(N[25:34]) +
                    TFIbyagenct[4] * sum(N[35:44])) /
                   sum(N[16:44])

for (a in 1:4) {
 TFIduetoCTbyage[a] <- TFIbyage[a] - TFIbyagenct[a]
 }
TFIduetoCTbyage.tot <- (TFIduetoCTbyage[1] * sum(N[16:19]) +
                        TFIduetoCTbyage[2] * sum(N[20:24]) +
                        TFIduetoCTbyage[3] * sum(N[25:34]) +
                        TFIduetoCTbyage[4] * sum(N[35:44])) /
                       sum(N[16:44])

# proportion of PID related TFIs due to CT
for (a in 1:4) {
 propCTofPIDTFIs[a] <- 1 - (TFIbyagenct[a] / TFIbyage[a])
 }
propCTofPIDTFIs44 <- 1 - (TFI44totnct / TFI44tot)
propCTofPIDTFIs.tot <- (propCTofPIDTFIs[1] * sum(N[16:19]) +
                        propCTofPIDTFIs[2] * sum(N[20:24]) +
                        propCTofPIDTFIs[3] * sum(N[25:34]) +
                        propCTofPIDTFIs[4] * sum(N[35:44])) /
                       sum(N[16:44])

}


# Data
list(
# PID incidence, r-infection rate, Etological fractions and re-
infection #rate
mu = c(-3.865, -3.595, -3.964, -4.402, -0.5856, 0.7104, 0.4815, 0.3117, 0.3277,
1.919),
Omega = structure(.Data =c(
573.855, -49.264, -10.817, -3.992, 323.371, 97.687, -112.351, -30.198, -5.401, -2.713,
-49.264, 301.419, -14.194, -3.299, 147.591, -78.069, 176.480, -72.284, -11.551, 2.012,
-10.817, -14.194, 105.908, -20.063, 37.684, -13.275, -46.636, 236.305, -118.245,
0.515,
-3.992, -3.299, -20.063, 57.687, 19.172, -2.664, -8.418, -125.677, 138.728, 0.088,
323.371, 147.591, 37.684, 19.172, 351.620, 1.363, -1.443, -1.164, 1.537, 0.030,
97.687, -78.069, -13.275, -2.664, 1.363, 285.706, -324.389, -85.846, -16.864, -7.957,
-112.351, 176.480, -46.636, -8.418, -1.443, -324.389, 734.182, -295.254, -50.046,
8.090,
-30.198, -72.284, 236.305, -125.677, -1.164, -85.846, -295.254, 1512.713, -758.618,
3.088,
-5.401, -11.551, -118.245, 138.728, 1.537, -16.864, -50.046, -758.618, 839.634, 0.705,
-2.713, 2.012, 0.515, 0.088, 0.030, -7.957, 8.090, 3.088, 0.705, 13.711),
.Dim = c(10,10)),


# Population sizes from census, age =1...44 - 2002
N=c(NA,NA,NA,NA,NA, NA,NA,NA,NA,NA, NA,NA,NA,NA,NA,
305500,306300,296400,291400,294800,
310100,313900,305600,294700,295000,
304100,317000,329600,349600,370300,
380900,376900,387800,390900,399400,
401200,402600,398700,391900,381900, 370900,356200,349000,343800),

# Routine PID data
# HES PID data - 2002
```

```
r.HESPID = c(1233,3101,9756,10526), # 16-19, 20-24, 25-34, 35-44

# KC-60 PID data
r.kc602008 = c(2900,3972,3538,1253), #16-19, 20-24, 25-34, 35-44

# predicted GPRD data  - 2002
r.GPRDPID = c(5083,8842,14932,9609), # 16-19, 20-24, 25-34, 35-44

# Westrom Progression data (A cohort study of 1,844)-assumes a=1 goes
# to 29
r.onePIDsev = structure(.Data =c(
2,23,34,
0,5,15
),
.Dim = c(2,3)),

n.onePIDsev = structure(.Data =c(
241,361,169,
71,89,60
),
.Dim = c(2,3)),

r.twoPID = c(29,7), n.twoPID = c(158,27),
r.threePID = c(23,3), n.threePID = c(61,4),
# Note: 0 TFIs in 451 control women so assume zero.
)

# Initial values 1
list(
Y = c(-5,-5,-5,-5,-1,-5,-5,-5,-5,-1),

HESPID = c(0.01,0.01,0.01,0.01),
kc602008 = c(0.01,0.01,0.01,0.01),
GPRDPID = c(0.01,0.01,0.01,0.01),

philap = 0.3,

beta0 = -2,
beta1 = c(NA,0.5),
beta2 = c(NA,0.05,0.05),
beta3 = c(NA,0.5,0.5)
)
A = structure(.Data =c(
0.01,0.01,
0.01,0.01,
0.01,0.01
),
.Dim = c(3,2)),
)

# Initial values 2
list(
Y = c(-1,-1,-1,-1,-1,-1,-1,-1,-1,-1),

HESPID = c(0.1,0.1,0.1,0.1),
kc602008 = c(0.1,0.1,0.1,0.1),
GPRDPID = c(0.1,0.1,0.1,0.1),

philap = 0.6,

beta0 = -5,
```

```
beta1 = c(NA,0.05),
beta2 = c(NA,0.5,0.5),
beta3 = c(NA,0.05,0.05),
)

A = structure(.Data =c(
0.1,0.1,
0.1,0.1,
0.1,0.1
),
.Dim = c(3,2)),
)
```