Web Material

Measurement of Current Substance Use in a Cohort of HIV-Infected Persons in

Continuity HIV Care, 2007–2015

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Web Appendix 1

JAGS code

<u>Code for Model 1</u>
```
### order variables in dataset y:
# 1. MRR result
# 2. SI result
# 3. Demographic group
### other variables in the model:
# d is latent indicator of true substance use that has probability pd
# G is number of groups, where g indexes group membership
# N is number of study participants indexed by i
# assessments are indexed by j (MRR=1, SI=2)
# a[j,1], s[i,j] are test sensitivity
# a[j,2], c[i,j] are test specificity

model {
 prev <- mean(d) # calculate prevalence within JAGS
 for (g in 1:G) {
  a_prev[g]~dunif(0,1)
 }
 for (i in 1:N) {
  for (j in 1:2) {
   y[i,j]~dbern(p[i,j]) #response on test j, 1=MRR, 2=SI
   p[i,j]<-(s[i,j]^d[i])*(1-c[i,j])^(1-d[i])
  }
  d[i]~dbern(pd[i])
  pd[i]<-a_prev[y[i,3]]
```

```
    s[i,1]<-a[1,1]
    c[i,1]<-a[1,2]
    s[i,2]<-a[2,1]
    c[i,2]<-a[2,2]
  }
  #priors
  a[1,1]~dunif(0,1) #sens MRR
  a[2,1]~dunif(0,1)  #sens SI
  a[1,2]~dbeta(90,10)  #spec MMR
  a[2,2]~dbeta(95,5)  #spec SI
}
```

Code for Model 2
```
### order variables in dataset y:
# 1. MRR result
# 2. SI result
# 3. Demographic group
### other variables in the model:
# d is latent indicator of true substance use that has probability pd
# G is number of groups, where g indexes group membership
# N is number of study participants indexed by i
# assessments are indexed by j (MRR=1, SI=2)
# a[1,g] is sensitivity of MRR for group g
# a[2,1] is specificity of MRR assumed constant across groups
# b[1,g] is sensitivity of SI for group g
# b[2,1] is specificity of SI assumed constant across groups

model {
  prev <- mean(d) # calculate prevalence within JAGS
  for (g in 1:G) {
    a_prev[g]~dunif(0,1)
    a[1,g]~dunif(0,1) #sens MRR
    b[1,g]~dunif(0,1) #sens self-report
  }
  a[2,1]~dbeta(90,10)  #spec MRR, non IDU
  b[2,1]~dbeta(95,5)  #spec self-report, non IDU
  for (i in 1:N) {
    for (j in 1:2) {
      y[i,j]~dbern(p[i,j]) #response on test j, 1=MRR, 2=SI
      p[i,j]<-(s[i,j]^d[i])*(1-c[i,j])^(1-d[i])
    }
    d[i]~dbern(pd[i])
    pd[i]<-a_prev[y[i,3]]
    s[i,1]<-a[1,y[i,3]] #sensitivity, MRR, per group
```

```
    c[i,1]<-a[2,1] #specificity, assumed equal across groups
    s[i,2]<-b[1,y[i,3]] #sensitivity, SI, per group
    c[i,2]<-b[2,1] #specificity assumed equal across groups
  }
}
```

Code for Model 3
```
### dataset includes:
# 1. MRR result (t1)
# 2. SI result (t2)
# 3. Demographic group (g)
### other variables in the model:
# N is number of study participants indexed by i
# G is number of groups, where g indexes group membership
# s is sensitivity of MRR and SI
# c is specificity of MRR and SI
# prev (indexed by G) is group-specific prevalence
# covu is unrestricted covariance – in transformed parameters block, covariance is restricted to
#   feasible range based on sensitivities
# cov is covariance, restricted to fall between ls and us based on sensitivity estimates

model <- "
data{
  int<lower=0> N;
  int<lower=0> G;
  int<lower=0,upper=G> g[N];
  int<lower=0,upper=1> t1[N];
  int<lower=0,upper=1> t2[N];
}
transformed data{
  int<lower=0,upper=1> tpat[N,4];
  for(i in 1:N){
    for(k in 1:4){
      tpat[i,k] = 0;
    }
    if(t1[i]==1 && t2[i]==1) tpat[i,1] = 1;
    if(t1[i]==1 && t2[i]==0) tpat[i,2] = 1;
    if(t1[i]==0 && t2[i]==1) tpat[i,3] = 1;
    if(t1[i]==0 && t2[i]==0) tpat[i,4] = 1;
  }
}
parameters{
  real<lower=0,upper=1> s[2];
  real<lower=0,upper=1> c[2];
```

```
  real<lower=0,upper=1> prev[G];
  real<lower=0,upper=1> covu; //unrestricted covariance - in transformed parameters, will be
restricted to feasible range based on sensitivities
}
transformed parameters{
  simplex[4] prob0[G];
  simplex[4] prob1[G];
  real cov;
  real ls;
  real us;
  ls = 0;
  us = (min(s)-s[1]*s[2]);
  cov = covu*(us-ls) + ls; //I think this scales the covariance to force it to be in feasible range
  for(j in 1:G){
    // probability of test result, given you are a case
    prob1[j,1] = (s[1]*s[2]      + cov) ; // 1,1
    prob1[j,2] = (s[1]*(1-s[2])   - cov) ;    // 1,0
    prob1[j,3] = (s[2]*(1-s[1])   - cov) ; // 0,1
    prob1[j,4] = ((1-s[1])*(1-s[2]) + cov) ;    // 0,0
    // probability of test result, given you are not a case
    prob0[j,1] = ((1-c[1])*(1-c[2]) ); // 1,1
    prob0[j,2] = ((1-c[1])*c[2]    );    // 1,0
    prob0[j,3] = (c[1]   *(1-c[2]) ); // 0,1
    prob0[j,4] = (c[1]   *c[2]    );    // 0,0
  }
}
model{
  s~beta(1,1);
  c[1]~beta(90,10);
  c[2]~beta(95,5);
  prev~beta(1,7);
  covu ~ uniform(0,1);
  for(i in 1:N){
    tpat[i] ~ multinomial(prob1[g[i]]*prev[g[i]] + prob0[g[i]]*(1-prev[g[i]]));
  }
}
generated quantities{
  real prev_overall=0;
  for(i in 1:N){
    prev_overall = prev_overall + prev[g[i]]/N;
  }
}
"
```

Web Table 1. Estimated prevalence of current substance use (overall and by subgroup), and estimated sensitivity and specificity of medical record review (MRR) and self-interview (SI) for detecting current substance use, in 2,064 persons in the Johns Hopkins HIV Clinical Cohort, 2007-2015, assuming exchangeable specificity, but sensitivity of MRR and SI and prevalence of substance use vary across subgroups (full model 2 results)

				Cocaine	Heroin	Alcohol	Hazardous Alcohol	Cigarettes
Cocaine								
Sensitivity, MRR								
IDU	Black	<45yrs	Male					
Y	Y	Y	Y	38.1 (13.4, 72.9)	53.8 (26.8, 81.7)	59.6 (32.4, 88.5)	59.6 (32.4, 88.5)	77.2 (60.9, 89.7)
			N	87.9 (49.9, 99.5)	42.8 (15.8, 81.8)	61.1 (27.0, 96.7)	61.1 (27.0, 96.7)	78.2 (62.9, 90.1)
		N	Y	70.6 (50.4, 91.5)	76.0 (57.0, 92.4)	59.9 (49.3, 73.0)	59.9 (49.3, 73.0)	79.1 (73.1, 84.7)
			N	77.3 (48.2, 97.7)	78.1 (36.5, 98.8)	57.4 (32.4, 92.5)	57.4 (32.4, 92.5)	74.4 (64.0, 83.6)
	N	Y	Y	57.7 (14.2, 96.1)	64.3 (12.6, 98.4)	76.1 (36.1, 98.7)	76.1 (36.1, 98.7)	62.0 (37.0, 83.9)
			N	69.8 (29.4, 97.6)	66.9 (25.6, 96.3)	55.0 (18.8, 95.6)	55.0 (18.8, 95.6)	89.7 (74.2, 97.8)
		N	Y	19.1 (0.8, 88.1)	31.4 (3.7, 83.9)	64.6 (31.4, 95.6)	64.6 (31.4, 95.6)	62.2 (41.9, 81.1)
			N	62.9 (18.8, 97.3)	65.1 (13.0, 98.4)	54.9 (26.7, 85.8)	54.9 (26.7, 85.8)	71.3 (52.9, 86.2)
N	Y	Y	Y	75.1 (32.7, 98.8)	68.3 (22.8, 98.2)	35.0 (27.7, 43.0)	35.0 (27.7, 43.0)	67.4 (57.1, 78.2)
			N	65.4 (32.8, 96.2)	75.8 (23.0, 99.0)	30.2 (19.7, 42.8)	30.2 (19.7, 42.8)	81.1 (67.2, 95.8)
		N	Y	64.7 (36.6, 95.0)	83.9 (48.2, 99.2)	53.1 (43.9, 63.6)	53.1 (43.9, 63.6)	76.6 (68.1, 85.5)
			N	88.7 (60.2, 99.5)	68.3 (23.6, 98.1)	42.8 (29.9, 59.4)	42.8 (29.9, 59.4)	88.2 (77.3, 98.4)
	N	Y	Y	55.7 (16.6, 95.4)	31.5 (0.6, 95.6)	42.4 (30.5, 56.1)	42.4 (30.5, 56.1)	60.0 (41.8, 78.6)
			N	32.0 (2.0, 94.3)	33.3 (0.9, 95.8)	20.3 (7.4, 40.8)	20.3 (7.4, 40.8)	85.0 (55.6, 99.1)
		N	Y	21.8 (0.8, 92.2)	22.3 (0.3, 93.3)	31.5 (21.6, 43.1)	31.5 (21.6, 43.1)	74.7 (64.0, 83.6)
			N	31.2 (0.8, 95.7)	32.8 (0.9, 95.8)	27.2 (10.0, 54.3)	27.2 (10.0, 54.3)	74.0 (42.6, 96.9)
Sensitivity, SI								
IDU	Black	<45yrs	Male					
Y	Y	Y	Y	55.4 (21.0, 93.6)	45.3 (21.1, 73.8)	86.1 (53.7, 99.3)	86.1 (53.7, 99.3)	88.9 (73.5, 98.2)
			N	33.6 (13.1, 61.0)	25.1 (7.7, 57.7)	38.9 (15.4, 79.1)	38.9 (15.4, 79.1)	81.2 (65.7, 93.2)
		N	Y	32.5 (21.5, 45.5)	34.4 (23.1, 47.3)	74.6 (61.9, 90.0)	74.6 (61.9, 90.0)	87.2 (81.2, 92.7)
			N	46.1 (25.6, 70.0)	28.7 (9.8, 57.1)	48.5 (26.9, 78.9)	48.5 (26.9, 78.9)	80.2 (69.4, 89.3)
	N	Y	Y	74.8 (23.3, 99.0)	44.6 (6.1, 94.5)	57.9 (2.29, 93.8)	57.9 (22.9, 93.8)	93.2 (71.6, 99.7)

			N	42.4 (14.1, 79.8)	56.9 (19.6, 92.6)	57.1 (19.4, 96.3)	57.1 (19.4, 96.3)	89.9 (74.1, 98.0)
		N	Y	35.7 (2.6, 95.4)	65.4 (12.9, 98.4)	83.5 (46.1, 99.2)	83.5 (46.1, 99.2)	85.3 (62.1, 98.7)
			N	42.4 (10.2, 89.0)	34.1 (4.1, 89.5)	86.0 (50.8, 99.4)	86.0 (50.8, 99.4)	89.3 (73.3, 98.4)
N	Y	Y	Y	72.7 (29.8, 98.6)	61.1 (17.8, 97.7)	81.7 (67.5, 95.8)	81.7 (67.5, 95.8)	83.6 (71.3, 96.4)
			N	61.8 (29.2, 95.8)	37.7 (6.8, 91.6)	87.0 (59.8, 99.4)	87.0 (59.8, 99.4)	92.0 (77.4, 99.6)
		N	Y	84.0 (51.2, 99.3)	87.9 (53.3, 99.5)	74.2 (62.1, 98.4)	74.2 (62.1, 88.1)	87.6 (78.1, 97.1)
			N	77.4 (45.7, 98.6)	47.1 (12.7, 94.4)	63.9 (44.2, 90.6)	63.9 (44.2, 90.6)	80.0 (68.6, 92.2)
	N	Y	Y	70.8 (23.6, 98.5)	31.3 (0.6, 95.7)	71.0 (55.9, 88.0)	71.0 (55.9, 88.0)	87.1 (64.3, 99.3)
			N	24.5 (1.1, 92.1)	33.1 (0.9, 95.9)	80.2 (51.5, 99.0)	80.2 (51.5, 99.0)	82.8 (52.2, 98.9)
		N	Y	24.3 (1.0, 93.5)	32.2 (0.7, 95.8)	82.4 (61.2, 98.4)	82.4 (61.2, 98.4)	76.3 (57.6, 95.4)
			N	31.1 (0.7, 95.7)	33.1 (0.9, 95.8)	65.0 (35.7, 97.1)	65.0 (35.7, 97.1)	71.1 (39.4, 96.7)
Specificity, MRR				97.0 (95.9, 98.1)	98.4 (97.5, 99.1)	90.9 (86.9, 94.6)	95.4 (93.5, 97.1)	90.4 (86.4, 94.4)
Specificity, SI				98.3 (97.3, 99.2)	99.4 (98.8, 99.7)	92.3 (86.2, 97.0)	94.1 (91.3, 97.3)	93.9 (88.9, 97.7)
Prevalence				12.4 (10.0, 16.4)	9.7 (7.8, 14.5)	51.3 (44.0, 58.2)	23.0 (17.1, 31.6)	54.7 (50.5, 58.5)

Abbreviations: IDU, injection drug use (as an HIV-acquisition risk factor); MRR, medical record review; SI, self-interview