

Analysis of Dr. Olby's Chiari study, 2nd document
 Jason A. Osborne, Feb 6, 2006

To build a model to describe way probability of presence of NEURO or presence of SHM might depend on factors under study, various selection algorithms were considered. The most illuminating is the branch and bound algorithm of Furnival and Wilson (1974) employed to report the chi-square statistic among the most significant models with a single factor, then with two factors, then with three factors, etc. For inspection of the output at the bottom of this document, entitled "Regression Models Selected by Score Criterion," the 95th percentiles of the relevant chisquare distributions for comparison are

$$\begin{array}{ll}
 \chi^2(.95, 1) = 3.84 & \chi^2(.9, 1) = 2.71 \\
 \chi^2(.95, 2) = 5.99 & \chi^2(.9, 2) = 4.61 \\
 \chi^2(.95, 3) = 7.81 & \chi^2(.9, 3) = 6.25 \\
 \chi^2(.95, 4) = 9.49 & \chi^2(.9, 4) = 7.78 \\
 \chi^2(.95, 5) = 11.07 & \chi^2(.9, 5) = 9.24
 \end{array}$$

In other words, if "Score Chi-Square" for a model with p variables exceeds $\chi^2(.95, p)$, then the model is well-determined and the difference from a null model with no factors is significant at level .05.

There were no models uncovered for SHM. There were many cases where SHM was missing, but even after an attempt was made to recode SHM as absent for all cases where SHMgrade = 0, no models were uncovered.

There are some interesting results for NEURO. The following four 2-predictor models were significant at level .05:

```

2      7.0419  hydrocephalus cdfossa
2      6.4337  cdfossa cdratio
2      6.2852  Kinking cdratio
2      6.0205  Herniation cdratio
  
```

and there was one 3-predictor model that was significant:

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3      8.0435  Kinking hydrocephalus cdfossa
  
```

The description of the fitted models appears in the output below as well. The idea of logistic regression is to model the *log odds* of NEURO signs as a *linear function* of the factors under study. If π denotes the chance of NEURO signs, then, for example, the *log odds* from the 3-predictor model are estimated by

$$\log \frac{\pi}{1 - \pi} = 6.3 + 0.86(\text{Kinking}) + .85 * \text{hydrocephalus} - .78\text{cdfossa}$$

/* BEGIN OUTPUT FOR BEST 2-PREDICTORS AND BEST 3-PREDICTORS MODELS */

Best 2-predictor model

8

12:36 Sunday, February 5, 2006

The LOGISTIC Procedure

Number of Observations Read 59
Number of Observations Used 58

Response Profile

Ordered Value	neuro	Total Frequency
1	1	13
2	2	45

Probability modeled is neuro=1.

NOTE: 1 observation was deleted due to missing values for the response or explanatory variables.

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	63.723	60.271
SC	65.784	66.453
-2 Log L	61.723	54.271

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	7.4518	2	0.0241
Score	7.0419	2	0.0296
Wald	6.0487	2	0.0486

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	6.3581	3.5533	3.2017	0.0736
hydrocephalus	1	0.7561	0.4574	2.7331	0.0983
cdfossa	1	-0.6840	0.2974	5.2901	0.0214

Odds Ratio Estimates

Effect	Point Estimate	95% Wald Confidence Limits	
hydrocephalus	2.130	0.869	5.220
cdfossa	0.505	0.282	0.904

The LOGISTIC Procedure

Number of Observations Read 59
 Number of Observations Used 58

Response Profile

Ordered Value	neuro	Total Frequency
1	1	13
2	2	45

Probability modeled is neuro=1.

NOTE: 1 observation was deleted due to missing values for the response or explanatory variables.

Model Fit Statistics

Criterion	Intercept	
	Only	and Covariates
AIC	63.723	60.954
SC	65.784	69.195
-2 Log L	61.723	52.954

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	8.7695	3	0.0325
Score	8.0435	3	0.0451
Wald	6.9039	3	0.0750

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	8.0360	3.8814	4.2865	0.0384
kink1	1	-0.8581	0.7506	1.3069	0.2529
hydrocephalus	1	0.8526	0.4690	3.3045	0.0691
cdfossa	1	-0.7845	0.3148	6.2085	0.0127

Odds Ratio Estimates

Effect	Point Estimate	95% Wald Confidence Limits
kink1	0.424	0.097 1.846
hydrocephalus	2.346	0.936 5.882
cdfossa	0.456	0.246 0.846

/*BEGIN SAS OUTPUT FOR MODEL SELECTION FOR NEURO*/

Regression Models Selected by Score Criterion

Number of Variables	Score Chi-Square	Variables Included in Model
1	5.4762	cdratio
1	4.4930	cdfossa
1	1.5004	Herniation
1	1.2315	hydrocephalus
1	0.1174	Kinking
1	0.0119	sex1
1	0.0005	Compression
2	7.0419	hydrocephalus cdfossa
2	6.4337	cdfossa cdratio
2	6.2852	Kinking cdratio
2	6.0205	Herniation cdratio
2	5.9524	hydrocephalus cdratio
2	5.4847	Compression cdratio
2	5.4768	sex1 cdratio
2	4.8165	sex1 cdfossa
3	8.0435	Kinking hydrocephalus cdfossa
3	7.7780	hydrocephalus cdfossa cdratio
3	7.5420	Kinking cdfossa cdratio
3	7.4266	sex1 hydrocephalus cdfossa
3	7.3892	hydrocephalus Herniation cdfossa
3	7.2508	Compression hydrocephalus cdfossa
3	6.7255	Kinking hydrocephalus cdratio
3	6.7053	Herniation cdfossa cdratio
3	6.6200	hydrocephalus Herniation cdratio
3	6.5991	Kinking Herniation cdratio
3	6.5710	sex1 cdfossa cdratio
3	6.4877	Compression cdfossa cdratio
3	6.3470	sex1 Kinking cdratio
3	6.2865	Compression Kinking cdratio
4	9.0413	sex1 Kinking hydrocephalus cdfossa
4	8.9590	Kinking hydrocephalus cdfossa cdratio
4	8.2256	Compression Kinking hydrocephalus cdfossa
4	8.1671	Kinking hydrocephalus Herniation cdfossa
4	8.0793	sex1 Kinking cdfossa cdratio
4	8.0725	hydrocephalus Herniation cdfossa cdratio
4	8.0101	sex1 hydrocephalus cdfossa cdratio
4	7.9793	sex1 hydrocephalus Herniation cdfossa
4	7.9192	Compression hydrocephalus cdfossa cdratio
5	9.7112	sex1 Kinking hydrocephalus cdfossa cdratio
5	9.2999	sex1 Kinking hydrocephalus Herniation cdfossa

/*BEGIN SAS OUTPUT FOR MODEL SELECTION FOR SHM*/

Regression Models Selected by Score Criterion

Number of Variables	Score Chi-Square	Variables Included in Model
1	1.9592	hydrocephalus
1	1.1269	cdratio
1	0.5967	Compression
2	2.7646	Compression hydrocephalus
2	2.5820	hydrocephalus cdratio
2	2.2427	sex1 hydrocephalus
2	2.0400	cdfossa cdratio
3	3.3201	Compression hydrocephalus cdratio
3	3.1508	sex1 Compression hydrocephalus
4	3.6970	sex1 Compression hydrocephalus cdratio
4	3.4673	Compression hydrocephalus cdfossa cdratio
4	3.4628	Compression Kinking hydrocephalus cdratio
4	3.4369	sex1 hydrocephalus cdfossa cdratio
5	4.1199	sex1 Compression hydrocephalus cdfossa cdratio
5	3.7832	sex1 Compression Kinking hydrocephalus cdratio
6	4.1680	sex1 Compression hydrocephalus FM_size cdfossa cdratio
6	4.1382	sex1 Compression Kinking hydrocephalus cdfossa cdratio
6	4.1229	sex1 Compression hydrocephalus Herniation cdfossa cdratio