Survival Analysis of Endoluminal Repair of Abdominal Aortic Aneurysms

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Prepared for Australian Safety and Efficacy Register of New Interventional Procedures – Surgical (ASERNIP-S)
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Important Notice

Use of this Report

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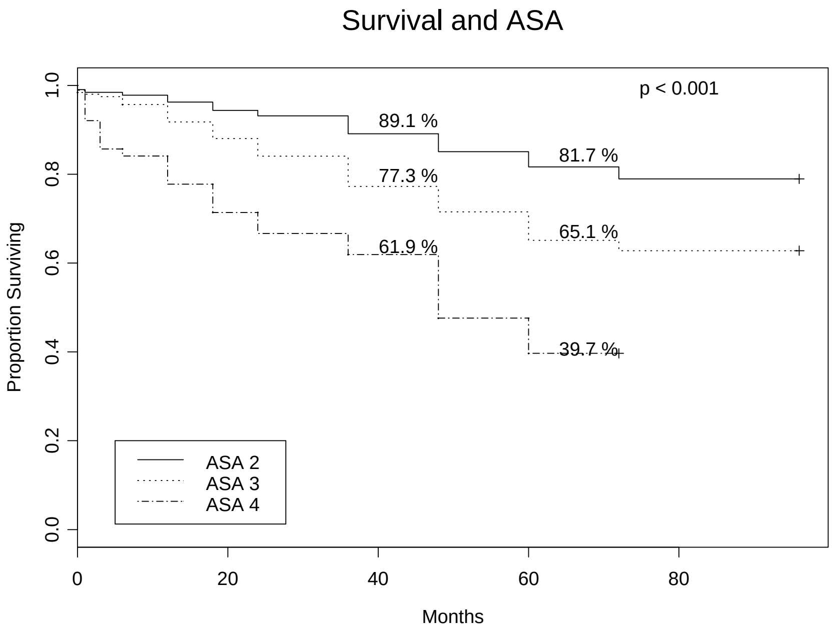
Executive Summary

Australian Safety and Efficacy Register of New Interventional Procedures – Surgical (ASERNIP-S) desired survival analyses be performed for the "audit of Endoluminal Repair of Abdominal Aortic Aneurysms" (AAA) that they are conducting for the Australian Federal Government. Data has been collected since October 1999 on patients who underwent Endoluminal Repair of AAA, up to February 2006. Right censored Kaplan-Meier Survival analysis was utilized to determine the survival rates and which factors statistically significantly influence survival. Freedom from Aneurysm Related deaths was also similarly analysed.

ASA, age, aneurysm size and creatinine were found to statistically significantly contribute to predict **survival.** Gender, aortic neck angle and Infrarenal Neck Length were NOT found to statistically significantly contribute to predict survival. ASA had the largest magnitude of difference. Patients with ASA of 4 or 5 have a 5 year expected survival rate of 40%, whilst ASA of 2 or less has a 5 year expected survival rate of 82%. Thus we expect 82% of patients who are not very sick (ASA 2 or less) to survive 5 years.

Figure 1 Survival curve showing effect of ASA



Expected 3 and 5 year survival rates are shown numerically on the above plot

ASA, creatinine, aneurysm size, infrarenal neck length and aortic neck angle were found to statistically significantly contribute to explain **aneurysm related deaths**. Age and Gender were NOT found to statistically significantly add to predict aneurysm related deaths.

In addition, maximum aneurysm diameter was found to statistically significantly contribute to the model predicting survival that already included age and ASA. This suggests that size (which is the most direct measure of severity of aneurysm) does statistically significantly contribute to the model of survival. This may suggest some justification to perform endoluminal repairs of AAA.

Right censored Kaplan-Meier Survival analysis is not the best method to build a multi-predictor model of survival. Kaplan-Meier treats predictor variables as classes. When more than two predictive variables were included in the survival fit, unusual things happened to the survival rates for particular combinations of variables.

A multi-predictor model of survival was built using logistic generalised linear regression in another report by the same author entitled "Predictive Model for Endoluminal Repair of

Abdominal Aortic Aneurysms". This model selected the variables that predicts 3 and 5 year survival likelihood. Age, size, asa and creatinine all statistically significantly contributed together to predict 3 and 5 year survival.

Tables of the 3 year and 5 year expected survival rates (Kaplan Meier) where produced stratified by age group, ASA and maximum aneurysm size. These tables follow.

Table 1 Expected 3 year survival by ASA, Age and aneurysm size

		Expected 3 year survival		
	Max	**Age (years)**		
ASA	**Diameter**	<75	75-80	>80
ASA II	<55 mm	93%	91%	89%
	55-65		65%	68%
	>65 mm	83%		75%
ASA III	<55 mm	94%	76%	78%
	55-65	83%	78%	72%
	>65 mm	66%	68%	44%
ASA IV	<55 mm			50%
	55-65	60%	65%	
	>65 mm	43%	38%	33%

Purple shading indicates estimates have a large error.

Table 2 Expected 5 year survival by ASA, Age and aneurysm size

		Expected 5 year survival		
	Max	**Age (years)**		
ASA	**Diameter**	<75	75-80	>80
ASA II	<55 mm	89%	80%	81%
	55-65	87%	57%	68%
	>65 mm	75%		63%
ASA III	<55 mm	84%	65%	62%
	55-65	77%	63%	54%
	>65 mm	59%	54%	29%
ASA IV	<55 mm		33%	25%
	55-65	50%	47%	
	>65 mm	29%	38%	22%

Method

Right censored Kaplan-Meier Survival analysis was utilized to determine the survival rates and which factors significantly influence survival. Freedom from aneurysm related deaths was also similarly assessed for data up to February 2006.

Survival Curves and tables were produced using **rounded months** until death, or until last known to be alive. The last time a person is known to be alive is either the last follow-up or the most recent Australian death registry check date. Those who are still alive are considered censored because we do not yet know how long they will survive.

The rounded months used were 0, 1, 3, 6, 12, 18, 24, 36, 48, 60 and 72 months.
S-PLUS Version 6.2.1 2003 Insightful Corp. was used to produce survival tables and curves. Survival curves and tables can be produced also by simply using actual months until death, or until last known to be alive. Those who don't die are considered censored because we do not yet know how long they will survive. The censored date was either the last follow-up or the most recent Australian death registry check date. Tables of these results are very long. The overall survival table and one which is stratified by aortic neck angle are reported in Appendix 1, Actual Months tables. Graphical and tabular survival assessments are more readily made utilising rounded months.

Survival was stratified by the following variables and the resultant survival curves are reported in the Results section:-

- Aortic neck angle
- Gender
- Age
- Size
- Infrarenal neck length
- ASA
- Creatinine.

Results

The overall survival curve is plotted below(showing rounded months)

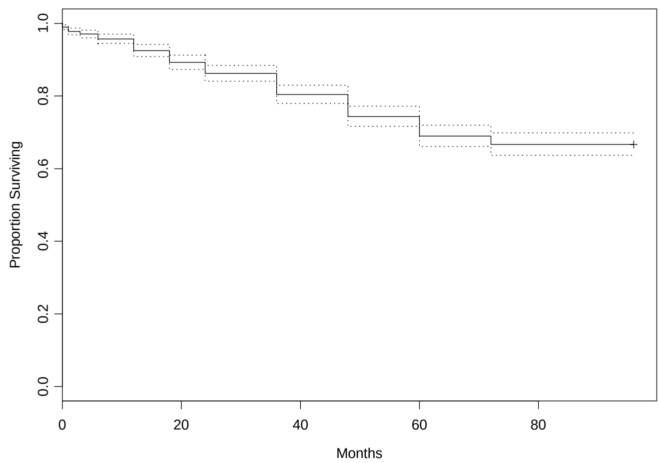


Figure 2 Survival curve (life table) showing 95% confidence intervals

The overall survival table is listed below. The 3 year and five survival statistics are highlighted.

Survival Table for all patients

Time (months)	Number entering this interval	Number of deaths	Proportion surviving	Survival Standard error	Lower 95%CI	Upper 95% CI
0	960	10	99.0%	0.33%	98.3%	99.6%
1	950	11	97.8%	0.47%	96.9%	98.7%
3	939	7	97.1%	0.54%	96.0%	98.2%
6	932	13	95.7%	0.65%	94.5%	97.0%
12	919	31	92.5%	0.85%	90.8%	94.2%
18	888	31	89.3%	1.00%	87.3%	91.3%
24	857	29	86.2%	1.11%	84.1%	88.5%
36 3year	828	56	**80.4%**	1.28%	77.9%	83.0%
48	772	58	74.4%	1.41%	71.7%	77.2%
60 5year	714	52	**69.0%**	1.49%	66.1%	71.9%
72	365	12	66.7%	1.58%	63.7%	69.9%

This says that after 3 years expect 80% patients to have survived. Similarly after 5 years expect 69% patients to have survived.

Actual months

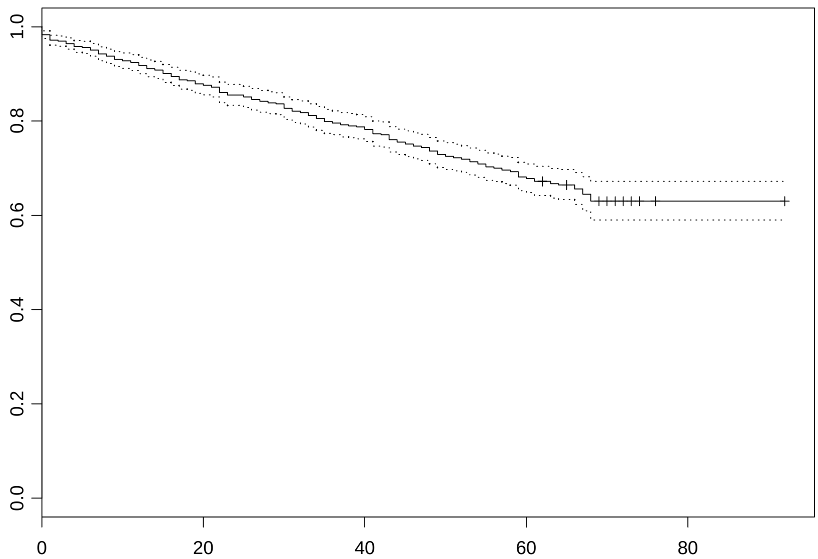


Figure 3 Overall survival curve utilising actual months until death

Aortic Neck Angle

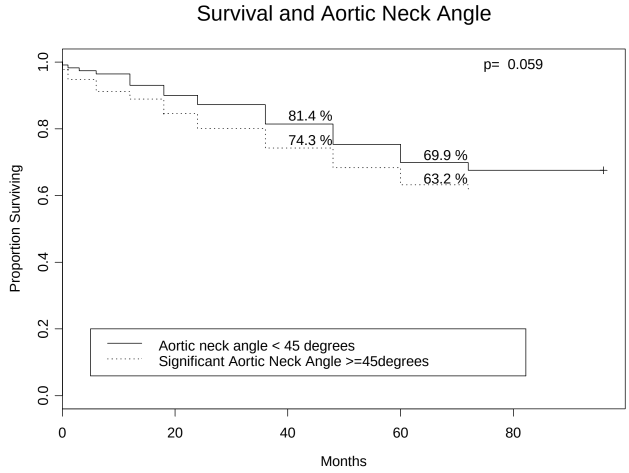


Figure 4 Survival curve showing effect of aortic neck angulation

Aortic Neck Angle was NOT found to statistically significantly contribute to a model of survival (although the relationship would be considered significant at the 10% level).

After 3 years (36 months) there was an 81% survival rate, for non significant neck angulation, whereas there was 74% survival expected for patients with significant neck angulation.

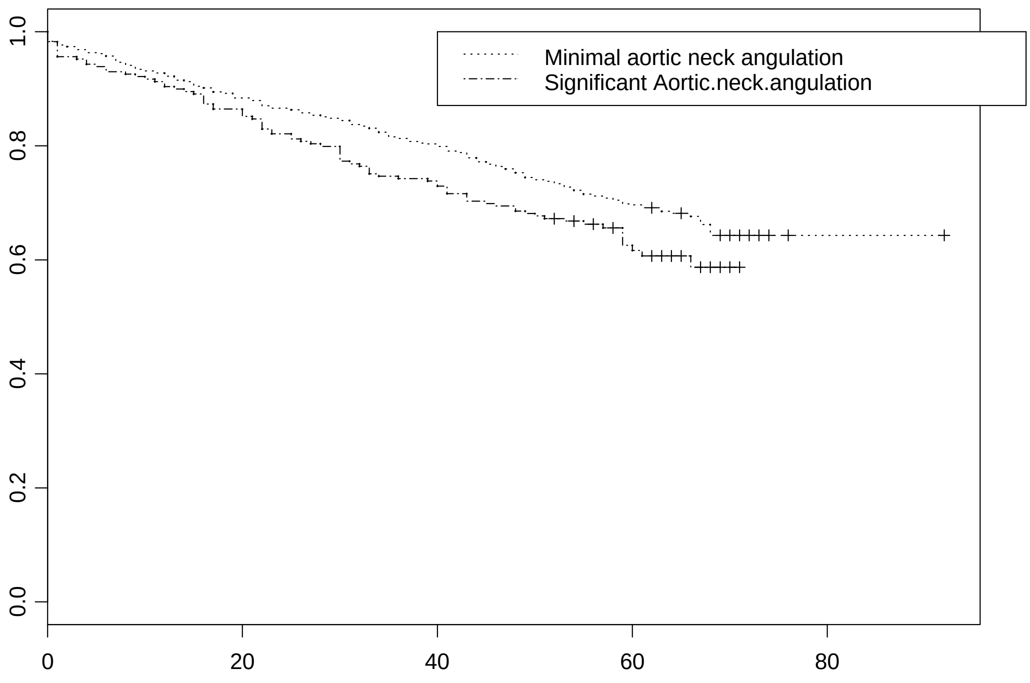


Figure 5 Aortic Neck Angle - Survival curve - utilising actual months until death

Gender

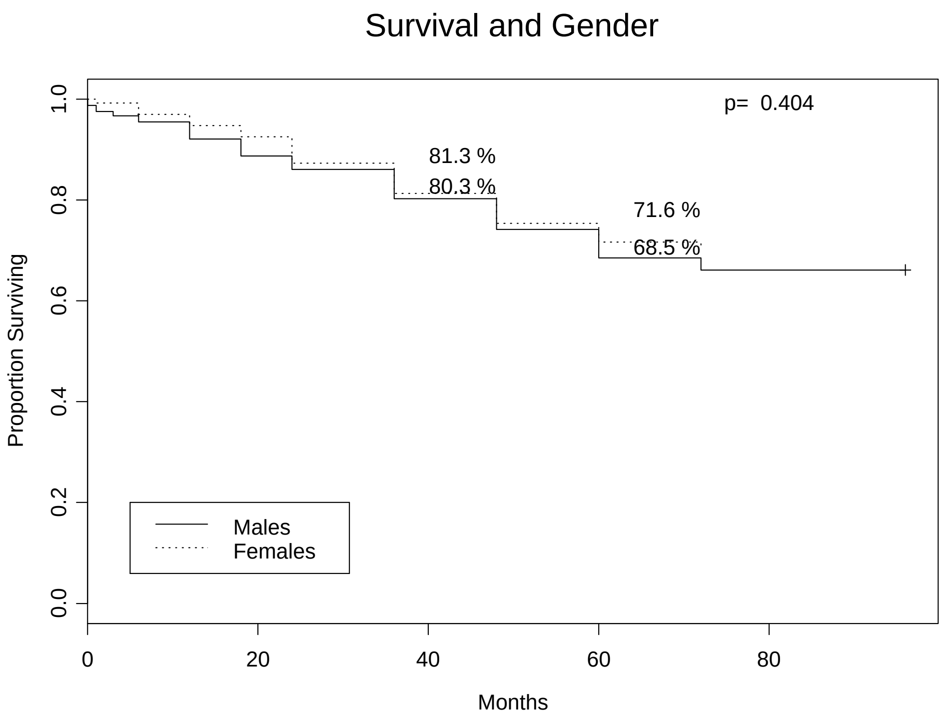


Figure 6 Survival curve stratified by Gender

Gender survival rates (after 3 and 5 years) were very similar. Gender was NOT found to statistically significantly contribute to a model of survival.

Age

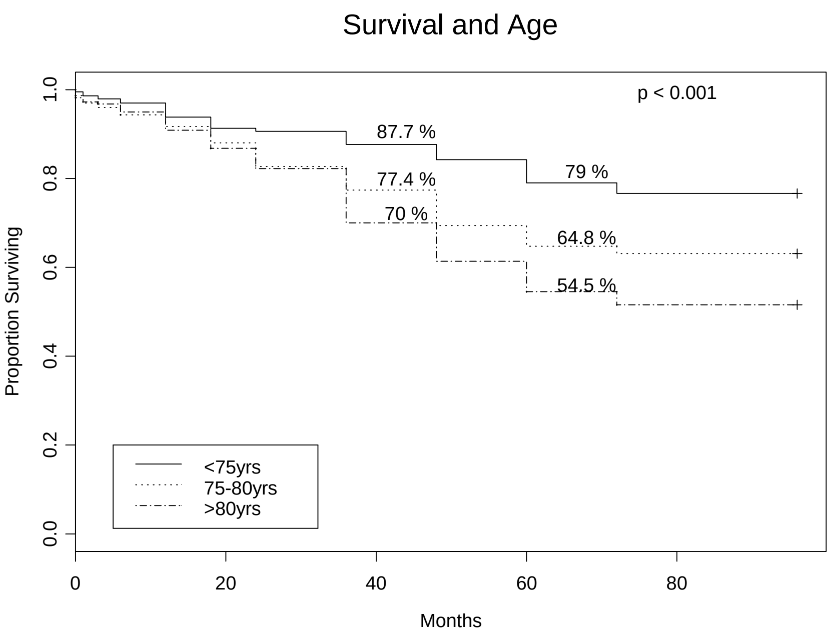


Figure 7 Survival curve stratified by Age

Age was found to statistically significantly contribute to a model of survival (p<.001).

Size

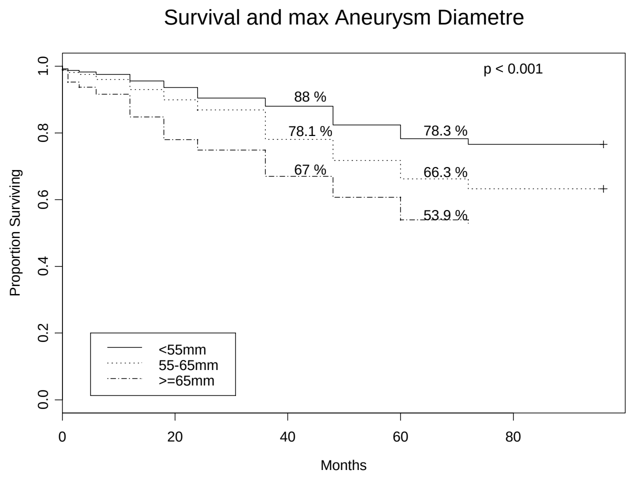


Figure 8 Survival stratified by Aneurysm Size

Aneurysm size was found to statistically significantly contribute to a model of survival (p<.001).

Infrarenal Neck Length

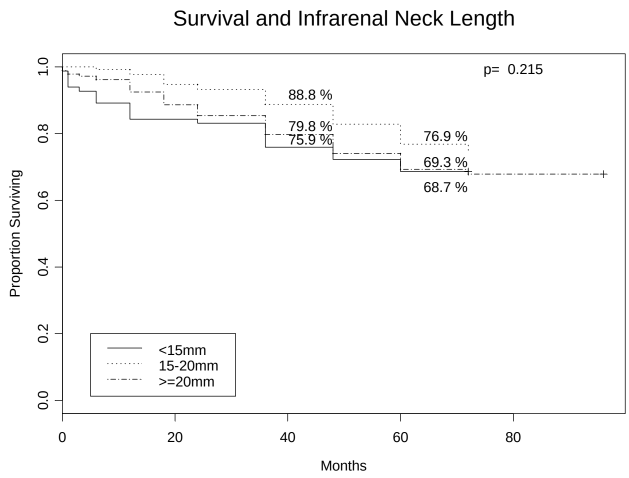


Figure 9 Survival stratified by Infrarenal Neck Length

Infrarenal Neck Length was NOT found to statistically significantly contribute to a model of survival (p =0.21).

Notice how mid range of infrarenal neck length has the best survival rates.
This curious result may mean that “normal” (middle size necks) increase your chance of survival.
Alternatively this may mean that other variables are dominating the survival model.
Note these survival models treat each level of neck length as a factor rather than an increasing scale.

ASA

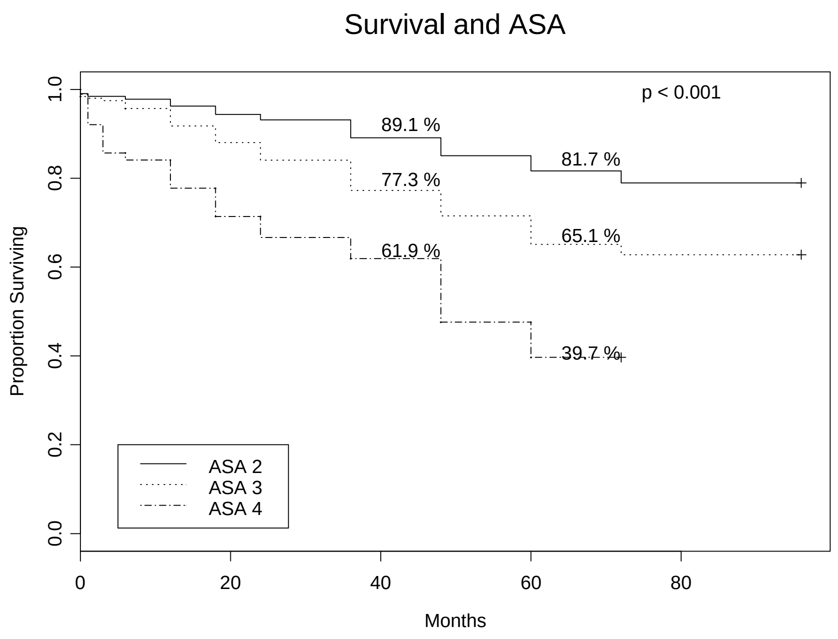


Figure 10 Survival stratified by ASA rating

ASA was found to statistically significantly contribute to a model of survival (p<.001).

Does Size add to ASA?

Aneurysm maximum diameter was found to statistically significantly (p < .001) contribute to explain variation in survival rates, when added to a model including ASA.
The size term contributed additional 39 (98-59) Chi-Squared with an extra 6 degrees of freedom, which corresponds to p-value of 6.0 e-07.

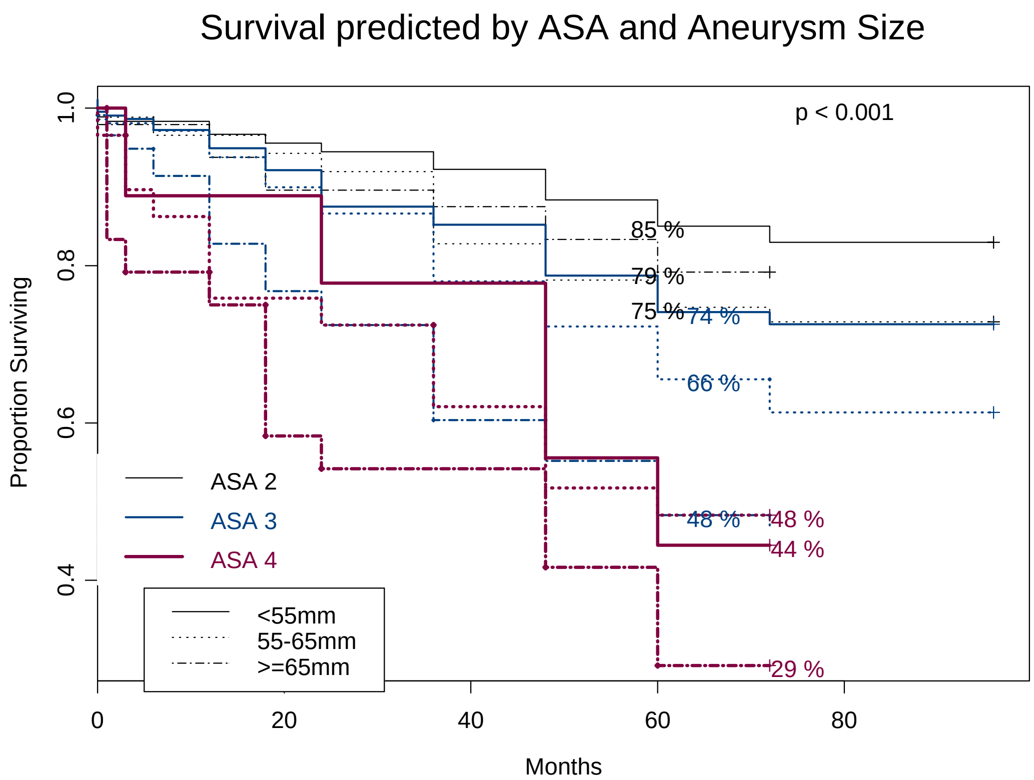


Figure 11 Survival stratified by Aneurysm Size and ASA

In the above model, people with ASA 2 with medium size aneurysms had a lower rate (75%) then those with larger aneurysms (5year survival rate of 79%). This is opposite to the expected. This probably relates to small sample size of a particular subgroup. All others lines are as would be expected.

Does Size add to Age?

Aneurysm Size statistically significantly contributes to the survival model which already accounts for age (p<0.001). Chi-Squared test comparing the survival models with and without aneurysm size, that already include age, results in an additional 44 (87-43) Chi-Squared with 6 degrees of freedom, which corresponds to p-value of 7.1e-10

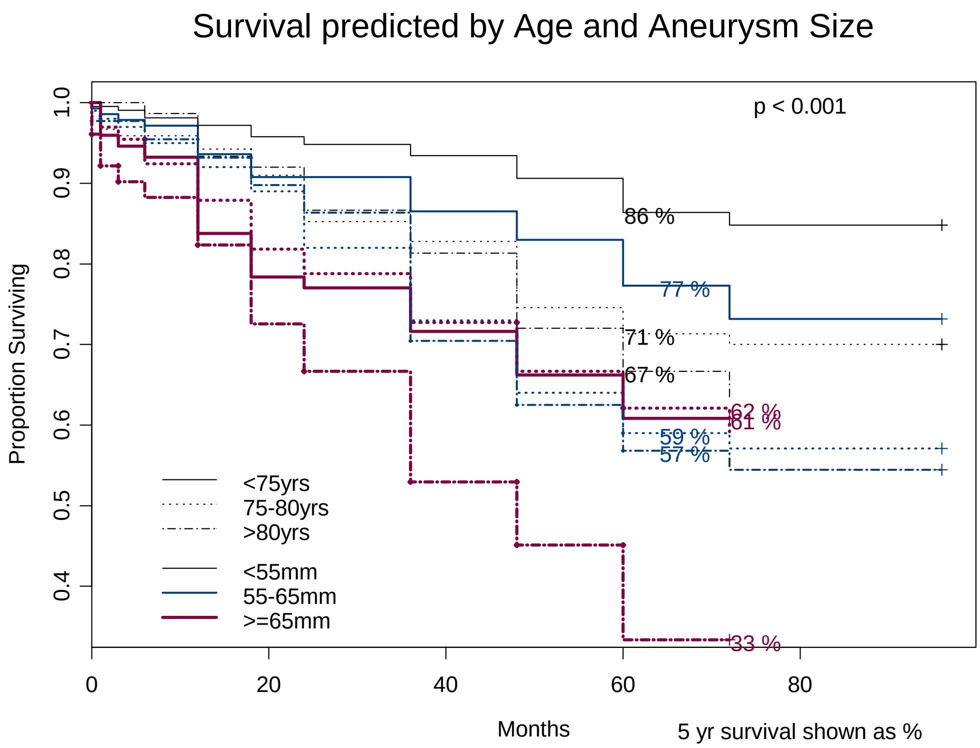


Figure 12 Survival stratified by Aneurysm Size and Age

For the most part the previous graph shows the expected relationships. However in the model, 75-80 year olds with medium size aneurysms had a slightly lower 5 year survival rate (59%) then those with larger aneurysms (5 year survival rate of 62%). This probably relates to sample size. Effectively this Kaplan-Meier survival model creates a new survival model for every level of the predictor variable. This means they do not force the relationship in a particular direction. Sometimes it may be more appropriate to use models that uses the scale of numerical continuous predictors (eg age, size and ASA).

Does Size add to Age and ASA model

Aneurysm Size statistically significantly contributes to the survival model which already accounts for age and ASA (p<0.001). Size contributes an additional 45 (144-99) chi-squared explained with 18 degrees of freedom difference, which corresponds to p= 0.0003497967 (p<0.001). Alternatively using Cox proportional hazards model size term has p = 4.2 *10-6 (p<0.001).

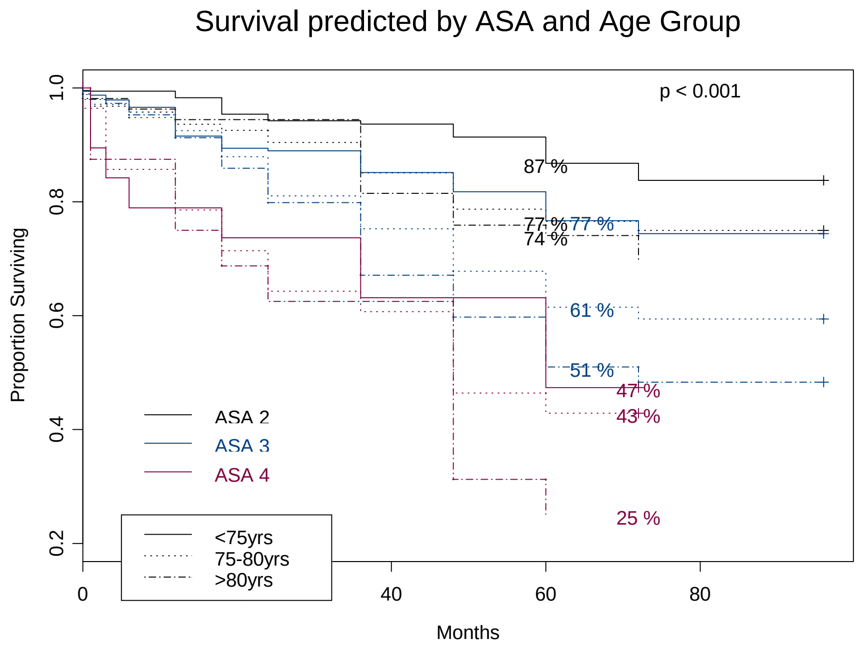


Figure 13 Survival stratified by ASA and Age

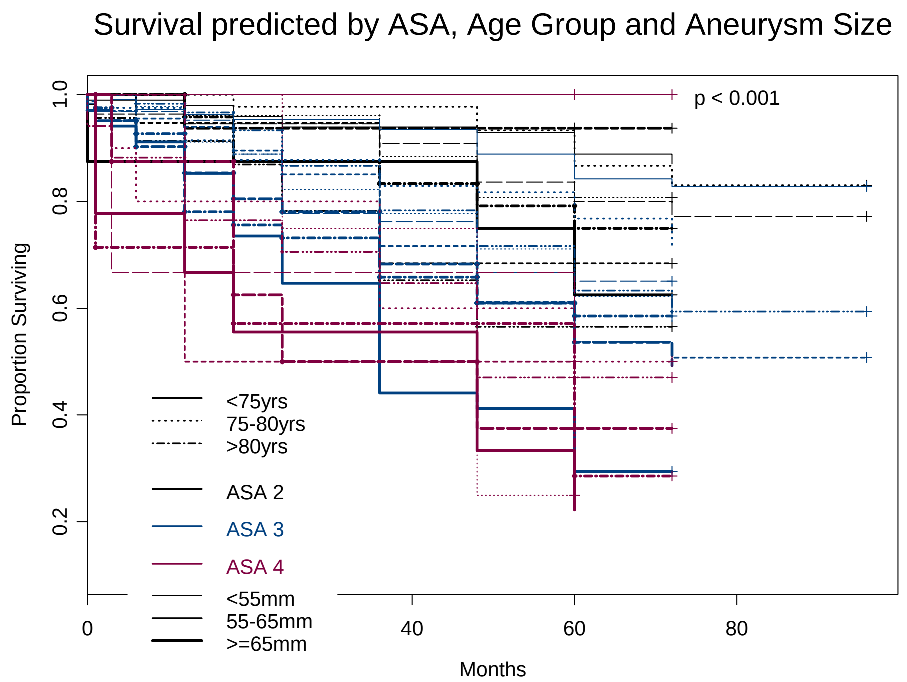


Figure 14 Survival stratified by Aneurysm Size, ASA and Size

With all three variables (ASA, Age and Size) there are too many lines to interpret the survival model. Note – ignore the top red line - Only 2 people in this group.

Survival Tables with Size, ASA and Age

Within each subgroup there were only a certain number of patients. The following table shows the number of patients in each subgroup. Notice how for ASA IV all the subgroups have size less than 20. Therefore predicted survival rates for ASA IV subgroups will have wide confidence intervals. In other words survival estimates may be inaccurate.

Table 3 Number in each subgroup Size, ASA and Age

		Number in each subgroup		
	Maximum	**Age (years)**		
ASA	**Diameter**	**<75**	**75-80**	**>80**
ASA II	<55 mm	99	55	26
	55-65	45	23	19
	>65 mm	24	16	8
ASA III	<55 mm	108	63	45
	55-65	82	60	67
	>65 mm	41	41	34
ASA IV	<55 mm		3	4
	55-65	10	17	2
	>65 mm	7	8	9

Table 4 Confidence Intervals for Survival Estimates

ASA	Age Group	Diameter	Time	Survival KaplanM	Lower 95%CI	Upper 95%CI	Span 95%CI
IV	<75	55-65	3year	60%	36%	100%	63%
IV	75-80	55-66	3year	65%	46%	92%	46%
IV	<75	55-65	**5year**	50%	27%	93%	66%
IV	<75	>65 mm	**5year**	29%	**9%**	**92%**	**83%**
IV	75-80	<55 mm	**5year**	33%	**7%**	**100%**	**93%**
IV	>80	>65 mm	**5year**	22%	**7%**	**75%**	**69%**

It may be questionable whether estimates which have small sub-group size should be included in the table. Purple Shading indicates unreliable estimates. In this case they show where the 95% Confidence Intervals have a span larger than 50%.

Table 1 Expected 3 year survival by ASA, Age and aneurysm size

		Expected 3 year survival		
	Max	**Age (years)**		
ASA	**Diameter**	<75	75-80	>80
ASA II	<55 mm	93%	91%	89%
	55-65	93%	65%	68%
	>65 mm	83%		75%
ASA III	<55 mm	94%	76%	78%
	55-65	83%	78%	72%
	>65 mm	66%	68%	44%
ASA IV	<55 mm			50%
	55-65	60%	65%	50%
	>65 mm	43%	38%	33%

Table 2 Expected 3 year survival by ASA, Age and aneurysm size

		Expected 5 year survival		
	Max	**Age (years)**		
ASA	**Diameter**	<75	75-80	>80
ASA II	<55 mm	89%	80%	81%
	55-65	87%	57%	68%
	>65 mm	75%		63%
ASA III	<55 mm	84%	65%	62%
	55-65	77%	63%	54%
	>65 mm	59%	54%	29%
ASA IV	<55 mm		33%	25%
	55-65	50%	47%	
	>65 mm	29%	38%	22%

For ASA II, 75-80years, >65mm only 1 of the 16 died in the first 12 months, since then no other patients in that particular sub-group have died.
Also ASA II, >80year, 55-65. Post 3 years no-one else has died, so entered 5year survival as 3year value of 68%.
There are no survival rate predictions for ASA IV, <75year, <55mm subgroup.
For ASA IV, age 75-80, <55mm, there is only 3 month (66.7%) and 5 year (33.3%)survival estimates, so it did not seem reasonable to estimate rate- particular given there were only 3 people in subgroup.
For ASA IV, >80, 55-65mm, there were only two people. 3year survival taken to be same as 1year survival.

Purple Shading indicates unreliable estimates. In this case they show where the 95% Confidence Intervals have a span larger than 50%. For completeness the 95% CI spans are shown in tabular form.

Table 5 3 year survival span by ASA, Age and size

		3 year survival SPAN 95%CI		
	Max	**Age (years)**		
ASA	**Diameter**	<75	75-80	>80
ASA II	<55 mm		15%	23%
	55-65		40%	43%
	>65 mm	30%		50%
ASA III	<55 mm	9%	21%	24%
	55-65	16%	21%	22%
	>65 mm	29%	29%	34%
ASA IV	<55 mm			80%
	55-65	63%	46%	
	>65 mm	75%	80%	70%

Table 6 5 year survival span by ASA, Age and size

		5 year Survival 95%CI Span		
	Max	**Age (years)**		
ASA	**Diameter**	<75	75-80	>80
ASA II	<55 mm	12%	21%	30%
	55-65	20%		
	>65 mm	35%		64%
ASA III	<55 mm	14%	24%	29%
	55-65	18%	25%	24%
	>65 mm	31%	31%	32%
ASA IV	<55 mm		93%	75%
	55-65	66%		
	>65 mm	83%		69%

Aneurysm Related Deaths (ARD)

Right censored Kaplan-Meier Survival analysis was utilized to determine which factors significantly influence aneurysm related deaths. ASA, Aortic Neck Angle and Infrarenal neck length was found to statistically significantly contribute to a model of freedom from aneurysm related deaths, as indicated on graphs by the p values below 0.05.

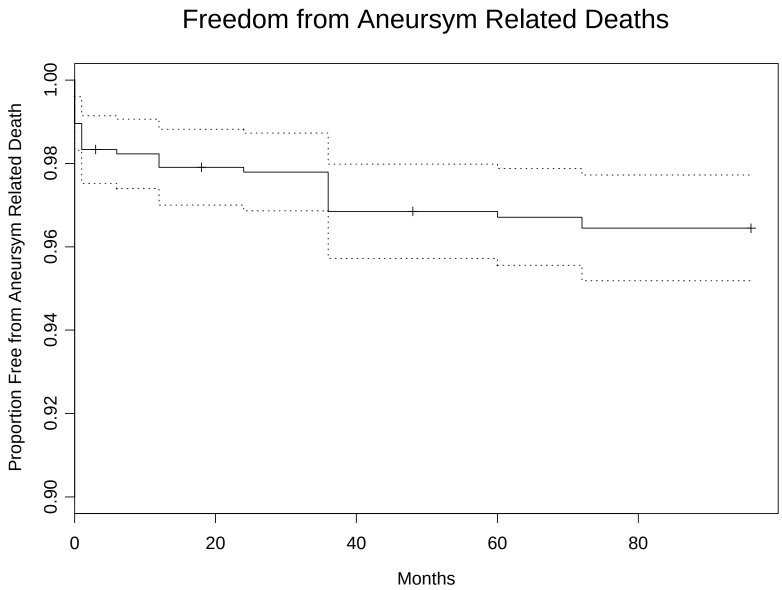


Figure 15 Freedom from ARD

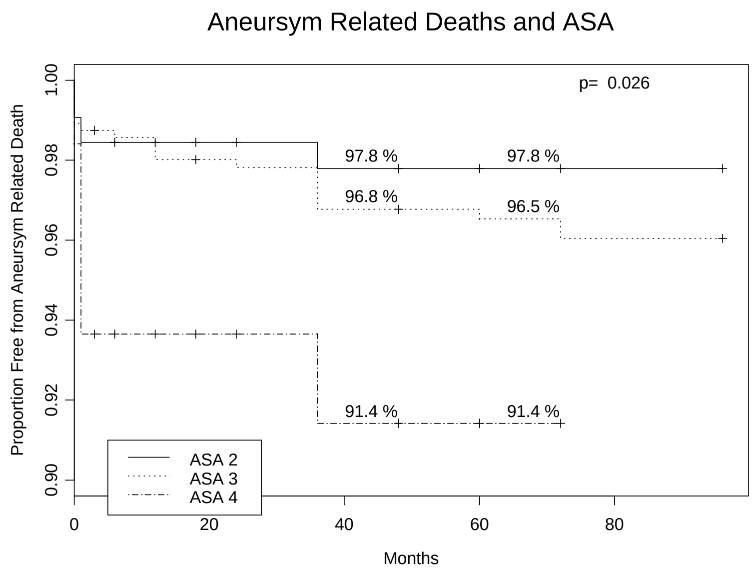


Figure 16 Freedom from ARD stratified by ASA

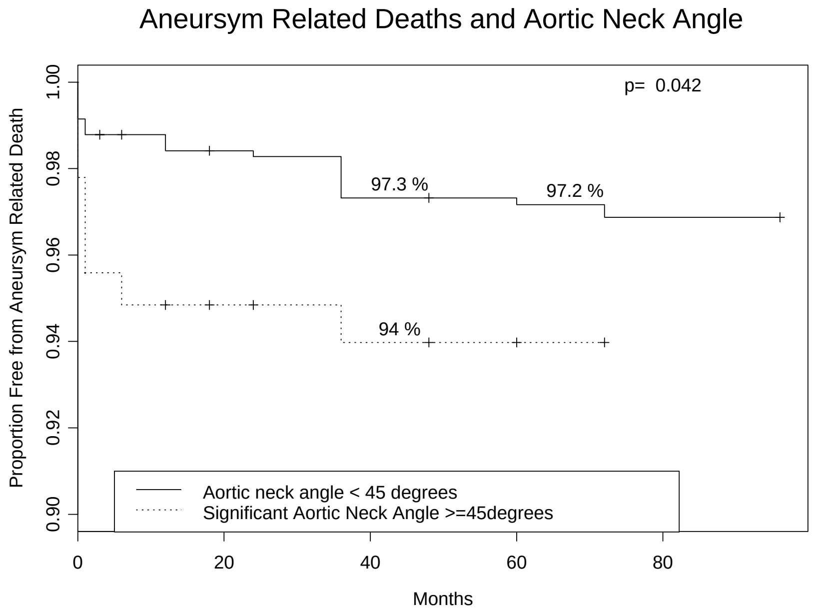


Figure 17 ARD and Aortic Neck Angle

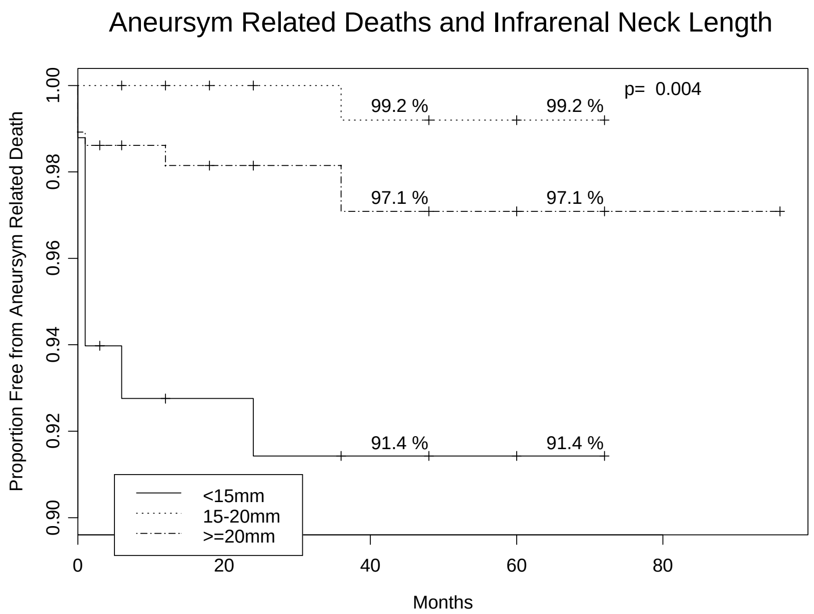


Figure 18 ARD and Infrarenal Neck Length

3 year freedom from aneurysm related death rate for <15mm infrarenal necks is 91.4%

Once again middle length necks had the highest freedom from aneurysm related death rates. This time this was for freedom from Aneurysm related death, whereas generally for survival this was also observed.

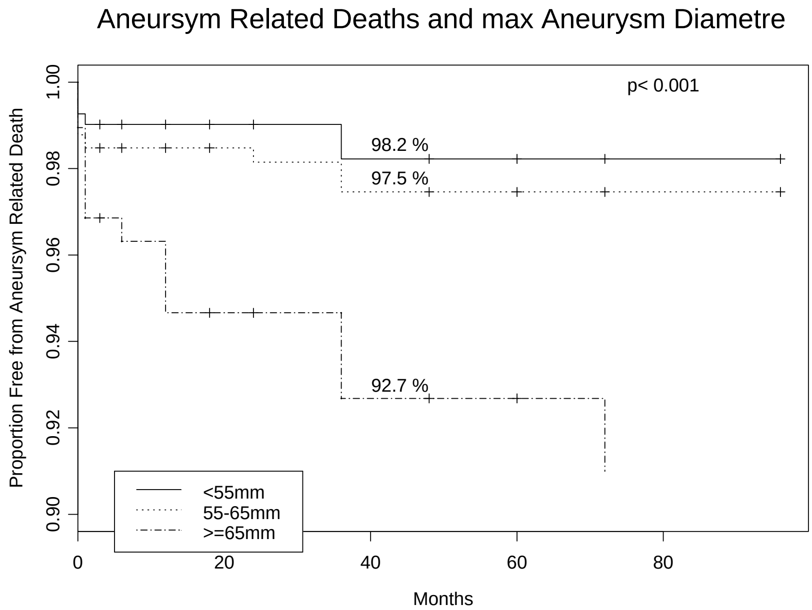


Figure 19 ARD and max Aneurysm Diameter

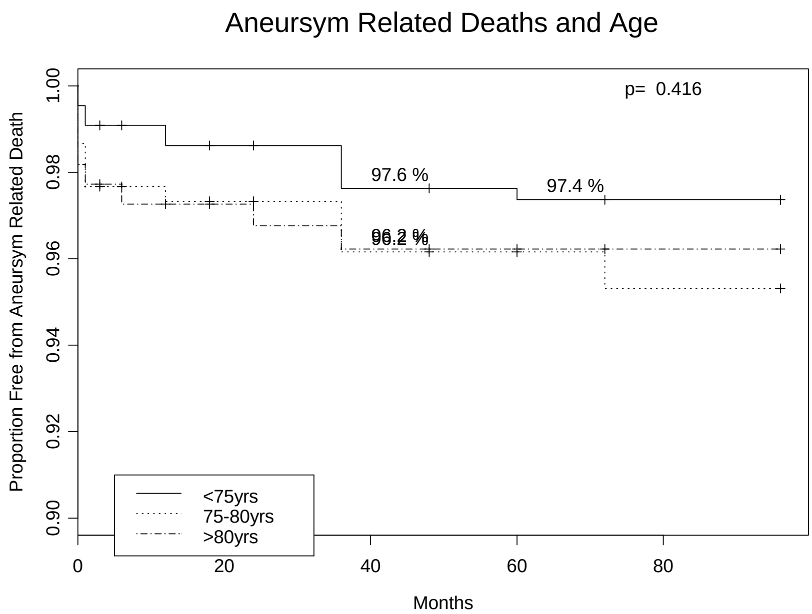


Figure 20 ARD and Age

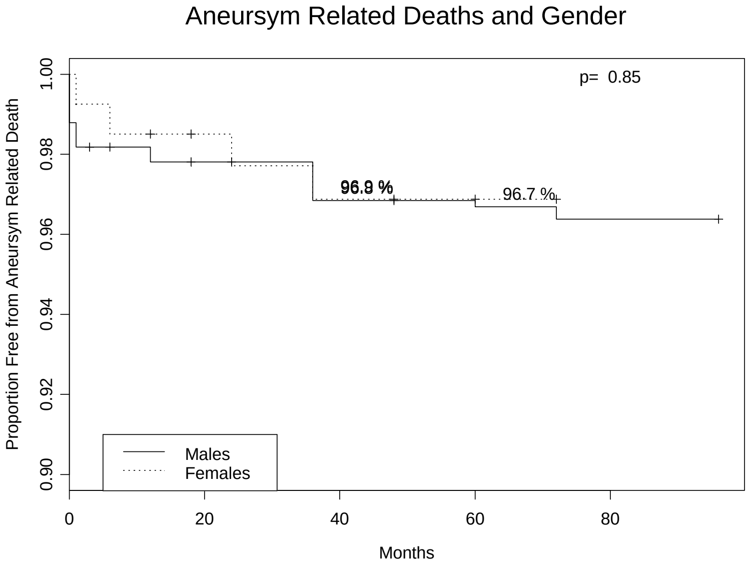


Figure 21 ARD and Gender

Does Size add to Age and ASA model

Aneurysm Size (p=0.03) statistically significantly contributes to the freedom from aneurysm related death- survival model, which already accounts for age and ASA. Size contributed an additional 31 (48-17) chi-squared, with 18 degrees of freedom difference, p= 0.031.

Using the Cox-proportional hazards model and accounting for actual diameter rather than diameter grouping.

As expected aneurysm diameter was the best predictor of freedom from aneurysm related deaths (this is shown most easily using the following cox-proportional hazards model output. Aneurysm size (p<0.001) had the lowest p-value indicated high statistical significance, compared to Age (p=0.02) and ASA (p=0.03).

Cox-Proportional Hazards Model Output (p-values)

```
                            coef exp(coef) se(coef)    z        p
Aneurysm Diameter Maximum 0.0549      1.06   0.0123 4.46 8.1e-006

coxph(formula = Surv(Months, AneurRelatedDeath) ~ Age, data = survivalASA)
      coef exp(coef) se(coef)    z     p
Age 0.0686      1.07   0.0297 2.31 0.021
coxph(formula = Surv(Months, AneurRelatedDeath) ~ ASA234, data = survivalASA)
        coef exp(coef) se(coef)    z    p
ASA234 0.702      2.02    0.323 2.17 0.03
```

Creatinine

Almost as an afterthought, analyses were performed to look at whether the creatinine levels were associated with survival and aneurysm related deaths.

Creatinine was found to statistically significantly contribute to a model of survival at both (120- and 160) cut-off levels, as indicated on graphs by the p-values below 0.05. Creatinine was also found to statistically significantly contribute to a model of freedom from aneurysm related deaths, only for the cut-off level of 120. This is possibly due to the larger sub-group size where creatinine levels are greater than 120. There were only 110 patients with creatinine $\geq$160 (4 aneurysm related deaths), whilst there was 330 with creatinine levels $\geq$120 (14 aneurysm related deaths).

The output follows. Cut-offs of 160 and 120 are shown. 160 was the suggestion of the surgeon, and 120 was the cut-off creatinine level used in other papers. At the request of the ASERNIPS staff, graphs are shown with and without their headings.

Survival and Creatinine

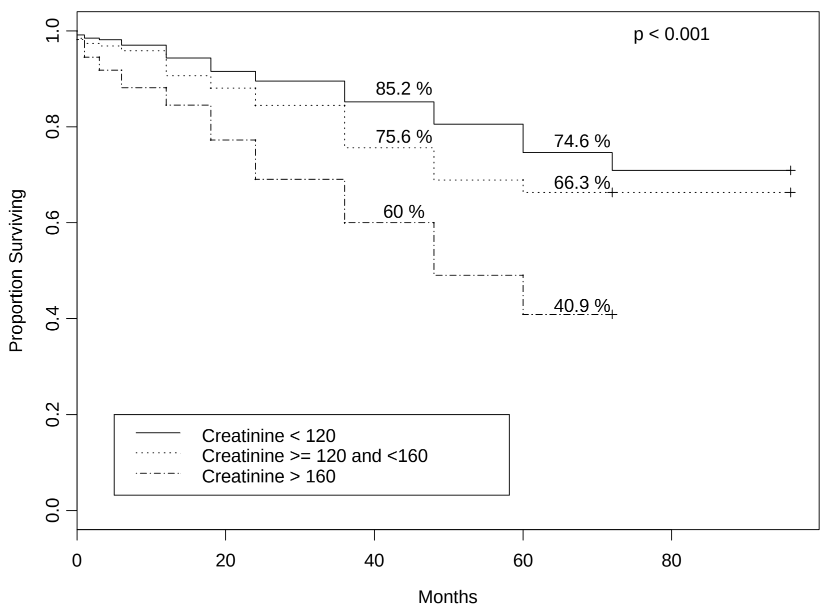


Figure 22 Survival Curve stratified by Creatinine

Creatinine was found to statistically significantly contribute to predict **survival (p<0.001).**

Survival tables follow.
In tables note that

n.risk	= number at risk
time	= Time (months)
n.risk	= Number entering this interval
n.event	= Number of deaths or number of aneurysm related deaths
survival	= Proportion surviving (survival rate)
std.err	= Survival Standard error
lower 95% CI	= Lower 95%Confidence interval around proportion surviving
Upper 95%CI	= Upper 95%Confidence interval around proportion surviving

Survival Table for Creatinine with 120 and 160 boundaries

3 and 5 year survival rates are highlighted below.

Creatinine < 120 Creat3=0

time	n.risk	n.event	survival	std.err	lower 95% CI	upper 95% CI
0	603	5	0.992	0.00369	0.984	0.999
1	598	4	0.985	0.00494	0.975	0.995
3	594	2	0.982	0.00545	0.971	0.992
6	592	7	0.970	0.00693	0.957	0.984
12	585	16	0.944	0.00939	0.925	0.962
18	569	17	0.915	0.01133	0.893	0.938
24	552	12	0.896	0.01246	0.871	0.920
36	540	26	**0.852**	0.01444	0.825	0.881
48	514	28	0.806	0.01610	0.775	0.838
60	486	36	**0.746**	0.01772	0.712	0.782
72	241	12	0.709	0.01982	0.671	0.749

Creatinine ≥ 120 and < 160 Creat3=1

time	n.risk	n.event	survival	std.err	lower 95% CI	upper 95% CI
0	193	3	0.984	0.0089	0.967	1.000
1	190	2	0.974	0.0114	0.952	0.997
3	188	1	0.969	0.0125	0.945	0.994
6	187	2	0.959	0.0143	0.931	0.987
12	185	10	0.907	0.0209	0.867	0.949
18	175	5	0.881	0.0233	0.836	0.928
24	170	7	0.845	0.0261	0.795	0.897
36	163	17	**0.756**	0.0309	0.698	0.820
48	146	13	0.689	0.0333	0.627	0.758
60	133	5	**0.663**	0.0340	0.600	0.733

Creatinine > 160 Creat3=2

time	n.risk	n.event	survival	std.err	lower 95% CI	upper 95% CI
0	110	2	0.982	0.0127	0.957	1.000
1	108	4	0.945	0.0217	0.904	0.989
3	104	3	0.918	0.0261	0.868	0.971
6	101	4	0.882	0.0308	0.824	0.944
12	97	4	0.845	0.0345	0.781	0.916
18	93	8	0.773	0.0400	0.698	0.855
24	85	9	0.691	0.0441	0.610	0.783
36	76	10	**0.600**	0.0467	0.515	0.699
48	66	12	0.491	0.0477	0.406	0.594
60	54	9	**0.409**	0.0469	0.327	0.512

```
Call:survdiff(formula = Surv(Months, Deceased) ~ Creat3, dat
a = survivalASA)

             N Observed Expected (O-E)^2/E (O-E)^2/V
Creat3=0   603      165    205.1     7.836    25.923
Creat3=1   193       65     61.0     0.267     0.338
Creat3=2   110       65     28.9    44.920    50.236

 Chisq= 53.5  on 2 degrees of freedom, p= 2.42e-012
```

Creatinine was found to statistically significantly contribute to predict aneurysm related deaths, when 120 and 160 were used as the boundaries**.**

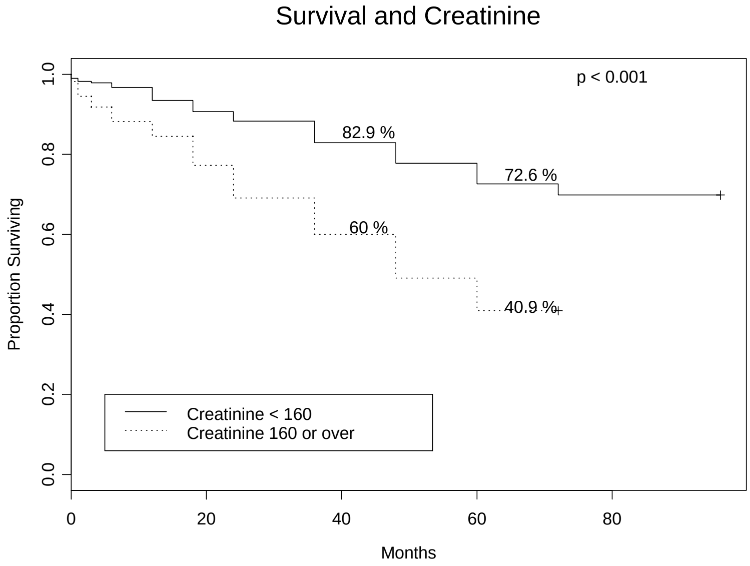


Figure 23 Survival and Creatinine Proportion using 160 limit

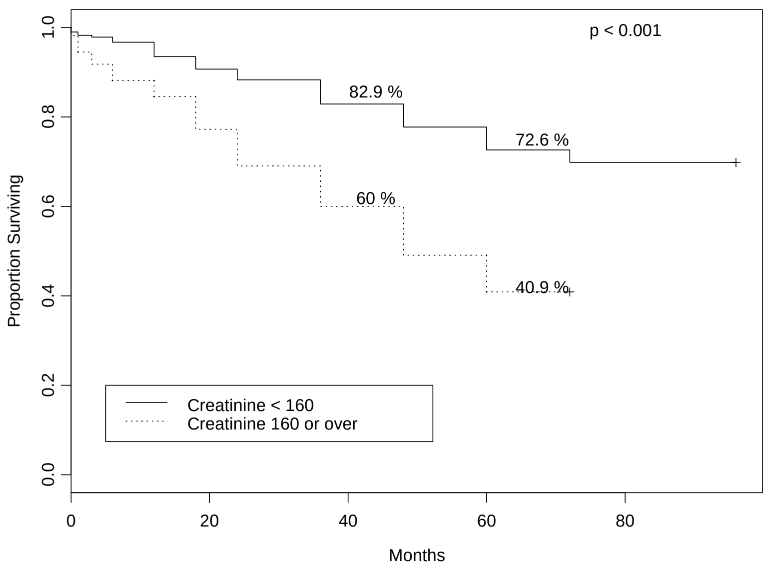


Figure 24 Survival curve for Creatinine with 160 as boundary

Creat160=0 which is **Creatinine < 160**

time	n.risk	n.event	survival	std.err	lower 95% CI	upper 95% CI
0	796	8	0.990	0.00354	0.983	0.997
1	788	6	0.982	0.00466	0.973	0.992
3	782	3	0.979	0.00512	0.969	0.989
6	779	9	0.967	0.00630	0.955	0.980
12	770	26	0.935	0.00876	0.918	0.952
18	744	22	0.907	0.01029	0.887	0.927
24	722	19	0.883	0.01139	0.861	0.906
36	703	43	0.829	0.01334	0.803	0.856
48	660	41	0.778	0.01474	0.749	0.807
60	619	41	0.726	0.01581	0.696	0.758
72	315	12	0.698	0.01710	0.666	0.733

Creat160=1 which is **Creatinine ≥ 160**

time	n.risk	n.event	survival	std.err	lower 95% CI	upper 95% CI
0	110	2	0.982	0.0127	0.957	1.000
1	108	4	0.945	0.0217	0.904	0.989
3	104	3	0.918	0.0261	0.868	0.971
6	101	4	0.882	0.0308	0.824	0.944
12	97	4	0.845	0.0345	0.781	0.916
18	93	8	0.773	0.0400	0.698	0.855
24	85	9	0.691	0.0441	0.610	0.783
36	76	10	0.600	0.0467	0.515	0.699
48	66	12	0.491	0.0477	0.406	0.594
60	54	9	0.409	0.0469	0.327	0.512

```
Call:survdiff(formula = Surv(Months, Deceased) ~ Creat160, data = survivalASA)
              N Observed Expected (O-E)^2/E (O-E)^2/V
Creat160=0 796      230    266.1      4.89      50.2
Creat160=1 110       65     28.9     44.92      50.2

 Chisq= 50.2  on 1 degrees of freedom, p= 1.36e-012
```

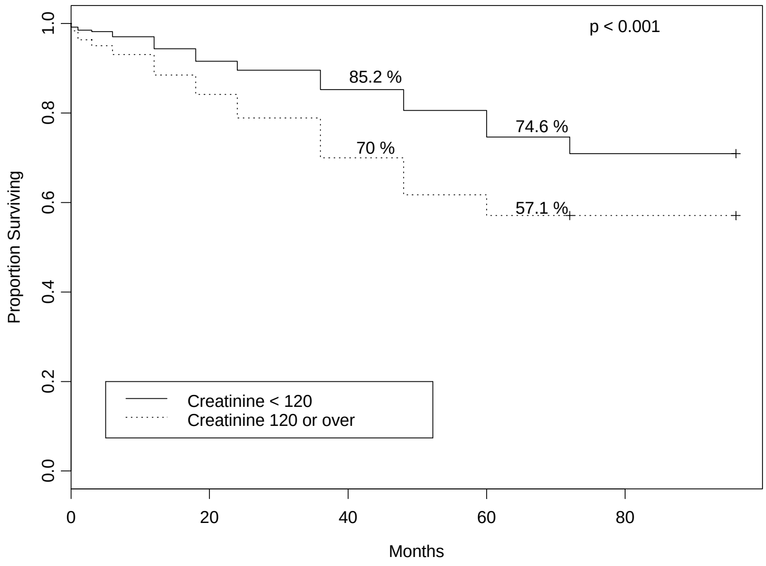


Figure 25 Survival curve for Creatinine using 120 limit

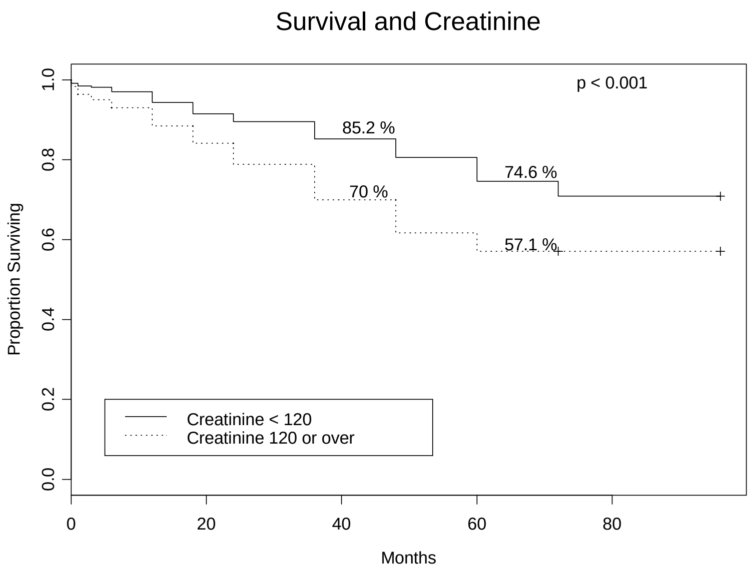


Figure 26 Survival curve for Creatinine using 120 limit

Creatinine was found to statistically significantly contribute to predict aneurysm related deaths, when use 120 level boundary**.**

Survival Table for Creatinine with 120 as boundary

```
Call: survfit(formula = Surv(IntervalEndMonths, Deceased) ~ Creat, data =
survivalASA)
                Creat=0 which is  Creatinine < 120

 time n.risk n.event survival std.err lower 95% CI upper 95% CI
```

```
   0     603         5     0.992 0.00369          0.984          0.999
   1     598         4     0.985 0.00494          0.975          0.995
   3     594         2     0.982 0.00545          0.971          0.992
   6     592         7     0.970 0.00693          0.957          0.984
  12     585        16     0.944 0.00939          0.925          0.962
  18     569        17     0.915 0.01133          0.893          0.938
  24     552        12     0.896 0.01246          0.871          0.920
  36     540        26     0.852 0.01444          0.825          0.881
  48     514        28     0.806 0.01610          0.775          0.838
  60     486        36     0.746 0.01772          0.712          0.782
  72     241        12     0.709 0.01982          0.671          0.749
```

Creat=1 which is **Creatinine ≥ 120**

```
 time n.risk n.event survival std.err lower 95% CI upper 95% CI
    0    303       5    0.983 0.00732        0.969        0.998
    1    298       6    0.964 0.01075        0.943        0.985
    3    292       4    0.950 0.01246        0.926        0.975
    6    288       6    0.931 0.01459        0.903        0.960
   12    282      14    0.884 0.01836        0.849        0.921
   18    268      13    0.842 0.02098        0.801        0.884
   24    255      16    0.789 0.02345        0.744        0.836
   36    239      27    0.700 0.02633        0.650        0.753
   48    212      25    0.617 0.02792        0.565        0.674
   60    187      14    0.571 0.02843        0.518        0.629

Call:survdiff(formula = Surv(Months, Deceased) ~ Creat, data = survivalASA)
          N Observed Expected (O-E)^2/E (O-E)^2/V
Creat=0 603      165    205.1      7.84      25.9
Creat=1 303      130     89.9     17.87      25.9

 Chisq= 25.9  on 1 degrees of freedom, p= 3.55e-007
```

Aneurysm Related Deaths and Creatinine

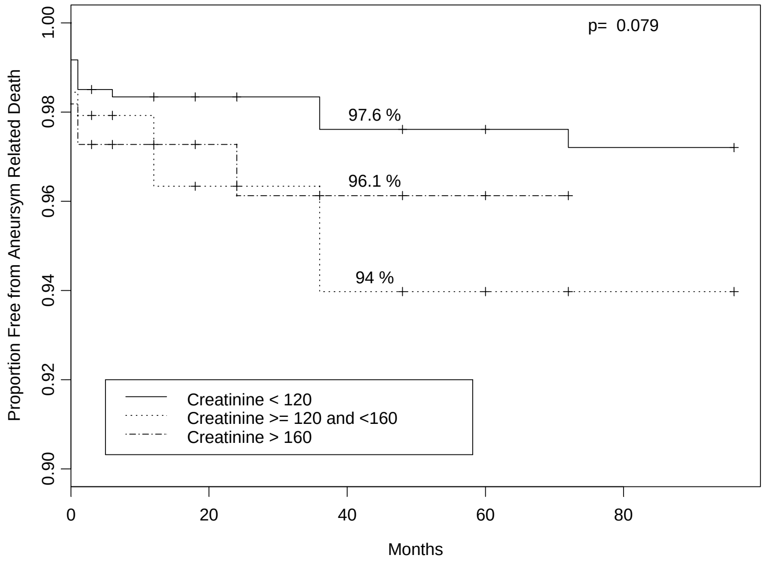


Figure 27 Freedom from ARD stratified by Creatinine

Creatinine was found to statistically significantly contribute to predict aneurysm related deaths, but only when the120 creatinine level boundary was used. Refer to Figure 30 below.

Survival tables follow.

Creatinine < 120 Creat3=0

time	n.risk	n.event	survival	std.err	lower 95% CI	upper 95% CI
0	603	5	0.992	0.00369	0.984	0.999
1	598	4	0.985	0.00494	0.975	0.995
6	592	1	0.983	0.00520	0.973	0.994
36	540	4	0.976	0.00631	0.964	0.989
72	241	1	0.972	0.00747	0.958	0.987

Creatinine ≥ 120 and < 160 Creat3=1

time	n.risk	n.event	survival	std.err	lower 95% CI	upper 95% CI
0	193	3	0.984	0.0089	0.967	1.000
1	190	1	0.979	0.0103	0.959	1.000
12	185	3	0.963	0.0136	0.937	0.990
36	163	4	0.940	0.0177	0.906	0.975

Creatinine > 160 Creat3=

time	n.risk	n.event	survival	std.err	lower 95% CI	upper 95% CI
0	110	2	0.982	0.0127	0.957	1.000
1	108	1	0.973	0.0155	0.943	1.000
24	85	1	0.961	0.0191	0.925	0.999

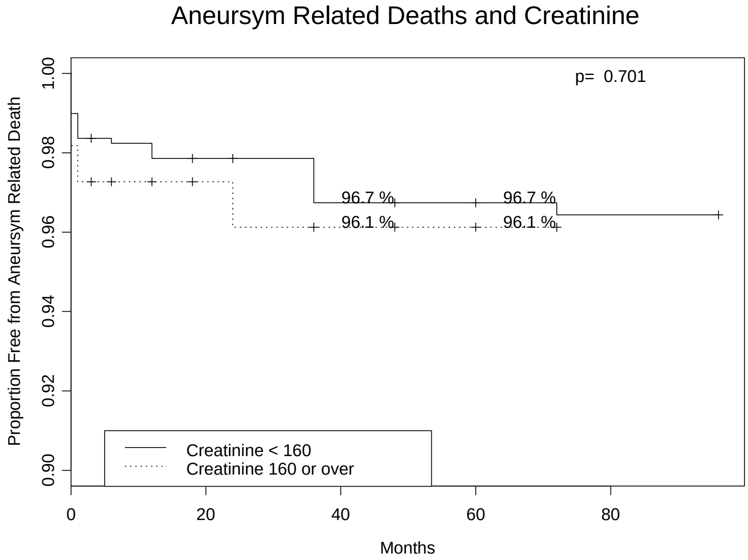


Figure 28 Freedom from ARD using 160 Creatinine limit

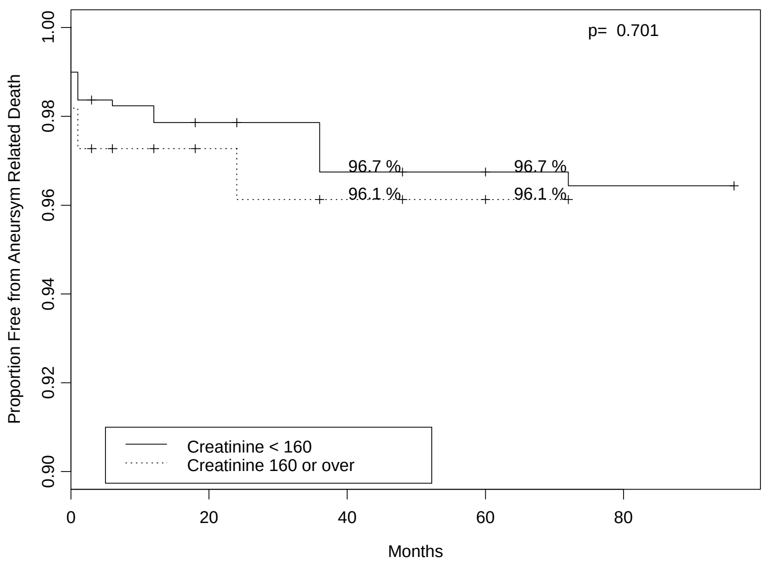


Figure 29 Freedom from ARD using 160 Creatinine limit

```
Call: survfit(formula = Surv(IntervalEndMonths, AneurRelatedDeath) ~ Creat160, data = survivalASA)

                Creat160=0   which is  Creatinine < 160
 time n.risk n.event survival std.err lower 95% CI upper 95% CI
    0    796       8    0.990 0.00354        0.983        0.997
    1    788       5    0.984 0.00449        0.975        0.993
    6    779       1    0.982 0.00466        0.973        0.992
   12    770       3    0.979 0.00514        0.969        0.989
   36    703       8    0.967 0.00641        0.955        0.980
   72    315       1    0.964 0.00709        0.951        0.978

                Creat160=1   which is  Creatinine ≥ 160
 time n.risk n.event survival std.err lower 95% CI upper 95% CI
    0    110       2    0.982  0.0127        0.957        1.000
    1    108       1    0.973  0.0155        0.943        1.000
   24     85       1    0.961  0.0191        0.925        0.999

survdiff(formula = Surv(Months, AneurRelatedDeath) ~ Creat160, data = survivalASA)
             N Observed Expected (O-E)^2/E (O-E)^2/V
Creat160=0 796       26    26.66    0.0163     0.147
Creat160=1 110        4     3.34    0.1301     0.147
 Chisq= 0.1  on 1 degrees of freedom, p= 0.701
```

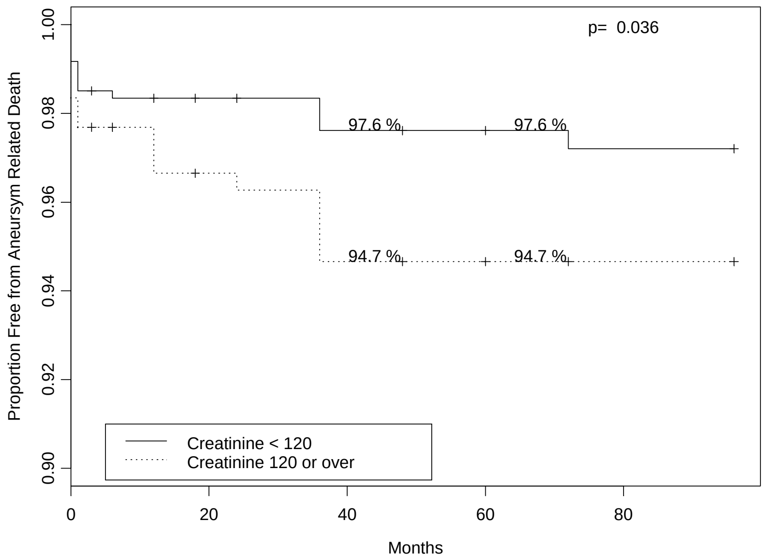


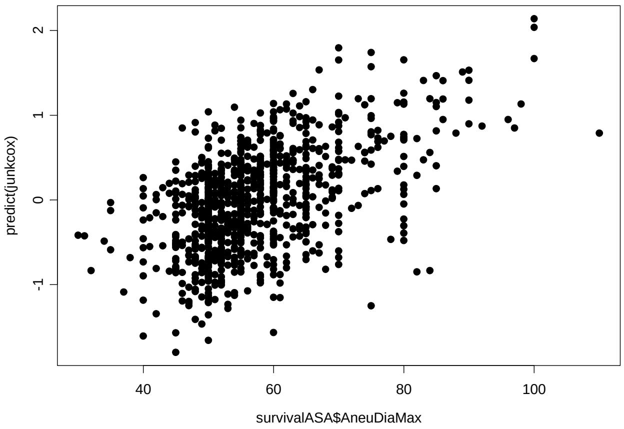
Figure 30 Freedom from ARD using 120 Creatinine limit

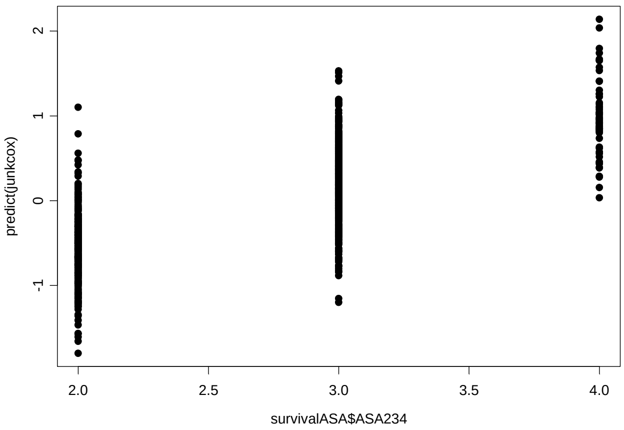
```
Call: survfit(formula = Surv(IntervalEndMonths, AneurRelatedDeath) ~ Creat,data = survivalASA)

                Creat=0 which is  Creatinine < 120
 time n.risk n.event survival std.err lower 95% CI upper 95% CI
    0    603       5    0.992 0.00369        0.984        0.999
    1    598       4    0.985 0.00494        0.975        0.995
    6    592       1    0.983 0.00520        0.973        0.994
   36    540       4    0.976 0.00631        0.964        0.989
   72    241       1    0.972 0.00747        0.958        0.987

                Creat=1 which is  Creatinine ≥ 120
 time n.risk n.event survival std.err lower 95% CI upper 95% CI
    0    303       5    0.983 0.00732        0.969        0.998
    1    298       2    0.977 0.00863        0.960        0.994
   12    282       3    0.967 0.01042        0.946        0.987
   24    255       1    0.963 0.01104        0.941        0.985
   36    239       4    0.947 0.01348        0.921        0.973

survdiff(formula = Surv(Months, AneurRelatedDeath) ~ Creat, data = survivalASA)
          N Observed Expected (O-E)^2/E (O-E)^2/V
Creat=0 603       15    20.36      1.41      4.42
Creat=1 303       15     9.64      2.98      4.42

 Chisq= 4.4  on 1 degrees of freedom, p= 0.0355  if limit is 120 creatinine
```

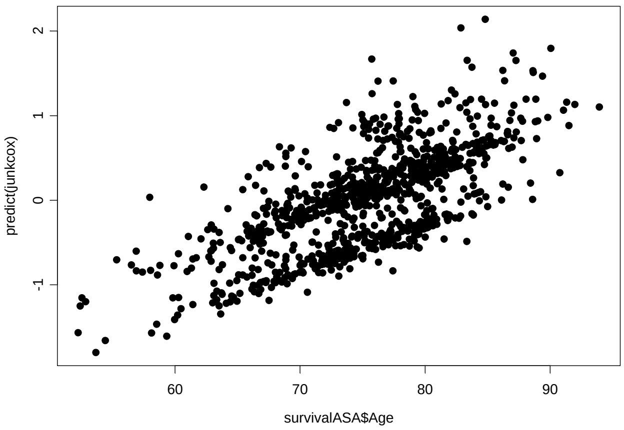
Appendix 0 - Cox-proportional hazards model

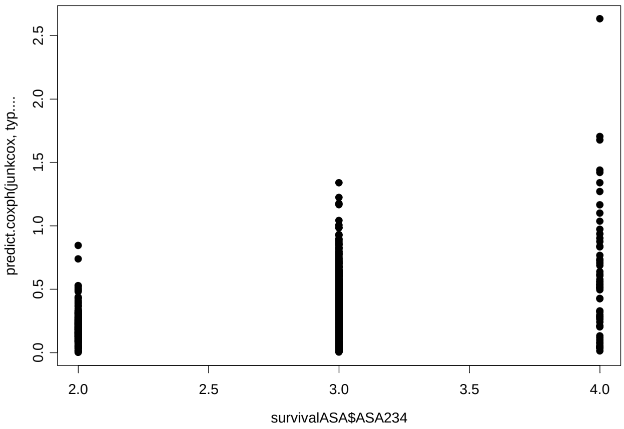
The cox-proportional hazards model is arguably the best choice to use for the continuous variables. However it cannot be plotted in the same format.

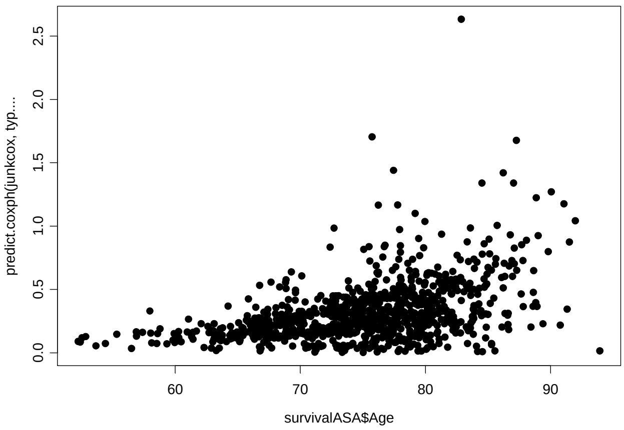
```
junkcox <- coxph(formula= Surv(Months, Deceased) ~ASA234 + Age + AneuDiaMax,
data=survivalASA)

summary(junkcox)
Call:
coxph(formula = Surv(Months, Deceased) ~ ASA234 + Age + AneuDiaMax, data = survivalASA)

  n= 918

             coef exp(coef) se(coef)    z        p
    ASA234 0.6001      1.82  0.10452 5.74 9.4e-009
       Age 0.0517      1.05  0.00927 5.58 2.4e-008
AneuDiaMax 0.0204      1.02  0.00501 4.07 4.6e-005

           exp(coef) exp(-coef) lower .95 upper .95
    ASA234      1.82      0.549      1.48      2.24
       Age      1.05      0.950      1.03      1.07
AneuDiaMax      1.02      0.980      1.01      1.03

Rsquare= 0.11   (max possible= 0.985 )
Likelihood ratio test= 106  on 3 df,   p=0
Wald test            = 109  on 3 df,   p=0
Score (logrank) test = 110  on 3 df,   p=0


plot(survivalASA$ASA234,predict(junkcox))
 plot(survivalASA$Age,predict(junkcox))
 plot(survivalASA$AneuDiaMax, predict(junkcox))

plot(survivalASA$ASA234, predict.coxph(junkcox, type='expected'))
 plot(survivalASA$Age, predict.coxph(junkcox, type='expected'))
 plot(survivalASA$AneuDiaMax, predict.coxph(junkcox, type='expected'))
```

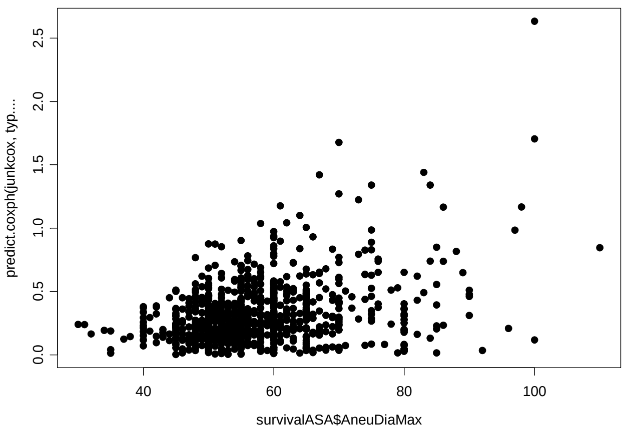

predict(junkcox)
survivalASA$AneuDiaMax


predict(junkcox)
survivalASA$ASA234


predict(junkcox)
survivalASA$Age







Cox proportional hazards method appears to predict the number who will die quite well.

Appendix 1 - Survival - SPLUS output

In tables note that

n.risk	= number at risk
time	= Time (months)
n.risk	= Number entering this interval
n.event	= Number of deaths or number of aneurysm related deaths
survival	= Proportion surviving (survival rate)
std.err	= Survival Standard error
lower 95% CI	= Lower 95%Confidence interval around proportion surviving
Upper 95%CI	= Upper 95%Confidence interval around proportion surviving

```
> #S code
> ########################################
> #   Survival Aust. Endo repair of AAA
> #######################################
>
>
> summary(survfit(Surv(IntervalEndMonths, Deceased), data=Survival) )
Call: survfit(formula = Surv(IntervalEndMonths, Deceased), data = Survival)

 time n.risk n.event survival std.err lower 95% CI upper 95% CI
    0    960      10    0.990 0.00328        0.983        0.996
    1    950      11    0.978 0.00472        0.969        0.987
    3    939       7    0.971 0.00543        0.960        0.982
    6    932      13    0.957 0.00653        0.945        0.970
   12    919      31    0.925 0.00850        0.908        0.942
   18    888      31    0.893 0.00999        0.873        0.913
   24    857      29    0.862 0.01111        0.841        0.885
   36    828      56    0.804 0.01281        0.779        0.830
   48    772      58    0.744 0.01409        0.717        0.772
   60    714      52    0.690 0.01493        0.661        0.719
   72    365      12    0.667 0.01581        0.637        0.699
>
> plot(survfit(Surv(IntervalEndMonths, Deceased),data=Survival), xlab="Months", ylab="Proportion
Surviving" )
>
> junk <- summary(survfit(Surv(IntervalEndMonths, Deceased) ~AorticNeckAngle , data=Survival) )
> junk1 <-  junk[[1]]
>
>
> #  Aortic neck angulation
>
> plot(survfit(Surv(IntervalEndMonths, Deceased) ~AorticNeckAngle , data=Survival) , lty=1:2,
+ xlab="Months", ylab="Proportion Surviving",
+ main="Survival and Aortic Neck Angle")
> legend(40, .2, c("< 45degrees Aortic neck angle", "Significant Aortic Neck Angle >=45degrees"),
lty=1:2)
>
> text(44, 1.06*junk1[8], paste(100*round(junk1[8],3),"%") )
>
> text(44, 1.06*junk1[18], paste(100*round(junk1[18],3),"%") )
>
>
> # Tests of significance
> survdiff(Surv(Months, Deceased) ~AorticNeckAngle , data=Survival)
Call:
survdiff(formula = Surv(Months, Deceased) ~ AorticNeckAngle, data =
       Survival)

                    N Observed Expected (O-E)^2/E (O-E)^2/V
AorticNeckAngle=0 824      259    270.1     0.456      3.57
AorticNeckAngle=1 136       51     39.9     3.089      3.57

 Chisq= 3.6  on 1 degrees of freedom, p= 0.0587
> coxph(formula= Surv(Months, Deceased) ~AorticNeckAngle , data=Survival)
Call:
coxph(formula = Surv(Months, Deceased) ~ AorticNeckAngle, data =
       Survival)


                coef exp(coef) se(coef)    z     p
AorticNeckAngle 0.29      1.34    0.153 1.89 0.058
```

```
Likelihood ratio test=3.35  on 1 df, p=0.0674  n= 960
>
> #junk2 <- survdiff(Surv(Months, Deceased) ~AorticNeckAngle , data=Survival)
> # prop.test( junk2$obs,junk2$n,alt="l")  # DOES NOT WORK
>
> #  Gender
>
> plot(survfit(Surv(IntervalEndMonths, Deceased) ~Gender , data=Survival) , lty=1:2,
+ xlab="Months", ylab="Proportion Surviving")
> legend(40, .2, c("Males", "Females"), lty=1:2)
>
> text(44, 1.06*junk1[8], paste(100*round(junk1[8],3),"%") )
>
> text(44, 1*junk1[18], paste(100*round(junk1[18],3),"%") )
>
>
> # Tests of significance
> survdiff(Surv(Months, Deceased) ~Gender , data=Survival)
Call:
survdiff(formula = Surv(Months, Deceased) ~ Gender, data = Survival)

           N Observed Expected (O-E)^2/E (O-E)^2/V
Gender=1 826      271    265.9    0.0983     0.695
Gender=2 134       39     44.1    0.5924     0.695

 Chisq= 0.7  on 1 degrees of freedom, p= 0.404
> coxph(formula= Surv(Months, Deceased) ~Gender , data=Survival)
Call:
coxph(formula = Surv(Months, Deceased) ~ Gender, data = Survival)


         coef exp(coef) se(coef)      z    p
Gender -0.142     0.867    0.171 -0.831 0.41

Likelihood ratio test=0.72  on 1 df, p=0.398  n= 960
>
>
>
>
> ################
> #Three levels
>
> #  ASA234
>
> survivalASA <- Survival[!is.na(Survival$ASA234),]
>
> summary(survfit(Surv(IntervalEndMonths, Deceased) ~ ASA234, data=survivalASA) )
Call: survfit(formula = Surv(IntervalEndMonths, Deceased) ~ ASA234, data =
       survivalASA)

                ASA234=2
 time n.risk n.event survival std.err lower 95% CI upper 95% CI
    0    322       3    0.991 0.00535        0.980        1.000
    1    319       2    0.984 0.00689        0.971        0.998
    6    317       2    0.978 0.00813        0.962        0.994
   12    315       5    0.963 0.01056        0.942        0.984
   18    310       6    0.944 0.01280        0.919        0.970
   24    304       4    0.932 0.01406        0.905        0.960
   36    300      13    0.891 0.01735        0.858        0.926
   48    287      13    0.851 0.01985        0.813        0.891
   60    274      11    0.817 0.02156        0.776        0.860
   72    151       5    0.790 0.02400        0.744        0.838

                ASA234=3
 time n.risk n.event survival std.err lower 95% CI upper 95% CI
    0    559       6    0.989 0.00436        0.981        0.998
    1    553       5    0.980 0.00587        0.969        0.992
    3    548       3    0.975 0.00661        0.962        0.988
    6    545      10    0.957 0.00857        0.940        0.974
   12    535      22    0.918 0.01162        0.895        0.941
   18    513      21    0.880 0.01374        0.854        0.907
   24    492      22    0.841 0.01547        0.811        0.872
   36    470      38    0.773 0.01772        0.739        0.808
   48    432      32    0.716 0.01908        0.679        0.754
   60    400      36    0.651 0.02016        0.613        0.692
   72    198       7    0.628 0.02124        0.588        0.671

                ASA234=4
 time n.risk n.event survival std.err lower 95% CI upper 95% CI
```

```
    0     63       1    0.984  0.0157        0.954        1.000
    1     62       4    0.921  0.0341        0.856        0.990
    3     58       4    0.857  0.0441        0.775        0.948
    6     54       1    0.841  0.0460        0.756        0.937
   12     53       4    0.778  0.0524        0.682        0.888
   18     49       4    0.714  0.0569        0.611        0.835
   24     45       3    0.667  0.0594        0.560        0.794
   36     42       3    0.619  0.0612        0.510        0.751
   48     39       9    0.476  0.0629        0.368        0.617
   60     30       5    0.397  0.0616        0.293        0.538

>
> junk <- summary(survfit(Surv(IntervalEndMonths, Deceased) ~ASA234 , data=survivalASA) )
> junk1 <-  junk[[1]]
>
> plot(survfit(Surv(IntervalEndMonths, Deceased) ~ASA234 , data=survivalASA) , lty=1:3,
+ xlab="Months", ylab="Proportion Surviving",
+ main="Survival and ASA")
> legend(40, .2, c("ASA 2", "ASA 3", "ASA 4"), lty=1:3)
>
> text(44, 1.04*junk1[7], paste(100*round(junk1[7],3),"%") )
>
> text(44, 1.04*junk1[18], paste(100*round(junk1[18],3),"%") )
>
> text(44, 1.04*junk1[29], paste(100*round(junk1[29],3),"%") )
>
>
>
> text(68, 1.04*junk1[9], paste(100*round(junk1[9],3),"%") )
>
> text(68, 1.04*junk1[20], paste(100*round(junk1[20],3),"%") )
>
> text(68, 1.04*junk1[31], paste(100*round(junk1[31],3),"%") )
>
> ################
> #  Age
>
> summary(survfit(Surv(IntervalEndMonths, Deceased) ~ AgeGroup, data=Survival) )
Call: survfit(formula = Surv(IntervalEndMonths, Deceased) ~ AgeGroup, data
        = Survival)

                AgeGroup=1
 time n.risk n.event survival std.err lower 95% CI upper 95% CI
    0    439       2    0.995 0.00321        0.989        1.000
    1    437       4    0.986 0.00554        0.976        0.997
    3    433       3    0.979 0.00676        0.966        0.993
    6    430       4    0.970 0.00809        0.955        0.986
   12    426      14    0.938 0.01147        0.916        0.961
   18    412      11    0.913 0.01342        0.888        0.940
   24    401       3    0.907 0.01389        0.880        0.934
   36    398      13    0.877 0.01568        0.847        0.908
   48    385      15    0.843 0.01737        0.809        0.878
   60    370      23    0.790 0.01943        0.753        0.829
   72    196       6    0.766 0.02119        0.726        0.809

                AgeGroup=2
 time n.risk n.event survival std.err lower 95% CI upper 95% CI
    0    301       4    0.987 0.00660        0.974        1.000
    1    297       5    0.970 0.00982        0.951        0.990
    3    292       3    0.960 0.01128        0.938        0.982
    6    289       5    0.944 0.01331        0.918        0.970
   12    284       8    0.917 0.01591        0.886        0.949
   18    276      11    0.880 0.01870        0.844        0.918
   24    265      16    0.827 0.02179        0.786        0.871
   36    249      16    0.774 0.02410        0.728        0.823
   48    233      24    0.694 0.02655        0.644        0.748
   60    209      14    0.648 0.02753        0.596        0.704
   72    114       3    0.631 0.02851        0.577        0.689

                AgeGroup=3
 time n.risk n.event survival std.err lower 95% CI upper 95% CI
    0    220       4    0.982 0.00901        0.964        1.000
    1    216       2    0.973 0.01098        0.951        0.994
    3    214       1    0.968 0.01183        0.945        0.992
    6    213       4    0.950 0.01469        0.922        0.979
   12    209       9    0.909 0.01938        0.872        0.948
   18    200       9    0.868 0.02281        0.825        0.914
   24    191      10    0.823 0.02575        0.774        0.875
   36    181      27    0.700 0.03090        0.642        0.763
   48    154      19    0.614 0.03283        0.553        0.681
```

```
   60    135      15    0.545 0.03357        0.483        0.615
   72     55       3    0.516 0.03587        0.450        0.591

>
> junk <- summary(survfit(Surv(IntervalEndMonths, Deceased) ~AgeGroup , data=Survival) )
> junk1 <-  junk[[1]]
>
> plot(survfit(Surv(IntervalEndMonths, Deceased) ~AgeGroup , data=Survival) , lty=1:3,
+ xlab="Months", ylab="Proportion Surviving",
+ main="Survival and Age")
> legend(40, .2, c("<75years", "75-80years", ">80years"), lty=1:3)
>
> text(44, 1.04*junk1[8], paste(100*round(junk1[8],3),"%") )
>
> text(44, 1.04*junk1[19], paste(100*round(junk1[19],3),"%") )
>
> text(44, 1.04*junk1[30], paste(100*round(junk1[30],3),"%") )
>
>
>
> text(68, 1.04*junk1[10], paste(100*round(junk1[10],3),"%") )
>
> text(68, 1.04*junk1[21], paste(100*round(junk1[21],3),"%") )
>
> text(68, 1.04*junk1[32], paste(100*round(junk1[32],3),"%") )
>
>
> # Tests of significance
> survdiff(Surv(Months, Deceased) ~AgeGroup , data=Survival)
Call:
survdiff(formula = Surv(Months, Deceased) ~ AgeGroup, data = Survival
        )

             N Observed Expected (O-E)^2/E (O-E)^2/V
AgeGroup=1 439       98    151.8     19.04     37.65
AgeGroup=2 301      109     94.2      2.31      3.34
AgeGroup=3 220      103     64.0     23.78     30.25

 Chisq= 45.6  on 2 degrees of freedom, p= 1.26e-010
> coxph(formula= Surv(Months, Deceased) ~AgeGroup , data=Survival)
Call:
coxph(formula = Surv(Months, Deceased) ~ AgeGroup, data = Survival)


          coef exp(coef) se(coef)    z        p
AgeGroup 0.459      1.58   0.0692 6.63 3.3e-011

Likelihood ratio test=43.4  on 1 df, p=4.41e-011  n= 960
>
> ####################
> #  Aneurysm Diameter
>
> survivalASA <- Survival[!is.na(Survival$DiaBand),]
>
> summary(survfit(Surv(IntervalEndMonths, Deceased) ~ DiaBand, data=survivalASA) )
Call: survfit(formula = Surv(IntervalEndMonths, Deceased) ~ DiaBand, data
         = survivalASA)

                DiaBand=1
 time n.risk n.event survival std.err lower 95% CI upper 95% CI
    0    410       3    0.993 0.00421        0.984        1.000
    1    407       2    0.988 0.00542        0.977        0.998
    3    405       2    0.983 0.00640        0.970        0.996
    6    403       3    0.976 0.00762        0.961        0.991
   12    400       8    0.956 0.01012        0.936        0.976
   18    392       8    0.937 0.01204        0.913        0.960
   24    384      13    0.905 0.01449        0.877        0.934
   36    371      10    0.880 0.01602        0.850        0.912
   48    361      23    0.824 0.01879        0.788        0.862
   60    338      17    0.783 0.02036        0.744        0.824
   72    184       4    0.766 0.02162        0.725        0.809

                DiaBand=2
 time n.risk n.event survival std.err lower 95% CI upper 95% CI
    0    329       4    0.988 0.00604        0.976        1.000
    1    325       2    0.982 0.00738        0.967        0.996
    3    323       2    0.976 0.00849        0.959        0.992
    6    321       5    0.960 0.01074        0.940        0.982
   12    316      10    0.930 0.01406        0.903        0.958
   18    306      10    0.900 0.01656        0.868        0.933
```

```
   24    296      10    0.869 0.01858        0.834        0.906
   36    286      29    0.781 0.02279        0.738        0.827
   48    257      21    0.717 0.02483        0.670        0.768
   60    236      18    0.663 0.02607        0.613        0.716
   72    111       5    0.633 0.02810        0.580        0.690

                DiaBand=3
 time n.risk n.event survival std.err lower 95% CI upper 95% CI
    0    191       2    0.990 0.00737        0.975        1.000
    1    189       7    0.953 0.01533        0.923        0.983
    3    182       3    0.937 0.01756        0.903        0.972
    6    179       4    0.916 0.02005        0.878        0.956
   12    175      13    0.848 0.02597        0.799        0.901
   18    162      13    0.780 0.02997        0.724        0.841
   24    149       6    0.749 0.03139        0.690        0.813
   36    143      15    0.670 0.03402        0.607        0.740
   48    128      12    0.607 0.03534        0.542        0.681
   60    116      13    0.539 0.03607        0.473        0.615
   72     55       1    0.529 0.03672        0.462        0.607

>
> junk <- summary(survfit(Surv(IntervalEndMonths, Deceased) ~DiaBand , data=survivalASA) )
> junk1 <-  junk[[1]]
>
> plot(survfit(Surv(IntervalEndMonths, Deceased) ~DiaBand , data=survivalASA) , lty=1:3,
+ xlab="Months", ylab="Proportion Surviving",
+ main="Survival relative to Anuerysm Size?")
> legend(40, .2, c("<55mm", "55-65mm", ">=65mm"), lty=1:3)
>
>
> text(44, 1.04*junk1[8], paste(100*round(junk1[8],3),"%") )
>
> text(44, 1.04*junk1[19], paste(100*round(junk1[19],3),"%") )
>
> text(44, 1.04*junk1[30], paste(100*round(junk1[30],3),"%") )
>
>
>
> text(68, 1.04*junk1[10], paste(100*round(junk1[10],3),"%") )
>
> text(68, 1.04*junk1[21], paste(100*round(junk1[21],3),"%") )
>
> text(68, 1.05*junk1[32], paste(100*round(junk1[32],3),"%") )
>
> # Tests of significance
> survdiff(Surv(Months, Deceased) ~DiaBand , data=survivalASA)
Call:
survdiff(formula = Surv(Months, Deceased) ~ DiaBand, data =
        survivalASA)

            N Observed Expected (O-E)^2/E (O-E)^2/V
DiaBand=1 410       93    141.2     16.44     31.51
DiaBand=2 329      116    103.7      1.47      2.26
DiaBand=3 191       89     53.1     24.18     29.66

 Chisq= 42.4  on 2 degrees of freedom, p= 6.06e-010
> coxph(formula= Surv(Months, Deceased) ~DiaBand , data=survivalASA)
Call:
coxph(formula = Surv(Months, Deceased) ~ DiaBand, data = survivalASA)


        coef exp(coef) se(coef)   z        p
DiaBand 0.47       1.6   0.0733 6.4 1.5e-010

Likelihood ratio test=40.3  on 1 df, p=2.22e-010  n= 930
>
> ################
>
> ###################
> #  Infrarenal Neck Length
>
> survivalASA <- Survival[!is.na(Survival$InfraNeck),]
>
> summary(survfit(Surv(IntervalEndMonths, Deceased) ~ InfraNeck, data=survivalASA) )
Call: survfit(formula = Surv(IntervalEndMonths, Deceased) ~ InfraNeck,
        data = survivalASA)

                InfraNeck=1
 time n.risk n.event survival std.err lower 95% CI upper 95% CI
    0     83       1    0.988  0.0120        0.965        1.000
```

```
    1     82       4    0.940  0.0261        0.890        0.992
    3     78       1    0.928  0.0284        0.874        0.985
    6     77       3    0.892  0.0341        0.827        0.961
   12     74       4    0.843  0.0399        0.769        0.925
   24     70       1    0.831  0.0411        0.755        0.916
   36     69       6    0.759  0.0469        0.672        0.857
   48     63       3    0.723  0.0491        0.633        0.826
   60     60       3    0.687  0.0509        0.594        0.794

                InfraNeck=2
 time n.risk n.event survival std.err lower 95% CI upper 95% CI
    6    134       1    0.993 0.00743        0.978        1.000
   12    133       2    0.978 0.01278        0.953        1.000
   18    131       4    0.948 0.01922        0.911        0.986
   24    127       2    0.933 0.02162        0.891        0.976
   36    125       6    0.888 0.02724        0.836        0.943
   48    119       8    0.828 0.03257        0.767        0.895
   60    111       8    0.769 0.03643        0.700        0.843
   72     54       2    0.740 0.04026        0.665        0.823

                InfraNeck=3
 time n.risk n.event survival std.err lower 95% CI upper 95% CI
    0    652       7    0.989 0.00404        0.981        0.997
    1    645       7    0.979 0.00568        0.967        0.990
    3    638       4    0.972 0.00642        0.960        0.985
    6    634       7    0.962 0.00752        0.947        0.977
   12    627      24    0.925 0.01032        0.905        0.945
   18    603      25    0.887 0.01242        0.862        0.911
   24    578      21    0.854 0.01382        0.828        0.882
   36    557      37    0.798 0.01574        0.767        0.829
   48    520      37    0.741 0.01716        0.708        0.775
   60    483      31    0.693 0.01806        0.659        0.730
   72    239       5    0.679 0.01881        0.643        0.717

>
> junk <- summary(survfit(Surv(IntervalEndMonths, Deceased) ~InfraNeck , data=survivalASA) )
> junk1 <-  junk[[1]]
>
> junk2 <- as.numeric( junk$time)
> junk3 <- c(which(junk2==36),which(junk2==60) )
>
>
> plot(survfit(Surv(IntervalEndMonths, Deceased) ~InfraNeck , data=survivalASA) , lty=1:3,
+ xlab="Months", ylab="Proportion Surviving",
+ main="Survival and Infrarenal Neck Length")
> legend(40, .2, c("<15mm", "15-20mm", ">=20mm"), lty=1:3)
>
>
> text(44, 1.04*junk1[junk3[1]], paste(100*round(junk1[junk3[1]],3),"%") )
> text(44, 1.04*junk1[junk3[2]], paste(100*round(junk1[junk3[2]],3),"%") )
> text(44, 1.04*junk1[junk3[3]], paste(100*round(junk1[junk3[3]],3),"%") )
>
> text(68, 1.04*junk1[junk3[4]], paste(100*round(junk1[junk3[4]],3),"%") )
> text(68, 1.04*junk1[junk3[5]], paste(100*round(junk1[junk3[5]],3),"%") )
> text(68, 1.04*junk1[junk3[6]], paste(100*round(junk1[junk3[6]],3),"%") )
>
> # Tests of significance
> survdiff(Surv(Months, Deceased) ~InfraNeck , data=survivalASA)
Call:
survdiff(formula = Surv(Months, Deceased) ~ InfraNeck, data =
       survivalASA)

              N Observed Expected (O-E)^2/E (O-E)^2/V
InfraNeck=1  83       26     24.2     0.140     0.155
InfraNeck=2 134       33     43.5     2.534     3.053
InfraNeck=3 652      205    196.3     0.382     1.500

 Chisq= 3.1  on 2 degrees of freedom, p= 0.215
> coxph(formula= Surv(Months, Deceased) ~InfraNeck , data=survivalASA)
Call:
coxph(formula = Surv(Months, Deceased) ~ InfraNeck, data =
       survivalASA)


            coef exp(coef) se(coef)     z    p
InfraNeck 0.0653      1.07   0.0995 0.656 0.51
```

Likelihood ratio test=0.44 on 1 df, p=0.507 n= 869
NOT STAT SIGN>

Does Size add to Age

```
> survdiff(Surv(Months, Deceased) ~AgeGroup, data=survivalASA)
Call:
survdiff(formula = Surv(Months, Deceased) ~ AgeGroup, data =
        survivalASA)

             N Observed Expected (O-E)^2/E (O-E)^2/V
AgeGroup=1 428       95    146.6     18.15     36.04
AgeGroup=2 288      104     89.5      2.35      3.38
AgeGroup=3 214       99     61.9     22.21     28.30

 Chisq= 43.1  on 2 degrees of freedom, p= 4.3e-010
> survdiff(Surv(Months, Deceased) ~AgeGroup +  DiaBand, data=survivalASA)
Call:
survdiff(formula = Surv(Months, Deceased) ~ AgeGroup + DiaBand, data
         = survivalASA)

                        N Observed Expected (O-E)^2/E (O-E)^2/V
AgeGroup=1, DiaBand=1 213       31     77.4    27.783    37.861
AgeGroup=1, DiaBand=2 141       35     47.8     3.444     4.131
AgeGroup=1, DiaBand=3  74       29     21.4     2.716     2.946
AgeGroup=2, DiaBand=1 122       36     40.3     0.466     0.543
AgeGroup=2, DiaBand=2 100       42     29.8     5.035     5.634
AgeGroup=2, DiaBand=3  66       26     19.4     2.236     2.408
AgeGroup=3, DiaBand=1  75       26     23.5     0.269     0.295
AgeGroup=3, DiaBand=2  88       39     26.1     6.408     7.075
AgeGroup=3, DiaBand=3  51       34     12.4    37.896    39.848

 Chisq= 87.2  on 8 degrees of freedom, p= 1.67e-015
>
```

Additonal 44 (87-43) Chi-Squared with 6 degrees of freedom.

The corresponding p-vlaue is p=7.1e-10

This suggests that Aneurysm Size does add stat sign to the survival model.

Further evidence that Diameter is adding to the model is to use the Cox proportional hazards ratio.

Likelihood ratio test=**73.6** on 2 df, p=1.11e-016 n= 930

Does Size add to ASA ?

Similarly it can be shown that Anue Dia adds stat sign to the model for ASA

```
> survivalASA <- Survival[!is.na(Survival$DiaBand),]
> survivalASA <- survivalASA[!is.na(survivalASA$ASA234),]
>
> survdiff(Surv(Months, Deceased) ~ASA234, data=survivalASA)
```

```
Call:
survdiff(formula = Surv(Months, Deceased) ~ ASA234, data =
        survivalASA)

           N Observed Expected (O-E)^2/E (O-E)^2/V
ASA234=2 315       62      111     21.57      35.0
ASA234=3 541      195      168      4.29      10.1
ASA234=4  62       37       15     32.51      34.5
```

Chisq= 59

```
  on 2 degrees of freedom, p= 1.55e-013
> survdiff(Surv(Months, Deceased) ~ASA234 +  DiaBand, data=survivalASA)
Call:
survdiff(formula = Surv(Months, Deceased) ~ ASA234 + DiaBand, data =
        survivalASA)

                      N Observed Expected (O-E)^2/E (O-E)^2/V
ASA234=2, DiaBand=1 180       29    64.57     19.60     25.32
ASA234=2, DiaBand=2  87       23    29.63      1.48      1.66
ASA234=2, DiaBand=3  48       10    16.70      2.69      2.87
ASA234=3, DiaBand=1 216       58    72.15      2.78      3.70
ASA234=3, DiaBand=2 209       76    65.46      1.70      2.20
ASA234=3, DiaBand=3 116       61    30.53     30.42     34.22
ASA234=4, DiaBand=1   9        5     2.54      2.39      2.43
ASA234=4, DiaBand=2  29       15     7.37      7.91      8.17
ASA234=4, DiaBand=3  24       17     5.05     28.31     29.03
```

Chisq= 98.4 on 8 degrees of freedom, p= 0

Chi	n	p
39.4	6	6E-07

```
>
>
> coxph(formula= Surv(Months, Deceased) ~ASA234, data=survivalASA)
Call:
coxph(formula = Surv(Months, Deceased) ~ ASA234, data = survivalASA)


        coef exp(coef) se(coef)   z        p
ASA234 0.748      2.11    0.102 7.3 2.9e-013

Likelihood ratio test=53.3  on 1 df, p=2.85e-013  n= 918
> coxph(formula= Surv(Months, Deceased) ~ASA234 + DiaBand , data=survivalASA)
Call:
coxph(formula = Surv(Months, Deceased) ~ ASA234 + DiaBand, data =
        survivalASA)
```

```
        coef exp(coef) se(coef)    z        p
 ASA234 0.644      1.90   0.1028 6.26 3.7e-010
DiaBand 0.392      1.48   0.0762 5.14 2.8e-007

Likelihood ratio test=79.3  on 2 df, p=0  n= 918
>
```

Chi	n	p
44.1	6	7.06E-08
87.2	8	1.72E-15
43.1	2	4.37E-10

```
> survdiff(Surv(Months, Deceased) ~ASA234, data=survivalASA)
Call:
survdiff(formula = Surv(Months, Deceased) ~ ASA234, data =
       survivalASA)

           N Observed Expected (O-E)^2/E (O-E)^2/V
ASA234=2 322       64    114.4     22.20      35.9
ASA234=3 559      202    174.5      4.35      10.3
ASA234=4  63       38     15.1     34.47      36.6

 Chisq= 61.7  on 2 degrees of freedom, p= 3.97e-014
> survdiff(Surv(Months, Deceased) ~ASA234 +  AgeGroup, data=survivalASA)
Call:
survdiff(formula = Surv(Months, Deceased) ~ ASA234 + AgeGroup, data
        = survivalASA)

                       N Observed Expected (O-E)^2/E (O-E)^2/V
ASA234=2, AgeGroup=1 174       26    63.86    22.448    28.662
ASA234=2, AgeGroup=2  94       23    32.65     2.853     3.222
ASA234=2, AgeGroup=3  54       15    17.88     0.464     0.497
ASA234=3, AgeGroup=1 236       58    79.15     5.651     7.696
ASA234=3, AgeGroup=2 174       69    53.00     4.832     5.894
ASA234=3, AgeGroup=3 149       75    42.31    25.256    29.606
ASA234=4, AgeGroup=1  19       10     5.03     4.912     5.030
ASA234=4, AgeGroup=2  28       16     6.66    13.101    13.497
ASA234=4, AgeGroup=3  16       12     3.46    21.084    21.500

 Chisq= 102  on 8 degrees of freedom, p= 0
>
>
> coxph(formula= Surv(Months, Deceased) ~ASA234, data=survivalASA)
Call:
coxph(formula = Surv(Months, Deceased) ~ ASA234, data = survivalASA)
```

```
        coef exp(coef) se(coef)    z      p
ASA234 0.753      2.12    0.101 7.44 1e-013

Likelihood ratio test=55.4  on 1 df, p=9.79e-014  n= 944
> coxph(formula= Surv(Months, Deceased) ~ASA234 + AgeGroup , data=survivalASA)
Call:
coxph(formula = Surv(Months, Deceased) ~ ASA234 + AgeGroup, data =
        survivalASA)


          coef exp(coef) se(coef)    z        p
  ASA234 0.692      2.00   0.1027 6.74 1.6e-011
AgeGroup 0.412      1.51   0.0706 5.84 5.2e-009

Likelihood ratio test=89.2  on 2 df, p=0  n= 944
>
> ##############
```

Does Size add to Age and ASA model

```
>
> survivalASA <- Survival[!is.na(Survival$DiaBand),]
> survivalASA <- survivalASA[!is.na(survivalASA$ASA234),]
>
> survdiff(Surv(Months, Deceased) ~ASA234 +  AgeGroup, data=survivalASA)
Call:
survdiff(formula = Surv(Months, Deceased) ~ ASA234 + AgeGroup, data
         = survivalASA)

                       N Observed Expected (O-E)^2/E (O-E)^2/V
ASA234=2, AgeGroup=1 168       25    61.13    21.358     27.19
ASA234=2, AgeGroup=2  94       23    32.43     2.740      3.10
ASA234=2, AgeGroup=3  53       14    17.35     0.645      0.69
ASA234=3, AgeGroup=1 231       56    77.12     5.783      7.90
ASA234=3, AgeGroup=2 164       65    49.67     4.732      5.73
ASA234=3, AgeGroup=3 146       74    41.35    25.774     30.26
ASA234=4, AgeGroup=1  19       10     5.03     4.911      5.03
ASA234=4, AgeGroup=2  28       16     6.68    12.992     13.39
ASA234=4, AgeGroup=3  15       11     3.24    18.586     18.94
```

Chisq= 98.8 on 8 degrees of freedom, p= 0

```
> survdiff(Surv(Months, Deceased) ~ASA234 +  AgeGroup + DiaBand, data=survivalASA)
Call:
survdiff(formula = Surv(Months, Deceased) ~ ASA234 + AgeGroup +
        DiaBand, data = survivalASA)

                                  N Observed Expected (O-E)^2/E
ASA234=2, AgeGroup=1, DiaBand=1  99       12   36.115 16.102111
```

```
ASA234=2, AgeGroup=1, DiaBand=2  45        7   16.956  5.845840
ASA234=2, AgeGroup=1, DiaBand=3  24        6    8.064  0.528319
ASA234=2, AgeGroup=2, DiaBand=1  55       12   19.846  3.102118
ASA234=2, AgeGroup=2, DiaBand=2  23       10    6.711  1.612259
ASA234=2, AgeGroup=2, DiaBand=3  16        1    5.869  4.039280
ASA234=2, AgeGroup=3, DiaBand=1  26        5    8.612  1.514952
ASA234=2, AgeGroup=3, DiaBand=2  19        6    5.963  0.000231
ASA234=2, AgeGroup=3, DiaBand=3   8        3    2.770  0.019015
ASA234=3, AgeGroup=1, DiaBand=1 108       18   38.973 11.286532
ASA234=3, AgeGroup=1, DiaBand=2  82       21   26.976  1.323846
ASA234=3, AgeGroup=1, DiaBand=3  41       17   11.170  3.042936
ASA234=3, AgeGroup=2, DiaBand=1  63       22   19.337  0.366680
ASA234=3, AgeGroup=2, DiaBand=2  60       23   18.769  0.953792
ASA234=3, AgeGroup=2, DiaBand=3  41       20   11.563  6.155174
ASA234=3, AgeGroup=3, DiaBand=1  45       18   13.841  1.249511
ASA234=3, AgeGroup=3, DiaBand=2  67       32   19.717  7.652027
ASA234=3, AgeGroup=3, DiaBand=3  34       24    7.795 33.691464
ASA234=4, AgeGroup=1, DiaBand=1   2        0    0.767  0.767411
ASA234=4, AgeGroup=1, DiaBand=2  10        5    2.678  2.012362
ASA234=4, AgeGroup=1, DiaBand=3   7        5    1.584  7.366697
ASA234=4, AgeGroup=2, DiaBand=1   3        2    0.752  2.071518
ASA234=4, AgeGroup=2, DiaBand=2  17        9    4.283  5.196660
ASA234=4, AgeGroup=2, DiaBand=3   8        5    1.648  6.818409
ASA234=4, AgeGroup=3, DiaBand=1   4        3    1.018  3.857938
ASA234=4, AgeGroup=3, DiaBand=2   2        1    0.407  0.864850
ASA234=4, AgeGroup=3, DiaBand=3   9        7    1.815 14.811590

                                (O-E)^2/V
ASA234=2, AgeGroup=1, DiaBand=1 18.495288
ASA234=2, AgeGroup=1, DiaBand=2  6.248259
ASA234=2, AgeGroup=1, DiaBand=3  0.546783
ASA234=2, AgeGroup=2, DiaBand=1  3.353775
ASA234=2, AgeGroup=2, DiaBand=2  1.661212
ASA234=2, AgeGroup=2, DiaBand=3  4.149659
ASA234=2, AgeGroup=3, DiaBand=1  1.571551
ASA234=2, AgeGroup=3, DiaBand=2  0.000237
ASA234=2, AgeGroup=3, DiaBand=3  0.019342
ASA234=3, AgeGroup=1, DiaBand=1 13.114110
ASA234=3, AgeGroup=1, DiaBand=2  1.467384
ASA234=3, AgeGroup=1, DiaBand=3  3.184638
ASA234=3, AgeGroup=2, DiaBand=1  0.395162
ASA234=3, AgeGroup=2, DiaBand=2  1.025953
ASA234=3, AgeGroup=2, DiaBand=3  6.450988
ASA234=3, AgeGroup=3, DiaBand=1  1.320196
ASA234=3, AgeGroup=3, DiaBand=2  8.262272
ASA234=3, AgeGroup=3, DiaBand=3 34.900846
ASA234=4, AgeGroup=1, DiaBand=1  0.774485
ASA234=4, AgeGroup=1, DiaBand=2  2.044524
```

```
ASA234=4, AgeGroup=1, DiaBand=3  7.457854
ASA234=4, AgeGroup=2, DiaBand=1  2.090917
ASA234=4, AgeGroup=2, DiaBand=2  5.310464
ASA234=4, AgeGroup=2, DiaBand=3  6.906267
ASA234=4, AgeGroup=3, DiaBand=1  3.898542
ASA234=4, AgeGroup=3, DiaBand=2  0.871790
ASA234=4, AgeGroup=3, DiaBand=3 15.010742

 Chisq= 144  on 26 degrees of freedom, p= 0
>
> coxph(formula= Surv(Months, Deceased) ~ASA234 + AgeGroup , data=survivalASA)
Call:
coxph(formula = Surv(Months, Deceased) ~ ASA234 + AgeGroup, data =
        survivalASA)


          coef exp(coef) se(coef)    z        p
  ASA234 0.691      2.00   0.1039 6.65 2.9e-011
AgeGroup 0.414      1.51   0.0716 5.78 7.5e-009

Likelihood ratio test=86.4  on 2 df, p=0  n= 918
> coxph(formula= Surv(Months, Deceased) ~ASA234 + AgeGroup + DiaBand, data=survivalASA)
Call:
coxph(formula = Surv(Months, Deceased) ~ ASA234 + AgeGroup + DiaBand,
        data = survivalASA)


          coef exp(coef) se(coef)    z        p
  ASA234 0.600      1.82   0.1044 5.75 8.9e-009
AgeGroup 0.384      1.47   0.0722 5.31 1.1e-007
 DiaBand 0.354      1.42   0.0769 4.60 4.2e-006

Likelihood ratio test=107  on 3 df, p=0  n= 918
>
```

Chi	n	p
45.2	18	0.000388

Actual months tables

time	n.risk	n.event	survival	std.err	lower 95% CI	upper 95% CI
0	961	16	0.983	0.00413	0.975	0.991
1	945	11	0.972	0.00533	0.962	0.982
2	934	2	0.970	0.00552	0.959	0.981
3	932	5	0.965	0.00596	0.953	0.976
4	927	6	0.958	0.00644	0.946	0.971
5	921	2	0.956	0.00659	0.943	0.969
6	919	5	0.951	0.00696	0.938	0.965
7	914	8	0.943	0.00749	0.928	0.958
8	906	5	0.938	0.00780	0.922	0.953
9	901	6	0.931	0.00816	0.915	0.947
10	895	3	0.928	0.00833	0.912	0.945
11	892	4	0.924	0.00855	0.907	0.941
12	888	6	0.918	0.00886	0.901	0.935
13	882	6	0.912	0.00916	0.894	0.930
14	876	3	0.908	0.00930	0.890	0.927
15	873	7	0.901	0.00963	0.882	0.920
16	866	6	0.895	0.00989	0.876	0.915
17	860	7	0.888	0.01019	0.868	0.908
18	853	2	0.886	0.01027	0.866	0.906
19	851	6	0.879	0.01051	0.859	0.900
20	845	3	0.876	0.01063	0.856	0.897
21	842	4	0.872	0.01078	0.851	0.893
22	838	11	0.861	0.01117	0.839	0.883
23	827	5	0.855	0.01135	0.833	0.878
25	822	4	0.851	0.01148	0.829	0.874
26	818	5	0.846	0.01164	0.823	0.869
27	813	4	0.842	0.01177	0.819	0.865
28	809	3	0.839	0.01186	0.816	0.862
29	806	2	0.837	0.01193	0.814	0.860
30	804	9	0.827	0.01219	0.804	0.852
31	795	6	0.821	0.01237	0.797	0.846
32	789	3	0.818	0.01245	0.794	0.843
33	786	6	0.812	0.01261	0.787	0.837
34	780	6	0.805	0.01277	0.781	0.831
35	774	6	0.799	0.01292	0.774	0.825
36	768	3	0.796	0.01300	0.771	0.822
37	765	4	0.792	0.01310	0.767	0.818
38	761	2	0.790	0.01314	0.764	0.816
39	759	2	0.788	0.01319	0.762	0.814
40	757	5	0.783	0.01331	0.757	0.809
41	752	9	0.773	0.01351	0.747	0.800
42	743	2	0.771	0.01355	0.745	0.798
43	741	10	0.761	0.01376	0.734	0.788
44	731	5	0.755	0.01386	0.729	0.783
45	726	4	0.751	0.01394	0.724	0.779
46	722	4	0.747	0.01402	0.720	0.775
47	718	3	0.744	0.01408	0.717	0.772
48	715	7	0.737	0.01421	0.709	0.765
49	708	7	0.729	0.01433	0.702	0.758
50	701	4	0.725	0.01440	0.698	0.754
51	697	3	0.722	0.01445	0.694	0.751
52	691	3	0.719	0.01450	0.691	0.748
53	661	5	0.714	0.01459	0.686	0.743
54	623	4	0.709	0.01468	0.681	0.738
55	570	5	0.703	0.01481	0.674	0.732
56	532	2	0.700	0.01487	0.672	0.730
57	503	3	0.696	0.01498	0.667	0.726
58	462	2	0.693	0.01506	0.664	0.723
59	432	7	0.682	0.01541	0.652	0.713
60	373	2	0.678	0.01554	0.648	0.709
61	351	3	0.672	0.01576	0.642	0.704
63	274	2	0.667	0.01602	0.637	0.700
64	231	1	0.664	0.01621	0.633	0.697
66	158	2	0.656	0.01706	0.623	0.690
67	116	2	0.645	0.01855	0.609	0.682
68	87	2	0.630	0.02088	0.590	0.672

```
plot(survfit(Surv(Survival$Months, Survival$Deceased)))
summary(survfit(Surv(Months, Deceased) ~Aortic.neck.angulation , data=Survival) )
plot(survfit(Surv(Months, Deceased) ~Aortic.neck.angulation , data=Survival) , lty=2:3)
legend(40, 1, c(“Minimal aortic neck angulation”, “Significant Aortic.neck.angulation”), lty=2:3)
```

```
Call: survfit(formula = Surv(Months, Deceased) ~ Aortic.neck.an
```

gulation, data = Survival)

Aortic.neck.angulation=0

time	n.risk	n.event	survival	std.err	lower 95% CI	upper 95% CI
0	732	12	0.984	0.00469	0.974	0.993
1	720	5	0.977	0.00557	0.966	0.988
2	715	2	0.974	0.00588	0.963	0.986
3	713	4	0.969	0.00645	0.956	0.981
4	709	4	0.963	0.00697	0.950	0.977
5	705	1	0.962	0.00709	0.948	0.976
6	704	3	0.958	0.00744	0.943	0.972
7	701	8	0.947	0.00830	0.931	0.963
8	693	4	0.941	0.00869	0.924	0.958
9	689	5	0.934	0.00915	0.917	0.953
10	684	2	0.932	0.00932	0.914	0.950
11	682	3	0.928	0.00958	0.909	0.947
12	679	4	0.922	0.00990	0.903	0.942
13	675	5	0.915	0.01029	0.895	0.936
14	670	2	0.913	0.01044	0.892	0.933
15	668	6	0.904	0.01087	0.883	0.926
16	662	2	0.902	0.01101	0.880	0.923
17	660	5	0.895	0.01134	0.873	0.917
18	655	2	0.892	0.01147	0.870	0.915
19	653	6	0.884	0.01184	0.861	0.907
21	647	3	0.880	0.01202	0.857	0.904
22	644	7	0.870	0.01242	0.846	0.895
23	637	3	0.866	0.01259	0.842	0.891
25	634	2	0.863	0.01269	0.839	0.889
26	632	4	0.858	0.01290	0.833	0.884
27	628	3	0.854	0.01306	0.829	0.880
28	625	2	0.851	0.01316	0.826	0.877
29	623	2	0.848	0.01326	0.823	0.875
30	621	3	0.844	0.01340	0.818	0.871
31	618	5	0.837	0.01364	0.811	0.865
32	613	2	0.835	0.01373	0.808	0.862
33	611	3	0.831	0.01386	0.804	0.858
34	608	5	0.824	0.01408	0.797	0.852
35	603	6	0.816	0.01433	0.788	0.844
36	597	2	0.813	0.01442	0.785	0.842
37	595	4	0.807	0.01458	0.779	0.836
38	591	2	0.805	0.01465	0.776	0.834
39	589	1	0.803	0.01469	0.775	0.833
40	588	3	0.799	0.01481	0.771	0.829
41	585	6	0.791	0.01503	0.762	0.821
42	579	2	0.788	0.01510	0.759	0.818
43	577	7	0.779	0.01534	0.749	0.809
44	570	5	0.772	0.01551	0.742	0.803
45	565	3	0.768	0.01561	0.738	0.799
46	562	3	0.764	0.01570	0.733	0.795
47	559	3	0.760	0.01580	0.729	0.791
48	556	5	0.753	0.01595	0.722	0.785
49	551	6	0.745	0.01612	0.714	0.777
50	545	3	0.740	0.01620	0.709	0.773
51	542	2	0.738	0.01626	0.707	0.770
52	538	3	0.734	0.01634	0.702	0.766
53	515	4	0.728	0.01646	0.696	0.761
54	485	4	0.722	0.01660	0.690	0.755
55	445	4	0.715	0.01676	0.683	0.749
56	419	2	0.712	0.01685	0.680	0.746
57	400	2	0.708	0.01696	0.676	0.742
58	367	2	0.705	0.01708	0.672	0.739
59	346	3	0.698	0.01729	0.665	0.733
60	303	1	0.696	0.01739	0.663	0.731
61	289	2	0.691	0.01760	0.658	0.727
63	226	2	0.685	0.01797	0.651	0.721
64	191	1	0.682	0.01823	0.647	0.718
66	127	1	0.676	0.01886	0.640	0.714
67	94	2	0.662	0.02102	0.622	0.704
68	70	2	0.643	0.02431	0.597	0.692

Aortic.neck.angulation=1

time	n.risk	n.event	survival	std.err	lower 95% CI	upper 95% CI
0	229	4	0.983	0.00866	0.966	1.000
1	225	6	0.956	0.01350	0.930	0.983
3	219	1	0.952	0.01413	0.925	0.980
4	218	2	0.943	0.01529	0.914	0.974
5	216	1	0.939	0.01583	0.908	0.970
6	215	2	0.930	0.01685	0.898	0.964

8	213	1	0.926	0.01732	0.892	0.960
9	212	1	0.921	0.01778	0.887	0.957
10	211	1	0.917	0.01823	0.882	0.953
11	210	1	0.913	0.01866	0.877	0.950
12	209	2	0.904	0.01947	0.867	0.943
13	207	1	0.900	0.01986	0.861	0.939
14	206	1	0.895	0.02024	0.856	0.936
15	205	1	0.891	0.02061	0.851	0.932
16	204	4	0.873	0.02198	0.831	0.918
17	200	2	0.865	0.02261	0.821	0.910
20	198	3	0.852	0.02350	0.807	0.899
21	195	1	0.847	0.02378	0.802	0.895
22	194	4	0.830	0.02484	0.782	0.880
23	190	2	0.821	0.02533	0.773	0.872
25	188	2	0.812	0.02581	0.763	0.864
26	186	1	0.808	0.02604	0.758	0.861
27	185	1	0.803	0.02626	0.754	0.857
28	184	1	0.799	0.02648	0.749	0.853
30	183	6	0.773	0.02768	0.721	0.829
31	177	1	0.769	0.02787	0.716	0.825
32	176	1	0.764	0.02805	0.711	0.821
33	175	3	0.751	0.02857	0.697	0.809
34	172	1	0.747	0.02874	0.692	0.805
36	171	1	0.742	0.02890	0.688	0.801
39	170	1	0.738	0.02906	0.683	0.797
40	169	2	0.729	0.02936	0.674	0.789
41	167	3	0.716	0.02979	0.660	0.777
43	164	3	0.703	0.03019	0.646	0.765
45	161	1	0.699	0.03032	0.642	0.761
46	160	1	0.694	0.03044	0.637	0.757
48	159	2	0.686	0.03068	0.628	0.748
49	157	1	0.681	0.03079	0.623	0.744
50	156	1	0.677	0.03090	0.619	0.740
51	155	1	0.672	0.03101	0.614	0.736
53	146	1	0.668	0.03114	0.610	0.732
55	125	1	0.663	0.03135	0.604	0.727
57	103	1	0.656	0.03170	0.597	0.721
59	86	4	0.626	0.03369	0.563	0.695
60	70	1	0.617	0.03438	0.553	0.688
61	62	1	0.607	0.03523	0.541	0.680
66	31	1	0.587	0.03916	0.515	0.669

Appendix 2 - Aneurysm Related Deaths – SPLUS Output

In tables note that

n.risk	= number at risk
time	= Time (months)
n.risk	= Number entering this interval
n.event	= Number of deaths or number of aneurysm related deaths
survival	= Proportion surviving (survival rate)
std.err	= Survival Standard error
lower 95% CI	= Lower 95%Confidence interval around proportion surviving
Upper 95%CI	= Upper 95%Confidence interval around proportion surviving

```
> #S code
> ########################################
> #   Survival Aust. Endo repair of AAA
> #######################################
>
> options(width=120)
>
> summary(survfit(Surv(IntervalEndMonths, AneurRelatedDeath), data=Survival) )
Call: survfit(formula = Surv(IntervalEndMonths, AneurRelatedDeath), data = Survival)

 time n.risk n.event survival std.err lower 95% CI upper 95% CI
    0    960      10    0.990 0.00328        0.983        0.996
    1    950       6    0.983 0.00413        0.975        0.991
    6    932       1    0.982 0.00426        0.974        0.991
   12    919       3    0.979 0.00463        0.970        0.988
   24    857       1    0.978 0.00476        0.969        0.987
   36    828       8    0.968 0.00577        0.957        0.980
   60    714       1    0.967 0.00592        0.956        0.979
   72    365       1    0.964 0.00647        0.952        0.977
>
> plot(survfit(Surv(IntervalEndMonths, AneurRelatedDeath),data=Survival),
+ xlab="Months", ylab="Proportion Free from Aneurysm Related Death",
+ ylim=c(.9,1),
+ main="Freedom from Aneurysm Related Deaths")
>
>
> ##########################
> #  Aortic neck angulation
>
> summary(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~ AorticNeckAngle, data=Survival) )
Call: survfit(formula = Surv(IntervalEndMonths, AneurRelatedDeath) ~ AorticNeckAngle, dat
a = Survival)

                AorticNeckAngle=0
 time n.risk n.event survival std.err lower 95% CI upper 95% CI
    0    824       7    0.992 0.00320        0.985        0.998
    1    817       3    0.988 0.00381        0.980        0.995
   12    795       3    0.984 0.00437        0.976        0.993
   24    742       1    0.983 0.00456        0.974        0.992
   36    719       7    0.973 0.00577        0.962        0.985
   60    621       1    0.972 0.00597        0.960        0.983
   72    333       1    0.969 0.00663        0.956        0.982

                AorticNeckAngle=1
 time n.risk n.event survival std.err lower 95% CI upper 95% CI
    0    136       3    0.978  0.0126        0.954        1.000
    1    133       3    0.956  0.0176        0.922        0.991
    6    129       1    0.948  0.0190        0.912        0.986
   36    109       1    0.940  0.0207        0.900        0.981


>
> win.graph()
> plot(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~AorticNeckAngle , data=Survival) ,
lty=1:2,
+ xlab="Months", ylab="Proportion Free from Aneurysm Related Death",
+ ylim=c(.9,1), main="Aneurysm Related Deaths and Aortic Neck Angle")
> legend(5, .91, c("Aortic neck angle < 45 degrees", "Significant Aortic Neck Angle >=45degrees"),
lty=1:2)
>
> junk <- summary(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~AorticNeckAngle ,
data=Survival) )
> junk1 <-  junk[[1]]
> junk2 <- as.numeric( junk$time)
> junk3 <- c(which(junk2==36),which(junk2==60) )
>
> text(44, 1.004*junk1[junk3[1]], paste(100*round(junk1[junk3[1]],3),"%") )
> text(44, 1.004*junk1[junk3[2]], paste(100*round(junk1[junk3[2]],3),"%") )
> text(68, 1.004*junk1[junk3[3]], paste(100*round(junk1[junk3[3]],3),"%") )
> text(68, 1.004*junk1[junk3[4]], paste(100*round(junk1[junk3[4]],3),"%") )
```

```
>
>
> # Tests of significance
> # survdiff(Surv(Months, AneurRelatedDeath) ~AorticNeckAngle , data=Survival)
> # coxph(formula= Surv(Months, AneurRelatedDeath) ~AorticNeckAngle , data=Survival)
> junk4 <- survdiff(Surv(Months, AneurRelatedDeath) ~AorticNeckAngle , data=Survival)
> text(80, 1, paste("p= ",round(1-pchisq(junk4$chisq, 1),3) ) )
>
> #########################
> #  Gender
> summary(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~Gender , data=Survival) )
Call: survfit(formula = Surv(IntervalEndMonths, AneurRelatedDeath) ~ Gender, data = Survi
val)

                Gender=1
 time n.risk n.event survival std.err lower 95% CI upper 95% CI
    0    826      10    0.988 0.00381        0.980        0.995
    1    816       5    0.982 0.00465        0.973        0.991
   12    789       3    0.978 0.00510        0.968        0.988
   36    711       7    0.968 0.00622        0.956        0.981
   60    613       1    0.967 0.00640        0.954        0.980
   72    314       1    0.964 0.00709        0.950        0.978

                Gender=2
 time n.risk n.event survival std.err lower 95% CI upper 95% CI
    1    134       1    0.993 0.00743        0.978        1.000
    6    133       1    0.985 0.01047        0.965        1.000
   24    124       1    0.977 0.01306        0.952        1.000
   36    117       1    0.969 0.01539        0.939        0.999

>
> win.graph()
> plot(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~Gender , data=Survival) , lty=1:2,
+ xlab="Months", ylab="Proportion Free from Aneurysm Related Death",
+ ylim=c(.9,1), main="Aneurysm Related Deaths and Gender")
> legend(5, .91, c("Males", "Females"), lty=1:2)
>
> junk <- summary(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~Gender , data=Survival) )
> junk1 <-  junk[[1]]
> junk2 <- as.numeric( junk$time)
> junk3 <- c(which(junk2==36),which(junk2==60) )
>
> text(44, 1.004*junk1[junk3[1]], paste(100*round(junk1[junk3[1]],3),"%") )
> text(44, 1.004*junk1[junk3[2]], paste(100*round(junk1[junk3[2]],3),"%") )
> text(68, 1.004*junk1[junk3[3]], paste(100*round(junk1[junk3[3]],3),"%") )
> text(68, 1.004*junk1[junk3[4]], paste(100*round(junk1[junk3[4]],3),"%") )
>
> # Tests of significance
> junk4 <- survdiff(Surv(Months, AneurRelatedDeath) ~Gender , data=Survival)
> # coxph(formula= Surv(Months, AneurRelatedDeath) ~Gender , data=Survival)
> text(80, 1, paste("p= ",round(1-pchisq(junk4$chisq, 1),3) ) )
>
>
> ################
> #Three levels
> #########################
> #  ASA234
>
> survivalASA <- Survival[!is.na(Survival$ASA234),]
>
> summary(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~ ASA234, data=survivalASA) )
Call: survfit(formula = Surv(IntervalEndMonths, AneurRelatedDeath) ~ ASA234, data = survi
valASA)

                ASA234=2
 time n.risk n.event survival std.err lower 95% CI upper 95% CI
    0    322       3    0.991 0.00535        0.980        1.000
    1    319       2    0.984 0.00689        0.971        0.998
   36    300       2    0.978 0.00826        0.962        0.994

                ASA234=3
 time n.risk n.event survival std.err lower 95% CI upper 95% CI
    0    559       6    0.989 0.00436        0.981        0.998
    1    553       1    0.987 0.00470        0.978        0.997
    6    545       1    0.986 0.00503        0.976        0.996
   12    535       3    0.980 0.00593        0.969        0.992
   24    492       1    0.978 0.00624        0.966        0.990
   36    470       5    0.968 0.00772        0.953        0.983
   60    400       1    0.965 0.00807        0.950        0.981
   72    198       1    0.960 0.00939        0.942        0.979

                ASA234=4
 time n.risk n.event survival std.err lower 95% CI upper 95% CI
    0     63       1    0.984  0.0157        0.954        1.000
    1     62       3    0.937  0.0307        0.878        0.999
   36     42       1    0.914  0.0372        0.844        0.990

>
> junk <- summary(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~ASA234 , data=survivalASA) )
> junk1 <-  junk[[1]]
>
```

```
> win.graph()
> plot(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~ASA234 , data=survivalASA) , lty=1:3,
+ xlab="Months", ylab="Proportion Free from Aneursym Related Death",
+ ylim=c(.9,1), main="Aneursym Related Deaths and ASA")
> legend(5, .91, c("ASA 2", "ASA 3", "ASA 4"), lty=1:3)
>
> text(44, 1.004*junk1[7], paste(100*round(junk1[7],3),"%") )
> text(44, 1.004*junk1[18], paste(100*round(junk1[18],3),"%") )
> text(44, 1.004*junk1[29], paste(100*round(junk1[29],3),"%") )
>
> text(68, 1.004*junk1[9], paste(100*round(junk1[9],3),"%") )
> text(68, 1.004*junk1[20], paste(100*round(junk1[20],3),"%") )
> text(68, 1.004*junk1[31], paste(100*round(junk1[31],3),"%") )
>
> # Tests of significance
> junk4 <- survdiff(Surv(Months, AneurRelatedDeath) ~ASA234 , data=survivalASA)
> # coxph(formula= Surv(Months, AneurRelatedDeath) ~ASA234 , data=survivalASA)
> text(80, 1, paste("p= ",round(1-pchisq(junk4$chisq, 2),3) ) )
>
> ################
> #  Age
>
> summary(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~ AgeGroup, data=Survival) )
Call: survfit(formula = Surv(IntervalEndMonths, AneurRelatedDeath) ~ AgeGroup, data = Sur
vival)

                AgeGroup=1
 time n.risk n.event survival std.err lower 95% CI upper 95% CI
    0    439       2    0.995 0.00321        0.989        1.000
    1    437       2    0.991 0.00454        0.982        1.000
   12    426       2    0.986 0.00558        0.975        0.997
   36    398       4    0.976 0.00741        0.962        0.991
   60    370       1    0.974 0.00784        0.958        0.989

                AgeGroup=2
 time n.risk n.event survival std.err lower 95% CI upper 95% CI
    0    301       4    0.987 0.00660        0.974        1.000
    1    297       3    0.977 0.00869        0.960        0.994
   12    284       1    0.973 0.00931        0.955        0.992
   36    249       3    0.962 0.01140        0.939        0.984
   72    114       1    0.953 0.01408        0.926        0.981

                AgeGroup=3
 time n.risk n.event survival std.err lower 95% CI upper 95% CI
    0    220       4    0.982 0.00901        0.964        1.000
    1    216       1    0.977 0.01005        0.958        0.997
    6    213       1    0.973 0.01100        0.951        0.994
   24    191       1    0.968 0.01206        0.944        0.992
   36    181       1    0.962 0.01313        0.937        0.988

>
>
> win.graph()
> plot(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~AgeGroup , data=Survival) , lty=1:3,
+ xlab="Months", ylab="Proportion Free from Aneursym Related Death",
+ ylim=c(.9,1), main="Aneursym Related Deaths and Age")
> legend(5, .91, c("<75years", "75-80years", ">80years"), lty=1:3)
>
> junk <- summary(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~AgeGroup , data=Survival) )
> junk1 <-  junk[[1]]
>
> junk2 <- as.numeric( junk$time)
> junk3 <- c(which(junk2==36),which(junk2==60) )
> text(44, 1.004*junk1[junk3[1]], paste(100*round(junk1[junk3[1]],3),"%") )
> text(44, 1.004*junk1[junk3[2]], paste(100*round(junk1[junk3[2]],3),"%") )
> text(44, 1.004*junk1[junk3[3]], paste(100*round(junk1[junk3[3]],3),"%") )
> text(68, 1.004*junk1[junk3[4]], paste(100*round(junk1[junk3[4]],3),"%") )
> text(68, 1.004*junk1[junk3[5]], paste(100*round(junk1[junk3[5]],3),"%") )
> text(68, 1.004*junk1[junk3[6]], paste(100*round(junk1[junk3[6]],3),"%") )
>
> # Tests of significance
> junk4 <-survdiff(Surv(Months, AneurRelatedDeath) ~AgeGroup , data=Survival)
> #coxph(formula= Surv(Months, AneurRelatedDeath) ~AgeGroup , data=Survival)
> text(80, 1, paste("p= ",round(1-pchisq(junk4$chisq, 2),3) ) )
>
> ###################
> #  Aneurysm Diameter
>
> survivalASA <- Survival[!is.na(Survival$DiaBand),]
>
> summary(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~ DiaBand, data=survivalASA) )
Call: survfit(formula = Surv(IntervalEndMonths, AneurRelatedDeath) ~ DiaBand, data = surv
ivalASA)

                DiaBand=1
 time n.risk n.event survival std.err lower 95% CI upper 95% CI
    0    410       3    0.993 0.00421        0.984        1.000
    1    407       1    0.990 0.00485        0.981        1.000
   36    371       3    0.982 0.00666        0.969        0.995

                DiaBand=2
```

```
 time n.risk n.event survival std.err lower 95% CI upper 95% CI
    0    329       4    0.988 0.00604        0.976        1.000
    1    325       1    0.985 0.00674        0.972        0.998
   24    296       1    0.981 0.00750        0.967        0.996
   36    286       2    0.975 0.00888        0.957        0.992

                DiaBand=3
 time n.risk n.event survival std.err lower 95% CI upper 95% CI
    0    191       2    0.990 0.00737        0.975        1.000
    1    189       4    0.969 0.01262        0.944        0.994
    6    179       1    0.963 0.01366        0.937        0.990
   12    175       3    0.947 0.01642        0.915        0.979
   36    143       3    0.927 0.01968        0.889        0.966
   72     55       1    0.910 0.02553        0.861        0.961

>
> junk <- summary(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~DiaBand , data=survivalASA)
)
> junk1 <-  junk[[1]]
>
> win.graph()
> plot(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~DiaBand , data=survivalASA) , lty=1:3,
+ xlab="Months", ylab="Proportion Free from Aneursym Related Death",
+ ylim=c(.9,1), main="Aneursym Related Deaths and max Aneurysm Diameter")
> legend(5, .91, c("<55mm", "55-65mm", ">=65mm"), lty=1:3)
>
>
> junk2 <- as.numeric( junk$time)
> junk3 <- c(which(junk2==36),which(junk2==60) )
> text(44, 1.004*junk1[junk3[1]], paste(100*round(junk1[junk3[1]],3),"%") )
> text(44, 1.004*junk1[junk3[2]], paste(100*round(junk1[junk3[2]],3),"%") )
> text(44, 1.004*junk1[junk3[3]], paste(100*round(junk1[junk3[3]],3),"%") )
> text(68, 1.004*junk1[junk3[4]], paste(100*round(junk1[junk3[4]],3),"%") )
> text(68, 1.004*junk1[junk3[5]], paste(100*round(junk1[junk3[5]],3),"%") )
> text(68, 1.004*junk1[junk3[6]], paste(100*round(junk1[junk3[6]],3),"%") )
>
> # Tests of significance
> junk4 <-survdiff(Surv(Months, AneurRelatedDeath) ~DiaBand , data=survivalASA)
> #coxph(formula= Surv(Months, AneurRelatedDeath) ~DiaBand , data=survivalASA)
> text(80, 1, paste("p= ",round(1-pchisq(junk4$chisq, 2),3) ) )
>
> ###################
> #  Infrarenal Neck Length
>
> survivalASA <- Survival[!is.na(Survival$InfraNeck),]
>
> summary(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~ InfraNeck, data=survivalASA) )
Call: survfit(formula = Surv(IntervalEndMonths, AneurRelatedDeath) ~ InfraNeck, data = su
rvivalASA)

                InfraNeck=1
 time n.risk n.event survival std.err lower 95% CI upper 95% CI
    0     83       1    0.988  0.0120        0.965        1.000
    1     82       4    0.940  0.0261        0.890        0.992
    6     77       1    0.928  0.0285        0.873        0.985
   24     70       1    0.914  0.0310        0.856        0.977

                InfraNeck=2
 time n.risk n.event survival std.err lower 95% CI upper 95% CI
   36    125       1    0.992 0.00797        0.977            1

                InfraNeck=3
 time n.risk n.event survival std.err lower 95% CI upper 95% CI
    0    652       7    0.989 0.00404        0.981        0.997
    1    645       2    0.986 0.00457        0.977        0.995
   12    627       3    0.981 0.00530        0.971        0.992
   36    557       6    0.971 0.00677        0.958        0.984

>
> junk <- summary(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~InfraNeck ,
data=survivalASA) )
> junk1 <-  junk[[1]]
>
> win.graph()
> plot(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~InfraNeck , data=survivalASA) ,
lty=1:3,
+ xlab="Months", ylab="Proportion Free from Aneursym Related Death",
+ ylim=c(.9,1), main="Aneursym Related Deaths and Infrarenal Neck Length")
> legend(5, .91, c("<15mm", "15-20mm", ">=20mm"), lty=1:3)
>
> junk2 <- as.numeric( junk$time)
> junk3 <- c(which(junk2==36),which(junk2==60) )
> text(44, 1.004*junk1[junk3[1]], paste(100*round(junk1[junk3[1]],3),"%") )
> text(44, 1.004*junk1[junk3[2]], paste(100*round(junk1[junk3[2]],3),"%") )
> text(44, 1.004*junk1[junk3[3]], paste(100*round(junk1[junk3[3]],3),"%") )
> text(68, 1.004*junk1[junk3[4]], paste(100*round(junk1[junk3[4]],3),"%") )
> text(68, 1.004*junk1[junk3[5]], paste(100*round(junk1[junk3[5]],3),"%") )
> text(68, 1.004*junk1[junk3[6]], paste(100*round(junk1[junk3[6]],3),"%") )
>
> # Tests of significance
> junk4 <-survdiff(Surv(Months, AneurRelatedDeath) ~InfraNeck , data=survivalASA)
```

```
> coxph(formula= Surv(Months, AneurRelatedDeath) ~InfraNeck , data=survivalASA)
Call:
coxph(formula = Surv(Months, AneurRelatedDeath) ~ InfraNeck, data = survivalASA)


            coef exp(coef) se(coef)     z    p
InfraNeck -0.452     0.636     0.25 -1.81 0.07

Likelihood ratio test=2.91  on 1 df, p=0.0879  n= 869
> text(80, 1, paste("p= ",round(1-pchisq(junk4$chisq, 2),3) ) )
>

> ##############
> # Does Size add to Age
>
> survivalASA <- Survival[!is.na(Survival$DiaBand),]
>
> survdiff(Surv(Months, AneurRelatedDeath) ~AgeGroup, data=survivalASA)
Call:
survdiff(formula = Surv(Months, AneurRelatedDeath) ~ AgeGroup, data
         = survivalASA)

             N Observed Expected (O-E)^2/E (O-E)^2/V
AgeGroup=1 428       10    13.73     1.013     1.934
AgeGroup=2 288       11     8.86     0.516     0.747
AgeGroup=3 214        8     6.41     0.394     0.509

 Chisq= 1.9  on 2 degrees of freedom, p= 0.38
> survdiff(Surv(Months, AneurRelatedDeath) ~AgeGroup +  DiaBand, data=survivalASA)
Call:
survdiff(formula = Surv(Months, AneurRelatedDeath) ~ AgeGroup +
        DiaBand, data = survivalASA)

                        N Observed Expected (O-E)^2/E (O-E)^2/V
AgeGroup=1, DiaBand=1 213        1     7.01 5.15e+000 6.83e+000
AgeGroup=1, DiaBand=2 141        2     4.50 1.39e+000 1.66e+000
AgeGroup=1, DiaBand=3  74        7     2.22 1.03e+001 1.12e+001
AgeGroup=2, DiaBand=1 122        5     3.87 3.29e-001 3.81e-001
AgeGroup=2, DiaBand=2 100        3     3.00 7.51e-006 8.42e-006
AgeGroup=2, DiaBand=3  66        3     1.98 5.19e-001 5.60e-001
AgeGroup=3, DiaBand=1  75        1     2.33 7.61e-001 8.32e-001
AgeGroup=3, DiaBand=2  88        3     2.67 4.05e-002 4.48e-002
AgeGroup=3, DiaBand=3  51        4     1.41 4.79e+000 5.06e+000

 Chisq= 23.4  on 8 degrees of freedom, p= 0.00283
>
> survdiff(Surv(Months, AneurRelatedDeath) ~Age, data=survivalASA)
Call:
survdiff(formula = Surv(Months, AneurRelatedDeath) ~ Age, data =
        survivalASA)

                     N Observed Expected (O-E)^2/E (O-E)^2/V
Age=46.2121834360027 1        0  0.03228    0.0323    0.0324
Age=52.2600958247776 1        0  0.03733    0.0373    0.0375

……
Age=91.5071868583162 1        0  0.03228    0.0323    0.0324
Age=91.9863107460643 1        0  0.03228    0.0323    0.0324
Age=93.9329226557153 1        1  0.00968  101.3430  102.3333

 Chisq= 1770  on 887 degrees of freedom, p= 0
> survdiff(Surv(Months, AneurRelatedDeath) ~Age +  AneuDiaMax, data=survivalASA)
Call:
survdiff(formula = Surv(Months, AneurRelatedDeath) ~ Age + AneuDiaMax,
        data = survivalASA)

                                     N Observed Expected (O-E)^2/E
Age=46.2121834360027,  AneuDiaMax=57 1        0  0.03228    0.0323
Age=52.2600958247776,  AneuDiaMax=60 1        0  0.03733    0.0373
Age=52.4271047227926,  AneuDiaMax=75 1        0  0.03228    0.0323
Age=52.5722108145106,  AneuDiaMax=50 1        0  0.03228    0.0323
Age=52.8542094455852,  AneuDiaMax=47 1        0  0.03733    0.0373
…….
Age=91.9863107460643,  AneuDiaMax=62    0.0324
Age=93.9329226557153,  AneuDiaMax=85  102.3333

 Chisq= 1872  on 926 degrees of freedom, p= 0
>
> coxph(formula= Surv(Months, AneurRelatedDeath) ~AgeGroup, data=survivalASA)
Call:
coxph(formula = Surv(Months, AneurRelatedDeath) ~ AgeGroup, data =
        survivalASA)


          coef exp(coef) se(coef)    z    p
AgeGroup 0.281      1.32    0.226 1.24 0.21

Likelihood ratio test=1.52  on 1 df, p=0.218  n= 930
> coxph(formula= Surv(Months, AneurRelatedDeath) ~AgeGroup + DiaBand , data=survivalASA)
Call:
coxph(formula = Surv(Months, AneurRelatedDeath) ~ AgeGroup + DiaBand,
```

```
        data = survivalASA)


          coef exp(coef) se(coef)     z       p
AgeGroup 0.204      1.23    0.229 0.891 0.37000
 DiaBand 0.805      2.24    0.244 3.297 0.00098

Likelihood ratio test=12.9  on 2 df, p=0.00161  n= 930
>
>
> ##############
> # Does Size add to ASA
>
> survivalASA <- Survival[!is.na(Survival$DiaBand),]
> survivalASA <- survivalASA[!is.na(survivalASA$ASA234),]
>
> survdiff(Surv(Months, AneurRelatedDeath) ~ASA234, data=survivalASA)
Call:
survdiff(formula = Surv(Months, AneurRelatedDeath) ~ ASA234, data =
        survivalASA)

           N Observed Expected (O-E)^2/E (O-E)^2/V
ASA234=2 315        7    10.42   1.12324   1.76506
ASA234=3 541       17    16.86   0.00108   0.00261
ASA234=4  62        5     1.71   6.30049   6.74386

 Chisq= 7.5  on 2 degrees of freedom, p= 0.0237
> survdiff(Surv(Months, AneurRelatedDeath) ~ASA234 +  DiaBand, data=survivalASA)
Call:
survdiff(formula = Surv(Months, AneurRelatedDeath) ~ ASA234 + DiaBand,
        data = survivalASA)

                      N Observed Expected (O-E)^2/E (O-E)^2/V
ASA234=2, DiaBand=1 180        4    5.995     0.664     0.841
ASA234=2, DiaBand=2  87        1    2.832     1.185     1.319
ASA234=2, DiaBand=3  48        2    1.595     0.103     0.110
ASA234=3, DiaBand=1 216        3    6.963     2.256     2.981
ASA234=3, DiaBand=2 209        5    6.543     0.364     0.472
ASA234=3, DiaBand=3 116        9    3.358     9.477    10.785
ASA234=4, DiaBand=1   9        0    0.267     0.267     0.270
ASA234=4, DiaBand=2  29        2    0.815     1.723     1.783
ASA234=4, DiaBand=3  24        3    0.632     8.863     9.119

 Chisq= 25.1  on 8 degrees of freedom, p= 0.00149
>
>
> coxph(formula= Surv(Months, AneurRelatedDeath) ~ASA234, data=survivalASA)
Call:
coxph(formula = Surv(Months, AneurRelatedDeath) ~ ASA234, data =
        survivalASA)


        coef exp(coef) se(coef)    z    p
ASA234 0.702      2.02    0.323 2.17 0.03

Likelihood ratio test=4.72  on 1 df, p=0.0298  n= 918
> coxph(formula= Surv(Months, AneurRelatedDeath) ~ASA234 + DiaBand , data=survivalASA)
Call:
coxph(formula = Surv(Months, AneurRelatedDeath) ~ ASA234 + DiaBand,
        data = survivalASA)


         coef exp(coef) se(coef)    z      p
 ASA234 0.498      1.65    0.321 1.55 0.1200
DiaBand 0.766      2.15    0.249 3.08 0.0021

Likelihood ratio test=14.6  on 2 df, p=0.00069  n= 918
>
>
>
> ##############
> # Does Age add to ASA
>
> survivalASA <- Survival[!is.na(Survival$ASA234),]
>
> survdiff(Surv(Months, AneurRelatedDeath) ~ASA234, data=survivalASA)
Call:
survdiff(formula = Surv(Months, AneurRelatedDeath) ~ ASA234, data =
        survivalASA)

           N Observed Expected (O-E)^2/E (O-E)^2/V
ASA234=2 322        7    11.12     1.528     2.401
ASA234=3 559       19    18.07     0.048     0.116
ASA234=4  63        5     1.81     5.638     6.032

 Chisq= 7.3  on 2 degrees of freedom, p= 0.0263
> survdiff(Surv(Months, AneurRelatedDeath) ~ASA234 +  AgeGroup, data=survivalASA)
Call:
survdiff(formula = Surv(Months, AneurRelatedDeath) ~ ASA234 +
        AgeGroup, data = survivalASA)
```

```
                       N Observed Expected (O-E)^2/E (O-E)^2/V
ASA234=2, AgeGroup=1 174        2    6.098    2.7540     3.450
ASA234=2, AgeGroup=2  94        4    3.213    0.1928     0.216
ASA234=2, AgeGroup=3  54        1    1.812    0.3641     0.388
ASA234=3, AgeGroup=1 236        6    7.900    0.4568     0.616
ASA234=3, AgeGroup=2 174        7    5.561    0.3723     0.456
ASA234=3, AgeGroup=3 149        6    4.608    0.4202     0.497
ASA234=4, AgeGroup=1  19        3    0.561   10.6015    10.853
ASA234=4, AgeGroup=2  28        1    0.796    0.0523     0.054
ASA234=4, AgeGroup=3  16        1    0.450    0.6706     0.685

 Chisq= 16  on 8 degrees of freedom, p= 0.0425
>
>
> coxph(formula= Surv(Months, AneurRelatedDeath) ~ASA234, data=survivalASA)
Call:
coxph(formula = Surv(Months, AneurRelatedDeath) ~ ASA234, data =
       survivalASA)


       coef exp(coef) se(coef)   z     p
ASA234 0.72      2.05    0.313 2.3 0.022

Likelihood ratio test=5.28  on 1 df, p=0.0215  n= 944
> coxph(formula= Surv(Months, AneurRelatedDeath) ~ASA234 + AgeGroup , data=survivalASA)
Call:
coxph(formula = Surv(Months, AneurRelatedDeath) ~ ASA234 + AgeGroup,
       data = survivalASA)


          coef exp(coef) se(coef)     z     p
  ASA234 0.692      2.00    0.316 2.188 0.029
AgeGroup 0.174      1.19    0.223 0.782 0.430

Likelihood ratio test=5.89  on 2 df, p=0.0526  n= 944
>
> ##############
> # Does Size add to Age and ASA model
>
> survivalASA <- Survival[!is.na(Survival$DiaBand),]
> survivalASA <- survivalASA[!is.na(survivalASA$ASA234),]
>
> survdiff(Surv(Months, AneurRelatedDeath) ~ASA234 +  AgeGroup, data=survivalASA)
Call:
survdiff(formula = Surv(Months, AneurRelatedDeath) ~ ASA234 +
       AgeGroup, data = survivalASA)

                       N Observed Expected (O-E)^2/E (O-E)^2/V
ASA234=2, AgeGroup=1 168        2    5.624    2.3351    2.9129
ASA234=2, AgeGroup=2  94        4    3.085    0.2713    0.3051
ASA234=2, AgeGroup=3  53        1    1.712    0.2964    0.3163
ASA234=3, AgeGroup=1 231        5    7.423    0.7907    1.0673
ASA234=3, AgeGroup=2 164        6    5.065    0.1727    0.2102
ASA234=3, AgeGroup=3 146        6    4.377    0.6015    0.7125
ASA234=4, AgeGroup=1  19        3    0.537   11.3105   11.5807
ASA234=4, AgeGroup=2  28        1    0.768    0.0699    0.0722
ASA234=4, AgeGroup=3  15        1    0.409    0.8535    0.8705

 Chisq= 16.8  on 8 degrees of freedom, p= 0.0322
> survdiff(Surv(Months, AneurRelatedDeath) ~ASA234 +  AgeGroup + DiaBand, data=survivalASA)
Call:
survdiff(formula = Surv(Months, AneurRelatedDeath) ~ ASA234 +
       AgeGroup + DiaBand, data = survivalASA)

                                  N Observed Expected (O-E)^2/E
ASA234=2, AgeGroup=1, DiaBand=1  99        1   3.2959  1.599352
ASA234=2, AgeGroup=1, DiaBand=2  45        0   1.5328  1.532828
ASA234=2, AgeGroup=1, DiaBand=3  24        1   0.7950  0.052839
ASA234=2, AgeGroup=2, DiaBand=1  55        3   1.8490  0.716530
ASA234=2, AgeGroup=2, DiaBand=2  23        1   0.6959  0.132936
ASA234=2, AgeGroup=2, DiaBand=3  16        0   0.5403  0.540322
ASA234=2, AgeGroup=3, DiaBand=1  26        0   0.8496  0.849613
ASA234=2, AgeGroup=3, DiaBand=2  19        0   0.6034  0.603412
ASA234=2, AgeGroup=3, DiaBand=3   8        1   0.2594  2.114917
ASA234=3, AgeGroup=1, DiaBand=1 108        0   3.6051  3.605134
ASA234=3, AgeGroup=1, DiaBand=2  82        1   2.6166  0.998743
ASA234=3, AgeGroup=1, DiaBand=3  41        4   1.2009  6.524412
ASA234=3, AgeGroup=2, DiaBand=1  63        2   1.9615  0.000757
ASA234=3, AgeGroup=2, DiaBand=2  60        1   1.8745  0.407974
ASA234=3, AgeGroup=2, DiaBand=3  41        3   1.2288  2.552854
ASA234=3, AgeGroup=3, DiaBand=1  45        1   1.3964  0.112536
ASA234=3, AgeGroup=3, DiaBand=2  67        3   2.0522  0.437689
ASA234=3, AgeGroup=3, DiaBand=3  34        2   0.9287  1.235820
ASA234=4, AgeGroup=1, DiaBand=1   2        0   0.0655  0.065473
ASA234=4, AgeGroup=1, DiaBand=2  10        1   0.2863  1.778931
ASA234=4, AgeGroup=1, DiaBand=3   7        2   0.1848 17.834995
ASA234=4, AgeGroup=2, DiaBand=1   3        0   0.0819  0.081877
ASA234=4, AgeGroup=2, DiaBand=2  17        1   0.4760  0.576743
ASA234=4, AgeGroup=2, DiaBand=3   8        0   0.2104  0.210353
ASA234=4, AgeGroup=3, DiaBand=1   4        0   0.1192  0.119210
ASA234=4, AgeGroup=3, DiaBand=2   2        0   0.0526  0.052566
```

```
ASA234=4, AgeGroup=3, DiaBand=3   9       1   0.2373  2.451009

                                (O-E)^2/V
ASA234=2, AgeGroup=1, DiaBand=1  1.812663
ASA234=2, AgeGroup=1, DiaBand=2  1.625519
ASA234=2, AgeGroup=1, DiaBand=3  0.054570
ASA234=2, AgeGroup=2, DiaBand=1  0.769349
ASA234=2, AgeGroup=2, DiaBand=2  0.136802
ASA234=2, AgeGroup=2, DiaBand=3  0.552916
ASA234=2, AgeGroup=3, DiaBand=1  0.879312
ASA234=2, AgeGroup=3, DiaBand=2  0.618869
ASA234=2, AgeGroup=3, DiaBand=3  2.143560
ASA234=3, AgeGroup=1, DiaBand=1  4.136131
ASA234=3, AgeGroup=1, DiaBand=2  1.102341
ASA234=3, AgeGroup=1, DiaBand=3  6.839227
ASA234=3, AgeGroup=2, DiaBand=1  0.000815
ASA234=3, AgeGroup=2, DiaBand=2  0.438059
ASA234=3, AgeGroup=2, DiaBand=3  2.678049
ASA234=3, AgeGroup=3, DiaBand=1  0.118775
ASA234=3, AgeGroup=3, DiaBand=2  0.473144
ASA234=3, AgeGroup=3, DiaBand=3  1.284411
ASA234=4, AgeGroup=1, DiaBand=1  0.065893
ASA234=4, AgeGroup=1, DiaBand=2  1.805025
ASA234=4, AgeGroup=1, DiaBand=3 18.044293
ASA234=4, AgeGroup=2, DiaBand=1  0.082511
ASA234=4, AgeGroup=2, DiaBand=2  0.589450
ASA234=4, AgeGroup=2, DiaBand=3  0.213046
ASA234=4, AgeGroup=3, DiaBand=1  0.120244
ASA234=4, AgeGroup=3, DiaBand=2  0.052926
ASA234=4, AgeGroup=3, DiaBand=3  2.484651

 Chisq= 47.5  on 26 degrees of freedom, p= 0.00617
```

ADDITIONAL CONTIBUTION OF SIZE is 47.5 - 16.8 = 30.7 Chi-square on 18 degrees of freedom p=.03117

30.7 18 0.03117

```
>
> coxph(formula= Surv(Months, AneurRelatedDeath) ~ASA234 + AgeGroup , data=survivalASA)
Call:
coxph(formula = Surv(Months, AneurRelatedDeath) ~ ASA234 + AgeGroup,
       data = survivalASA)


          coef exp(coef) se(coef)     z    p
  ASA234 0.669      1.95    0.326 2.053 0.04
AgeGroup 0.214      1.24    0.229 0.936 0.35

Likelihood ratio test=5.59  on 2 df, p=0.0611  n= 918
> coxph(formula= Surv(Months, AneurRelatedDeath) ~ASA234 + AgeGroup + DiaBand, data=survivalASA)
Call:
coxph(formula = Surv(Months, AneurRelatedDeath) ~ ASA234 + AgeGroup +
       DiaBand, data = survivalASA)


          coef exp(coef) se(coef)     z      p
  ASA234 0.476      1.61    0.324 1.469 0.1400
AgeGroup 0.152      1.16    0.231 0.656 0.5100
 DiaBand 0.753      2.12    0.250 3.015 0.0026

Likelihood ratio test=15  on 3 df, p=0.00183  n= 918

> coxph(formula= Surv(Months, AneurRelatedDeath) ~ASA234 + Age +AneuDiaMax, data=survivalASA)
Call:
coxph(formula = Surv(Months, AneurRelatedDeath) ~ ASA234 + Age +
       AneuDiaMax, data = survivalASA)


             coef exp(coef) se(coef)    z       p
    ASA234 0.4073      1.50   0.3217 1.27 0.21000
       Age 0.0481      1.05   0.0298 1.61 0.11000
AneuDiaMax 0.0483      1.05   0.0130 3.73 0.00019

Likelihood ratio test=20.4  on 3 df, p=0.000137  n= 918

>
summary(coxph(formula= Surv(Months, AneurRelatedDeath) ~AneuDiaMax, data=survivalASA))
Call:
coxph(formula = Surv(Months, AneurRelatedDeath) ~ AneuDiaMax, data =
       survivalASA)

  n= 918

             coef exp(coef) se(coef)    z       p
AneuDiaMax 0.0549      1.06   0.0123 4.46 8.1e-006

           exp(coef) exp(-coef) lower .95 upper .95
AneuDiaMax      1.06      0.947      1.03      1.08

Rsquare= 0.017   (max possible= 0.345 )
```

```
Likelihood ratio test= 15.4  on 1 df,   p=0.0000849
Wald test            = 19.9  on 1 df,   p=8.07e-006
Score (logrank) test = 20.7  on 1 df,   p=5.38e-006

> summary(coxph(formula= Surv(Months, AneurRelatedDeath) ~Age, data=survivalASA))
Call:
coxph(formula = Surv(Months, AneurRelatedDeath) ~ Age, data =
        survivalASA)

  n= 918

      coef exp(coef) se(coef)    z     p
Age 0.0686      1.07   0.0297 2.31 0.021

    exp(coef) exp(-coef) lower .95 upper .95
Age      1.07      0.934      1.01      1.14

Rsquare= 0.006   (max possible= 0.345 )
Likelihood ratio test= 5.62  on 1 df,   p=0.0177
Wald test            = 5.32  on 1 df,   p=0.021
Score (logrank) test = 5.32  on 1 df,   p=0.0211

> summary(coxph(formula= Surv(Months, AneurRelatedDeath) ~ASA, data=survivalASA))
Problem: Object "ASA" not found
Use traceback() to see the call stack
> summary(coxph(formula= Surv(Months, AneurRelatedDeath) ~ASA234, data=survivalASA))
Call:
coxph(formula = Surv(Months, AneurRelatedDeath) ~ ASA234, data =
        survivalASA)

  n= 918

        coef exp(coef) se(coef)    z    p
ASA234 0.702      2.02    0.323 2.17 0.03

       exp(coef) exp(-coef) lower .95 upper .95
ASA234      2.02      0.496      1.07       3.8

Rsquare= 0.005   (max possible= 0.345 )
Likelihood ratio test= 4.72  on 1 df,   p=0.0298
Wald test            = 4.73  on 1 df,   p=0.0297
Score (logrank) test = 4.76  on 1 df,   p=0.0291

>
```

Appendix 3 – SPLUS code

Some sample code follows.

Aneurysm Related Deaths

```
#S code
##########################################
#   Survival Aust. Endo repair of AAA
#########################################
options(width=120)
summary(survfit(Surv(IntervalEndMonths, AneurRelatedDeath), data=Survival) )
plot(survfit(Surv(IntervalEndMonths, AneurRelatedDeath),data=Survival),
xlab="Months", ylab="Proportion Free from Aneursym Related Death",
ylim=c(.9,1),
main="Freedom from Aneursym Related Deaths")

###########################
#  Aortic neck angulation
summary(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~ AorticNeckAngle, data=Survival) )
win.graph()
plot(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~AorticNeckAngle , data=Survival) , lty=1:2,
xlab="Months", ylab="Proportion Free from Aneursym Related Death",
ylim=c(.9,1), main="Aneursym Related Deaths and Aortic Neck Angle")
legend(5, .91, c("Aortic neck angle < 45 degrees", "Significant Aortic Neck Angle >=45degrees"), lty=1:2)
junk <- summary(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~AorticNeckAngle , data=Survival) )
junk1 <-  junk[[1]]
junk2 <- as.numeric( junk$time)
junk3 <- c(which(junk2==36),which(junk2==60) )
text(44, 1.004*junk1[junk3[1]], paste(100*round(junk1[junk3[1]],3),"%") )
text(44, 1.004*junk1[junk3[2]], paste(100*round(junk1[junk3[2]],3),"%") )
text(68, 1.004*junk1[junk3[3]], paste(100*round(junk1[junk3[3]],3),"%") )
text(68, 1.004*junk1[junk3[4]], paste(100*round(junk1[junk3[4]],3),"%") )
# Tests of significance
# survdiff(Surv(Months, AneurRelatedDeath) ~AorticNeckAngle , data=Survival)
# coxph(formula= Surv(Months, AneurRelatedDeath) ~AorticNeckAngle , data=Survival)
junk4 <- survdiff(Surv(Months, AneurRelatedDeath) ~AorticNeckAngle , data=Survival)
text(80, 1, paste("p= ",round(1-pchisq(junk4$chisq, 1),3) ) )

###########################
#  Gender
summary(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~Gender , data=Survival) )

win.graph()
plot(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~Gender , data=Survival) , lty=1:2,
xlab="Months", ylab="Proportion Free from Aneursym Related Death",
ylim=c(.9,1), main="Aneursym Related Deaths and Gender")
legend(5, .91, c("Males", "Females"), lty=1:2)
junk <- summary(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~Gender , data=Survival) )
junk1 <-  junk[[1]]
junk2 <- as.numeric( junk$time)
junk3 <- c(which(junk2==36),which(junk2==60) )
text(44, 1.004*junk1[junk3[1]], paste(100*round(junk1[junk3[1]],3),"%") )
text(44, 1.004*junk1[junk3[2]], paste(100*round(junk1[junk3[2]],3),"%") )
text(68, 1.004*junk1[junk3[3]], paste(100*round(junk1[junk3[3]],3),"%") )
text(68, 1.004*junk1[junk3[4]], paste(100*round(junk1[junk3[4]],3),"%") )
# Tests of significance
junk4 <- survdiff(Surv(Months, AneurRelatedDeath) ~Gender , data=Survival)
# coxph(formula= Surv(Months, AneurRelatedDeath) ~Gender , data=Survival)
text(80, 1, paste("p= ",round(1-pchisq(junk4$chisq, 1),3) ) )

################
#Three levels
###########################
#  ASA234
survivalASA <- Survival[!is.na(Survival$ASA234),]
summary(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~ ASA234, data=survivalASA) )
junk <- summary(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~ASA234 , data=survivalASA) )
junk1 <-  junk[[1]]
win.graph()
plot(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~ASA234 , data=survivalASA) , lty=1:3,
xlab="Months", ylab="Proportion Free from Aneursym Related Death",
ylim=c(.9,1), main="Aneursym Related Deaths and ASA")
legend(5, .91, c("ASA 2", "ASA 3", "ASA 4"), lty=1:3)

text(44, 1.004*junk1[7], paste(100*round(junk1[7],3),"%") )
text(44, 1.004*junk1[18], paste(100*round(junk1[18],3),"%") )
```

```
text(44, 1.004*junk1[29], paste(100*round(junk1[29],3),"%") )
text(68, 1.004*junk1[9], paste(100*round(junk1[9],3),"%") )
text(68, 1.004*junk1[20], paste(100*round(junk1[20],3),"%") )
text(68, 1.004*junk1[31], paste(100*round(junk1[31],3),"%") )

# Tests of significance
junk4 <- survdiff(Surv(Months, AneurRelatedDeath) ~ASA234 , data=survivalASA)
# coxph(formula= Surv(Months, AneurRelatedDeath) ~ASA234 , data=survivalASA)
text(80, 1, paste("p= ",round(1-pchisq(junk4$chisq, 2),3) ) )

################
#  Age
summary(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~ AgeGroup, data=Survival) )
win.graph()
plot(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~AgeGroup , data=Survival) , lty=1:3,
xlab="Months", ylab="Proportion Free from Aneursym Related Death",
ylim=c(.9,1), main="Aneursym Related Deaths and Age")
legend(5, .91, c("<75years", "75-80years", ">80years"), lty=1:3)
junk <- summary(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~AgeGroup , data=Survival) )
junk1 <-  junk[[1]]
junk2 <- as.numeric( junk$time)
junk3 <- c(which(junk2==36),which(junk2==60) )
text(44, 1.004*junk1[junk3[1]], paste(100*round(junk1[junk3[1]],3),"%") )
text(44, 1.004*junk1[junk3[2]], paste(100*round(junk1[junk3[2]],3),"%") )
text(44, 1.004*junk1[junk3[3]], paste(100*round(junk1[junk3[3]],3),"%") )
text(68, 1.004*junk1[junk3[4]], paste(100*round(junk1[junk3[4]],3),"%") )
text(68, 1.004*junk1[junk3[5]], paste(100*round(junk1[junk3[5]],3),"%") )
text(68, 1.004*junk1[junk3[6]], paste(100*round(junk1[junk3[6]],3),"%") )
# Tests of significance
junk4 <-survdiff(Surv(Months, AneurRelatedDeath) ~AgeGroup , data=Survival)
#coxph(formula= Surv(Months, AneurRelatedDeath) ~AgeGroup , data=Survival)
text(80, 1, paste("p= ",round(1-pchisq(junk4$chisq, 2),3) ) )

####################
#  Aneurysm Diameter
survivalASA <- Survival[!is.na(Survival$DiaBand),]
summary(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~ DiaBand, data=survivalASA) )
junk <- summary(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~DiaBand , data=survivalASA) )
junk1 <-  junk[[1]]
win.graph()
plot(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~DiaBand , data=survivalASA) , lty=1:3,
xlab="Months", ylab="Proportion Free from Aneursym Related Death",
ylim=c(.9,1), main="Aneursym Related Deaths and max Aneurysm Diameter")
legend(5, .91, c("<55mm", "55-65mm", ">=65mm"), lty=1:3)
junk2 <- as.numeric( junk$time)
junk3 <- c(which(junk2==36),which(junk2==60) )
text(44, 1.004*junk1[junk3[1]], paste(100*round(junk1[junk3[1]],3),"%") )
text(44, 1.004*junk1[junk3[2]], paste(100*round(junk1[junk3[2]],3),"%") )
text(44, 1.004*junk1[junk3[3]], paste(100*round(junk1[junk3[3]],3),"%") )
text(68, 1.004*junk1[junk3[4]], paste(100*round(junk1[junk3[4]],3),"%") )
text(68, 1.004*junk1[junk3[5]], paste(100*round(junk1[junk3[5]],3),"%") )
text(68, 1.004*junk1[junk3[6]], paste(100*round(junk1[junk3[6]],3),"%") )
# Tests of significance
junk4 <-survdiff(Surv(Months, AneurRelatedDeath) ~DiaBand , data=survivalASA)
#coxph(formula= Surv(Months, AneurRelatedDeath) ~DiaBand , data=survivalASA)
# text(80, 1, paste("p= ",round(1-pchisq(junk4$chisq, 2),3) ) )
text(80, 1, “p< 0.001” )

####################
#  Infrarenal Neck Length
survivalASA <- Survival[!is.na(Survival$InfraNeck),]
summary(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~ InfraNeck, data=survivalASA) )
junk <- summary(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~InfraNeck , data=survivalASA) )
junk1 <-  junk[[1]]
junk
win.graph()
plot(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~InfraNeck , data=survivalASA) , lty=1:3,
xlab="Months", ylab="Proportion Free from Aneursym Related Death",
ylim=c(.9,1), main="Aneursym Related Deaths and Infrarenal Neck Length")
legend(5, .91, c("<15mm", "15-20mm", ">=20mm"), lty=1:3)
junktime <- as.numeric( junk$time)
junk3 <- c(which(junk2==36),which(junk2==60) )
junk24 <- c(which(junk2==24))
junk36 <- c(which(junk2==36))
junk60 <- c(which(junk2==60))
junkstrata <- as.character(junk$strata)
junk3y <- data.frame(name=levels(junk$strata), sur3= rep(-1,3), sur5= rep(-2,3) , stringsAsFactors=FALSE)
junk3y[junk3y$name==junkstrata[junk36], 2]<- as.numeric(junk1[junk36])
junk3y[junkstrata[junk60], 3]<- junk1[junk60]
```

```
junk3y <- as.data.frame(junk3y)
junk3y[junk3y$sur3==-1, 2]
if(length(junk3y$sur3[junk3y$sur3==-1])
text(44, 1.004*junk1[junk3[1]], paste(100*round(junk1[junk3[1]],3),"%") )
text(44, 1.004*junk1[junk3[2]], paste(100*round(junk1[junk3[2]],3),"%") )
text(44, 1.004*junk1[junk3[3]], paste(100*round(junk1[junk3[3]],3),"%") )
text(68, 1.004*junk1[junk3[4]], paste(100*round(junk1[junk3[4]],3),"%") )
text(68, 1.004*junk1[junk3[5]], paste(100*round(junk1[junk3[5]],3),"%") )
text(68, 1.004*junk1[junk3[6]], paste(100*round(junk1[junk3[6]],3),"%") )

# Tests of significance
junk4 <-survdiff(Surv(Months, AneurRelatedDeath) ~InfraNeck , data=survivalASA)
coxph(formula= Surv(Months, AneurRelatedDeath) ~InfraNeck , data=survivalASA)
text(80, 1, paste("p= ",round(1-pchisq(junk4$chisq, 2),3) ) )

##############
# Does Size add to Age
survivalASA <- Survival[!is.na(Survival$DiaBand),]
survdiff(Surv(Months, AneurRelatedDeath) ~AgeGroup, data=survivalASA)
survdiff(Surv(Months, AneurRelatedDeath) ~AgeGroup +  DiaBand, data=survivalASA)
survdiff(Surv(Months, AneurRelatedDeath) ~Age, data=survivalASA)
survdiff(Surv(Months, AneurRelatedDeath) ~Age +  AneuDiaMax, data=survivalASA)
coxph(formula= Surv(Months, AneurRelatedDeath) ~AgeGroup, data=survivalASA)
coxph(formula= Surv(Months, AneurRelatedDeath) ~AgeGroup + DiaBand , data=survivalASA)

##############
# Does Size add to ASA
survivalASA <- Survival[!is.na(Survival$DiaBand),]
survivalASA <- survivalASA[!is.na(survivalASA$ASA234),]
survdiff(Surv(Months, AneurRelatedDeath) ~ASA234, data=survivalASA)
survdiff(Surv(Months, AneurRelatedDeath) ~ASA234 +  DiaBand, data=survivalASA)
coxph(formula= Surv(Months, AneurRelatedDeath) ~ASA234, data=survivalASA)
coxph(formula= Surv(Months, AneurRelatedDeath) ~ASA234 + DiaBand , data=survivalASA)

##############
# Does Age add to ASA
survivalASA <- Survival[!is.na(Survival$ASA234),]
survdiff(Surv(Months, AneurRelatedDeath) ~ASA234, data=survivalASA)
survdiff(Surv(Months, AneurRelatedDeath) ~ASA234 +  AgeGroup, data=survivalASA)
coxph(formula= Surv(Months, AneurRelatedDeath) ~ASA234, data=survivalASA)
coxph(formula= Surv(Months, AneurRelatedDeath) ~ASA234 + AgeGroup , data=survivalASA)

##############
# Does Size add to Age and ASA model
survivalASA <- Survival[!is.na(Survival$DiaBand),]
survivalASA <- survivalASA[!is.na(survivalASA$ASA234),]
survdiff(Surv(Months, AneurRelatedDeath) ~ASA234 +  AgeGroup, data=survivalASA)
survdiff(Surv(Months, AneurRelatedDeath) ~ASA234 +  AgeGroup + DiaBand, data=survivalASA)
coxph(formula= Surv(Months, AneurRelatedDeath) ~ASA234 + AgeGroup , data=survivalASA)
coxph(formula= Surv(Months, AneurRelatedDeath) ~ASA234 + AgeGroup + DiaBand, data=survivalASA)
```

Creatinine

```
# Copied Creatinine from spreadhseet sorted by RegID
##########################
# Creatinine    Creat120orOver
survivalASA <- Survival[!is.na(Survival$Creat),]
summary(survfit(Surv(IntervalEndMonths, Deceased) ~ Creat, data=survivalASA) )
junk <- summary(survfit(Surv(IntervalEndMonths, Deceased) ~ Creat , data=survivalASA) )
junk1 <-  junk[[1]]
junk2 <- as.numeric( junk$time)
junk3 <- c(which(junk2==36),which(junk2==60) )
win.graph()
par(mar=c(5,4,1,1)+.1)
plot(survfit(Surv(IntervalEndMonths, Deceased) ~Creat , data=survivalASA) , lty=1:3,
xlab="Months", ylab="Proportion Surviving")
#xlab="Months", ylab="Proportion Surviving", main="Survival and Creatinine")
legend(5, .2, c("Creatinine < 120", "Creatinine 120 or over"), lty=1:2)

text(44, 1.04*junk1[junk3[1]], paste(100*round(junk1[junk3[1]],3),"%") )
text(44, 1.04*junk1[junk3[2]], paste(100*round(junk1[junk3[2]],3),"%") )
text(68, 1.04*junk1[junk3[3]], paste(100*round(junk1[junk3[3]],3),"%") )
text(68, 1.04*junk1[junk3[4]], paste(100*round(junk1[junk3[4]],3),"%") )

# Tests of significance
junk4 <- survdiff(Surv(Months, Deceased) ~Creat , data=survivalASA)
1-pchisq(junk4$chisq,1)
```

```
text(80, 1, "p < 0.001")
# text(80, 1, paste("p= ",round(1-pchisq(junk4$chisq, 1),3) ) ) )

### 160 or over
survivalASA <- Survival[!is.na(Survival$Creat160),]

summary(survfit(Surv(IntervalEndMonths, Deceased) ~ Creat160, data=survivalASA) )

junk <- summary(survfit(Surv(IntervalEndMonths, Deceased) ~ Creat160 , data=survivalASA) )
junk1 <-  junk[[1]]
junk2 <- as.numeric( junk$time)
junk3 <- c(which(junk2==36),which(junk2==60) )

win.graph()
par(mar=c(5,4,1,1)+.1)
plot(survfit(Surv(IntervalEndMonths, Deceased) ~Creat160 , data=survivalASA) , lty=1:3,
xlab="Months", ylab="Proportion Surviving")
#xlab="Months", ylab="Proportion Surviving", main="Survival and Creatinine")
legend(5, .2, c("Creatinine < 160", "Creatinine 160 or over"), lty=1:2)

text(44, 1.04*junk1[junk3[1]], paste(100*round(junk1[junk3[1]],3),"%") )
text(44, 1.04*junk1[junk3[2]], paste(100*round(junk1[junk3[2]],3),"%") )
text(68, 1.04*junk1[junk3[3]], paste(100*round(junk1[junk3[3]],3),"%") )
text(68, 1.04*junk1[junk3[4]], paste(100*round(junk1[junk3[4]],3),"%") )

# Tests of significance
junk4 <- survdiff(Surv(Months, Deceased) ~Creat160 , data=survivalASA)
1-pchisq(junk4$chisq,1)
text(80, 1, "p < 0.001")
# text(80, 1, paste("p= ",round(1-pchisq(junk4$chisq, 1),3) ) ) )

### 160 or over
####  AneurRelatedDeath  ###  ###
survivalASA <- Survival[!is.na(Survival$Creat160),]
summary(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~ Creat160, data=survivalASA) )
junk <- summary(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~ Creat160 , data=survivalASA) )
junk1 <-  junk[[1]]
junk2 <- as.numeric( junk$time)
junk3 <- c(which(junk2==36),which(junk2==60) )
win.graph()
par(mar=c(5,4,1,1)+.1)
plot(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~Creat160 , data=survivalASA) , lty=1:3,
xlab="Months", ylab="Proportion Free from Aneursym Related Death",ylim=c(.9,1))
# main="Aneursym Related Deaths and Creatinine")

legend(5, .91, c("Creatinine < 160", "Creatinine 160 or over"), lty=1:2)

text(44, 1.002*junk1[5], paste(100*round(junk1[5],3),"%") )
text(44, 1.002*junk1[9], paste(100*round(junk1[9],3),"%") )
text(68, 1.002*junk1[5], paste(100*round(junk1[5],3),"%") )
text(68, 1.002*junk1[9], paste(100*round(junk1[9],3),"%") )

# Tests of significance
junk4 <- survdiff(Surv(Months, AneurRelatedDeath) ~Creat160 , data=survivalASA)
1-pchisq(junk4$chisq,1)
text(80, 1, paste("p= ",round(1-pchisq(junk4$chisq, 1),3) ) )

### creat_120 limit
############################
summary(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~ Creat, data=survivalASA) )

junk <- summary(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~ Creat , data=survivalASA) )
junk1 <-  junk[[1]]
junk2 <- as.numeric( junk$time)
junk3 <- c(which(junk2==36),which(junk2==60) )

win.graph()
par(mar=c(5,4,1,1)+.1)
plot(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~Creat , data=survivalASA) , lty=1:3,
xlab="Months", ylab="Proportion Free from Aneursym Related Death",ylim=c(.9,1))
# ylim=c(.9,1), main="Aneursym Related Deaths and Creatinine")

legend(5, .91, c("Creatinine < 120", "Creatinine 120 or over"), lty=1:2)

text(44, 1.002*junk1[4], paste(100*round(junk1[4],3),"%") )
text(44, 1.002*junk1[10], paste(100*round(junk1[10],3),"%") )
text(68, 1.002*junk1[4], paste(100*round(junk1[4],3),"%") )
text(68, 1.002*junk1[10], paste(100*round(junk1[10],3),"%") )
```

```
# Tests of significance
junk4 <- survdiff(Surv(Months, AneurRelatedDeath) ~Creat , data=survivalASA)
1-pchisq(junk4$chisq,1)
text(80, 1, paste("p= ",round(1-pchisq(junk4$chisq, 1),3) ) )

##################
#Three levels
##########################
#  Creatinine

survivalASA <- Survival[!is.na(Survival$Creat),]

summary(survfit(Surv(IntervalEndMonths, Deceased) ~ Creat3, data=survivalASA) )

junk <- summary(survfit(Surv(IntervalEndMonths, Deceased) ~ Creat3 , data=survivalASA) )
junk1 <-  junk[[1]]
junk2 <- as.numeric( junk$time)
junk3 <- c(which(junk2==36),which(junk2==60) )

win.graph()
par(mar=c(5,4,1,1)+.1)
plot(survfit(Surv(IntervalEndMonths, Deceased) ~Creat3, data=survivalASA) , lty=1:3,
xlab="Months", ylab="Proportion Surviving")
#xlab="Months", ylab="Proportion Surviving", main="Survival and Creatinine")
legend(5, .2, c("Creatinine < 120", "Creatinine >= 120 and <160","Creatinine > 160" ), lty=1:3)

text(44, 1.04*junk1[junk3[1]], paste(100*round(junk1[junk3[1]],3),"%") )
text(44, 1.04*junk1[junk3[2]], paste(100*round(junk1[junk3[2]],3),"%") )
text(44, 1.05*junk1[junk3[3]], paste(100*round(junk1[junk3[3]],3),"%") )
text(68, 1.04*junk1[junk3[4]], paste(100*round(junk1[junk3[4]],3),"%") )
text(68, 1.04*junk1[junk3[5]], paste(100*round(junk1[junk3[5]],3),"%") )
text(68, 1.06*junk1[junk3[6]], paste(100*round(junk1[junk3[6]],3),"%") )

# Tests of significance
junk4 <- survdiff(Surv(Months, Deceased) ~Creat3 , data=survivalASA)
junk4

ifelse( 1-pchisq(junk4$chisq, 2)<.001,
text(80, 1, "p < 0.001"),
text(80, 1, paste("p= ",round(1-pchisq(junk4$chisq, 2),3) ) ) )



# Aneur related deaths

survivalASA <- Survival[!is.na(Survival$Creat),]

summary(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~ Creat3, data=survivalASA) )

junk <- summary(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~ Creat3 , data=survivalASA) )
junk

junk1 <-  junk[[1]]
junk2 <- as.numeric( junk$time)
junk3 <- c(which(junk2==36),which(junk2==60) )
junk3


win.graph()
par(mar=c(5,4,1,1)+.1)
plot(survfit(Surv(IntervalEndMonths, AneurRelatedDeath) ~Creat3, data=survivalASA) , lty=1:3,
xlab="Months", ylab="Proportion Free from Aneursym Related Death",ylim=c(.9,1))
legend(5, .92, c("Creatinine < 120", "Creatinine >= 120 and <160","Creatinine > 160" ), lty=1:3)

text(44, 1.004*junk1[junk3[1]], paste(100*round(junk1[junk3[1]],3),"%") )
text(44, 1.004*junk1[junk3[2]], paste(100*round(junk1[junk3[2]],3),"%") )
text(44, 1.004*junk1[12], paste(100*round(junk1[12],3),"%") )

# Tests of significance
junk4 <- survdiff(Surv(Months, AneurRelatedDeath) ~Creat3 , data=survivalASA)
junk4
text(80, 1, paste("p= ",round(1-pchisq(junk4$chisq, 2),3) ) )
```

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