Integrated Evidence-Based Data Analysis with with Automated Applications for Survival, Mortality, and Life Expectancy Insurance Products

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*National Cancer Institute:Surveillance, Epidemiology, End Results; (SEER*Stat 5.0 - 1973-2000)

Underwriting Vignette

- 70 year old women non-smoker with recent history of a 2 cm. breast cancer localized to the right breast and microscopically determined to be adenocarcinoma, grades 3 & 4*.
- The patient is currently undergoing treatment with surgery, radiation and chemotherapy.
- She is applying for a $5 million policy of Variable Universal Life Insurance and a large paid-up annuity policy
- There are no other risk factors or impairments

- *Grade 3 = poorly differentiated adenocarcinoma
- *Grade 4= undifferentiated (anaplastic) adenocarcinoma

TABLE 1, BREAST CARCINOMA SURVIVAL 1988-1999, AGES 65-74, LOCAL, GRADES 3&4 8/14/02

		Alive at Start	Died	Lost to Follow-up	Observed Interval	Observed Cum	Expected Interval	Expected Cum	Relative Interval	Relative Cum	2 S.E. Obs Interval	2 S.E. Obs Cum	2 S.E. Rel Interval	2 S.E. Rel Cum
1	< 1 yr	5,319	116	486	0.9771	0.9771	0.9803	0.9803	0.9968	0.9968	0.0042	0.0042	0.0043	0.0043
2	1-<2 yr	4,717	174	535	0.9609	0.9389	0.9786	0.9592	0.9819	0.9788	0.0058	0.007	0.0059	0.0073
3	2-<3 yr	4,008	156	483	0.9586	0.9	0.9767	0.9368	0.9814	0.9608	0.0065	0.009	0.0066	0.0097
4	3-<4 yr	3,369	121	453	0.9615	0.8654	0.9747	0.9129	0.9864	0.948	0.0069	0.0107	0.007	0.0117
5	4-<5 yr	2,795	98	422	0.9621	0.8326	0.9725	0.8875	0.9893	0.9381	0.0075	0.0121	0.0077	0.0137
6	5-<6 yr	2,275	94	378	0.9549	0.7951	0.97	0.8605	0.9845	0.9239	0.0091	0.0138	0.0094	0.0161
7	6-<7 yr	1,803	85	349	0.9478	0.7536	0.9671	0.8319	0.9801	0.9059	0.011	0.0158	0.0114	0.019
8	7-<8 yr	1,369	50	320	0.9586	0.7224	0.964	0.8015	0.9944	0.9013	0.0115	0.0174	0.0119	0.0217
9	8-<9 yr	999	51	303	0.9398	0.6789	0.9608	0.7694	0.9782	0.8824	0.0163	0.0202	0.017	0.0262
10	9-<10 yr	645	19	250	0.9635	0.6541	0.9567	0.7356	1.007	0.8892	0.0165	0.0224	0.0172	0.0305
11	10-<11 yr	376	14	196	0.9496	0.6212	0.9526	0.7002	0.9969	0.8872	0.0262	0.0273	0.0275	0.0391
12	11-<12 yr	166	6	160	0.9302	0.5778	0.9485	0.6631	0.9807	0.8715	0.0549	0.0426	0.0579	0.0642

The median survival time is greater than 12.

No adjustment for heterogeneity.

CHART 1

BREAST CARCINOMA 1988-1999,
AGES 65-74, LOCAL, GRADES 3&4

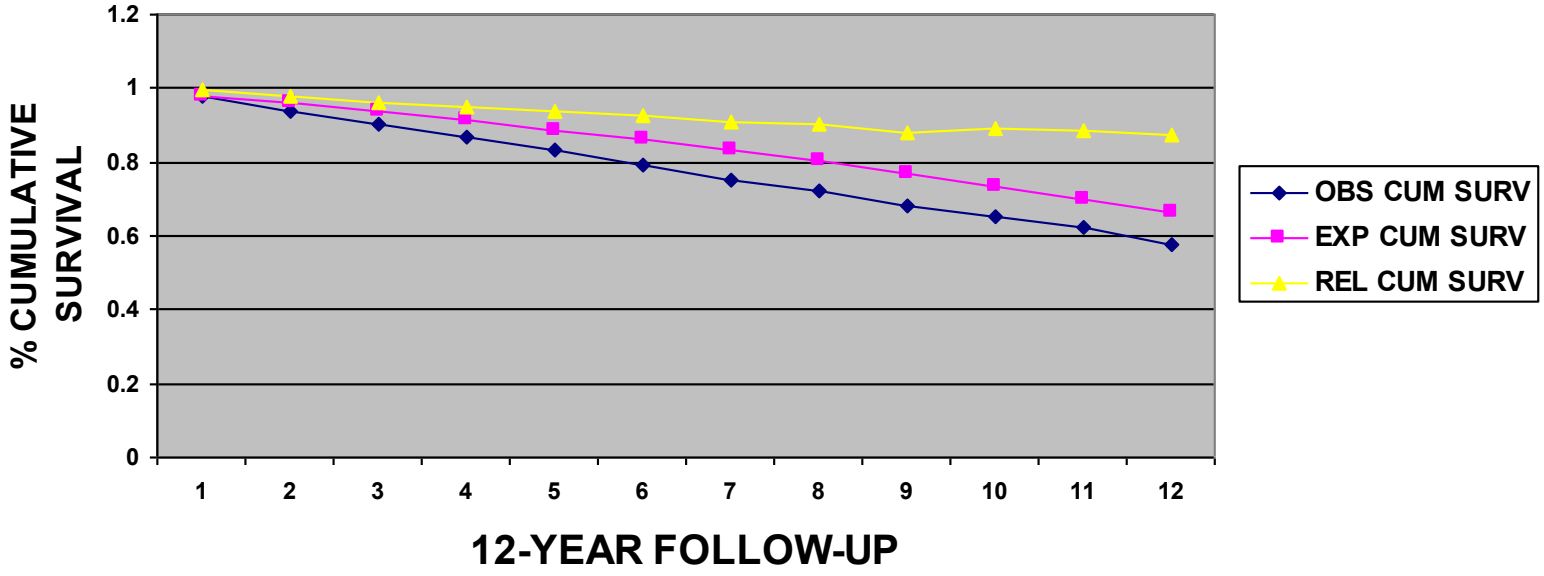


TABLE 2. Breast Carcinoma Mortality 1988-1999, Ages 65-74, Local, Grades 3&4

SOURCE: Observed & derived data; SEER Survival matrix source table: SEER Cancer Data 1973-1999 (SEER*Stat 4.2.3)

Interval	Duration	Alive at	Lost to	Exposure	Number of Deaths		Mortality	Mean Annual Mortality Rate/1,000		
	Start-end (Years)	Start	Follow-up	Person-years	Observed	Expected	Ratio	Observed	Expected	Excess
			w	$E = l\text{-}w/2$		d' = q'E	100d/d'	$q_i = d_i/E_i$	q'=1-p'	EDR = q-q'
No.	t to t+ch t	l		E	d	d'		q	q'	(q-q')
1	0-1	5,319	486	5076.0	116	100.00	116	0.0229	0.0197	0.0032
2	1-2	4,717	535	4449.5	174	95.22	183	0.0391	0.0214	0.0177
3	2-3	4,008	483	3766.5	156	87.76	178	0.0414	0.0233	0.0181
4	3-4	3,369	453	3142.5	121	79.51	152	0.0385	0.0253	0.0132
5	4-5	2,795	422	2584.0	98	71.06	138	0.0379	0.0275	0.0104
6	5-6	2,275	378	2086.0	94	62.58	150	0.0451	0.03	0.0151
7	6-7	1,803	349	1628.5	85	53.58	159	0.0522	0.0329	0.0193
8	7-8	1,369	320	1209.0	50	43.52	115	0.0414	0.036	0.0054
9	8-9	999	303	847.5	51	33.22	154	0.0602	0.0392	0.0210
10	9-10	645	250	520.0	19	22.52	84	0.0365	0.0433	-0.0068
11	10-11	376	196	278.0	14	13.18	106	0.0504	0.0474	0.0030
12	11-12	166	160	86.0	6	4.43	135	0.0698	0.0515	0.0183

CHART 2

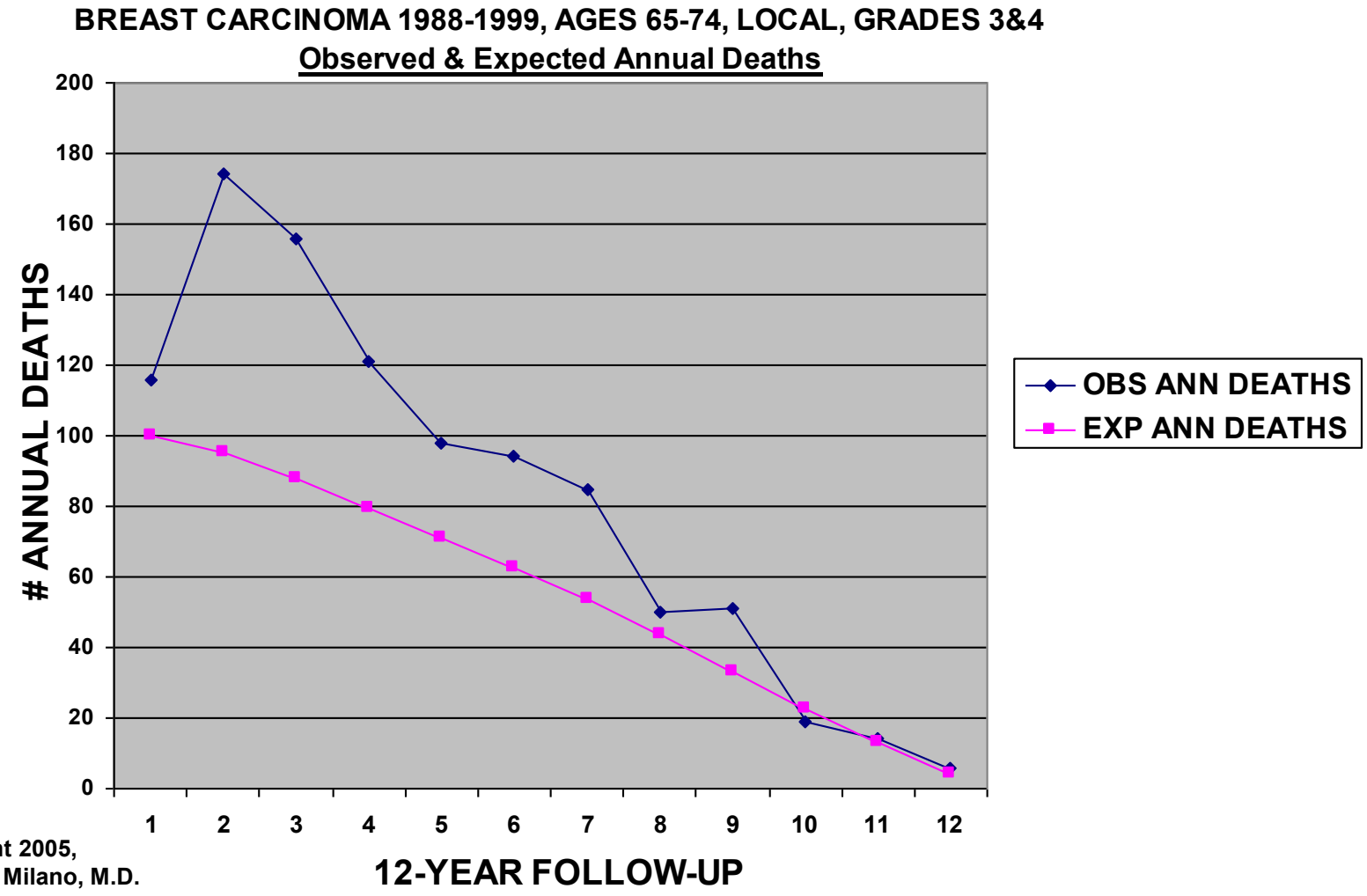


TABLE 3

BREAST CARCINOMA 1988-1999, AGES 65-74, LOCAL, GRADES 3&4

AGGREGATE AVERAGE ANNUAL SURVIVAL, RELATIVE MORTALITY, ABSOLUTE MORTALITY

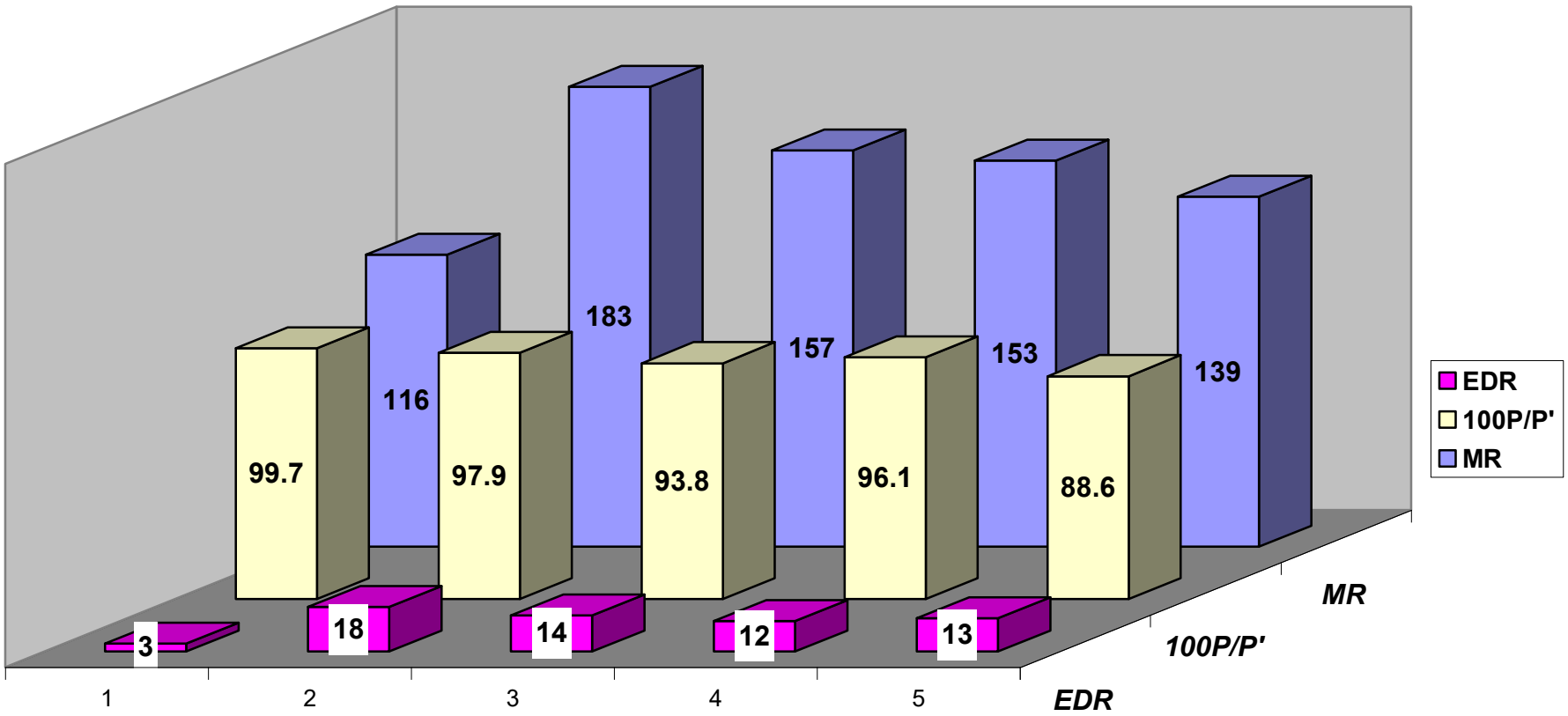
Duration	ℓ	E	d	d'	MR	q	q'	EDR	P	P'	100P/P'
0-1	5,319	5,076.0	116	100.00	116	0.0229	0.0197	3.2	0.9771	0.9803	99.7
1-2	4,717	4,449.5	174	95.22	183	0.0391	0.0214	17.7	0.9389	0.9593	97.9
2-5	4,008	9,493.0	375	238.32	157	0.0395	0.0251	14.4	0.8326	0.8881	93.8
0-5	5,319	19,018.5	665	433.54	153	0.0350	0.0228	12.2	0.9000	0.9370	96.1
5-10	2,275	6,291.0	299	215.42	139	0.0475	0.0342	13.3	0.6541	0.7383	88.6

Basis of Expected Deaths: 1970, 1980, 1990 U.S. Life Tables

Relative Mortality (MR) = 100d/d'
Absolute Mortality (EDR) = 1000*(q-q')
Relative Survival = 100P/P'

CHART 3. BREAST CARCINOMA, AGES 65-74, LOCAL, GRADES 3&4

Aggregate Average Annual Survival, Relative Mortality (MR), Absolute Mortality (EDR/M)



(1) **0-1** (2) **1-2** (3) **2-5** (4) **0-5** (5) **5-10 years**

Chart 4

DEBITS and/or ADDITIONAL EXTRAS

BREAST CARCINOMA, AGES 65-74, LOCAL, GRADES 3&4* 8/14/02

National Nancer Institute: SEER Cancer Data 1988-1999; SEER*Stat 4.2.0

Duration Start-End	Mortality Ratio (%)	Debits	Excess Death Rate	Additional Extras
t to t+ch t	100d/d'	MR-100	EDR	$M X years
0-1	116	16	3.2	3
1-2	183	83	17.7	18
2-5	157	57	14.4	14
5-10	139	39	13.3	13
10-15				
15-20				

SUGGESTED UNDERWRITING ACTION

FOR LIFE INSURANCE

Postpone 2-years, then:

$14M x 5-years

*Poorly differentiated / undifferentiated breast carcinoma

TABLE 4. Observed Female Life Expectancy (Breast Cancer) at Attained Age 70*

Age x	q'	EDR	Proj. q	l_x	d_x	L_x	T_x	LIFE EXPECTANCY e_x
70	0.01969	0.0122	0.0319	1000.00	31.89	984.06	13,620.44	13.62
71	0.02168	0.0122	0.0339	968.11	32.80	951.71	12,636.39	13.05
72	0.02386	0.0122	0.0361	935.31	33.73	918.45	11,684.68	12.49
73	0.02618	0.0122	0.0384	901.58	34.60	884.28	10,766.23	11.94
74	0.02860	0.0122	0.0408	866.98	35.37	849.29	9,881.95	11.40
75	0.03111	0.0122	0.0433	831.61	36.02	813.60	9,032.66	10.86
76	0.03387	0.0133	0.0472	795.59	37.53	776.83	8,219.06	10.33
77	0.03707	0.0133	0.0504	758.06	38.18	738.97	7,442.23	9.82
78	0.04090	0.0133	0.0542	719.88	39.02	700.37	6,703.26	9.31
79	0.04542	0.0133	0.0587	680.86	39.98	660.87	6,002.89	8.82
80	0.05053	0.0133	0.0638	640.88	40.91	620.43	5,342.02	8.34
81	0.05606	0.0133	0.0694	599.97	41.61	579.17	4,721.59	7.87
82	0.06215	0.0133	0.0755	558.36	42.13	537.30	4,142.42	7.42
83	0.06878	0.0133	0.0821	516.23	42.37	495.05	3,605.13	6.98
84	0.07607	0.0133	0.0894	473.86	42.35	452.68	3,110.08	6.56
85	0.08445	0.0133	0.0978	431.51	42.18	410.42	2,657.40	6.16
86	0.09402	0.0133	0.1073	389.33	41.78	368.44	2,246.98	5.77
87	0.10431	0.0133	0.1176	347.55	40.88	327.11	1,878.54	5.41
88	0.11512	0.0133	0.1284	306.67	39.38	286.98	1,551.43	5.06
89	0.12673	0.0133	0.1400	267.29	37.43	248.58	1,264.45	4.73
90	0.14015	0.0133	0.1535	229.86	35.27	212.22	1,015.87	4.42
91	0.15536	0.0133	0.1687	194.59	32.82	178.18	803.65	4.13
92	0.17101	0.0133	0.1843	161.77	29.82	146.86	625.47	3.87
93	0.18626	0.0133	0.1996	131.95	26.33	118.79	478.61	3.63
94	0.20148	0.0133	0.2148	105.62	22.69	94.28	359.82	3.41
95	0.21737	0.0133	0.2307	82.94	19.13	73.37	265.54	3.20
96	0.23434	0.0133	0.2476	63.80	15.80	55.90	192.17	3.01
97	0.25091	0.0133	0.2642	48.00	12.68	41.66	136.27	2.84
98	0.26715	0.0133	0.2805	35.32	9.91	30.37	94.60	2.68
99	0.28318	0.0133	0.2965	25.42	7.54	21.65	64.23	2.53
100	0.30017	0.0133	0.3135	17.88	5.60	15.08	42.59	2.38
101	0.31818	0.0133	0.3315	12.28	4.07	10.24	27.51	2.24
102	0.33727	0.0133	0.3506	8.21	2.88	6.77	17.27	2.10
103	0.35750	0.0133	0.3708	5.33	1.98	4.34	10.50	1.97
104	0.37895	0.0133	0.3923	3.35	1.32	2.70	6.16	1.84
105	0.40169	0.0133	0.4150	2.04	0.85	1.62	3.46	1.70
106	0.42579	0.0133	0.4391	1.19	0.52	0.93	1.85	1.55
107	0.45134	0.0133	0.4646	0.67	0.31	0.51	0.92	1.37
108	0.47842	0.0133	0.4917	0.36	0.18	0.27	0.40	1.13
109	0.50712	0.0133	0.5204	0.18	0.09	0.13	0.13	0.74
110								

* 1989-91 U.S. Decennial Tables for White Females

TABLE 5. Expected (Normal) Female Life Expectancy Starting at Attained Age 70*

Age x	q'	EDR	Proj. q	l_x	d_x	L_x	T_x	LIFE EXPECTANCY e_x
70	0.01969	0.0000	0.0197	1000.00	19.69	990.16	15,455.20	15.46
71	0.02168	0.0000	0.0217	980.31	21.25	969.68	14,465.04	14.76
72	0.02386	0.0000	0.0239	959.06	22.88	947.62	13,495.36	14.07
73	0.02618	0.0000	0.0262	936.17	24.51	923.92	12,547.74	13.40
74	0.02860	0.0000	0.0286	911.66	26.07	898.63	11,623.82	12.75
75	0.03111	0.0000	0.0311	885.59	27.55	871.82	10,725.20	12.11
76	0.03387	0.0000	0.0339	858.04	29.06	843.51	9,853.38	11.48
77	0.03707	0.0000	0.0371	828.98	30.73	813.61	9,009.87	10.87
78	0.04090	0.0000	0.0409	798.25	32.65	781.92	8,196.26	10.27
79	0.04542	0.0000	0.0454	765.60	34.77	748.21	7,414.33	9.68
80	0.05053	0.0000	0.0505	730.83	36.93	712.36	6,666.12	9.12
81	0.05606	0.0000	0.0561	693.90	38.90	674.45	5,953.76	8.58
82	0.06215	0.0000	0.0622	655.00	40.71	634.64	5,279.31	8.06
83	0.06878	0.0000	0.0688	614.29	42.25	593.16	4,644.67	7.56
84	0.07607	0.0000	0.0761	572.04	43.51	550.28	4,051.50	7.08
85	0.08445	0.0000	0.0845	528.52	44.63	506.21	3,501.22	6.62
86	0.09402	0.0000	0.0940	483.89	45.50	461.14	2,995.01	6.19
87	0.10431	0.0000	0.1043	438.39	45.73	415.53	2,533.87	5.78
88	0.11512	0.0000	0.1151	392.67	45.20	370.06	2,118.34	5.39
89	0.12673	0.0000	0.1267	347.46	44.03	325.45	1,748.28	5.03
90	0.14015	0.0000	0.1402	303.43	42.53	282.17	1,422.83	4.69
91	0.15536	0.0000	0.1554	260.90	40.53	240.64	1,140.67	4.37
92	0.17101	0.0000	0.1710	220.37	37.69	201.53	900.03	4.08
93	0.18626	0.0000	0.1863	182.68	34.03	165.67	698.50	3.82
94	0.20148	0.0000	0.2015	148.66	29.95	133.68	532.83	3.58
95	0.21737	0.0000	0.2174	118.71	25.80	105.80	399.15	3.36
96	0.23434	0.0000	0.2343	92.90	21.77	82.02	293.35	3.16
97	0.25091	0.0000	0.2509	71.13	17.85	62.21	211.33	2.97
98	0.26715	0.0000	0.2672	53.28	14.23	46.17	149.12	2.80
99	0.28318	0.0000	0.2832	39.05	11.06	33.52	102.96	2.64
100	0.30017	0.0000	0.3002	27.99	8.40	23.79	69.44	2.48
101	0.31818	0.0000	0.3182	19.59	6.23	16.47	45.65	2.33
102	0.33727	0.0000	0.3373	13.36	4.50	11.10	29.17	2.18
103	0.35750	0.0000	0.3575	8.85	3.16	7.27	18.07	2.04
104	0.37895	0.0000	0.3790	5.69	2.16	4.61	10.80	1.90
105	0.40169	0.0000	0.4017	3.53	1.42	2.82	6.19	1.75
106	0.42579	0.0000	0.4258	2.11	0.90	1.66	3.37	1.59
107	0.45134	0.0000	0.4513	1.21	0.55	0.94	1.71	1.41
108	0.47842	0.0000	0.4784	0.67	0.32	0.51	0.77	1.15
109	0.50712	0.0000	0.5071	0.35	0.18	0.26	0.26	0.75
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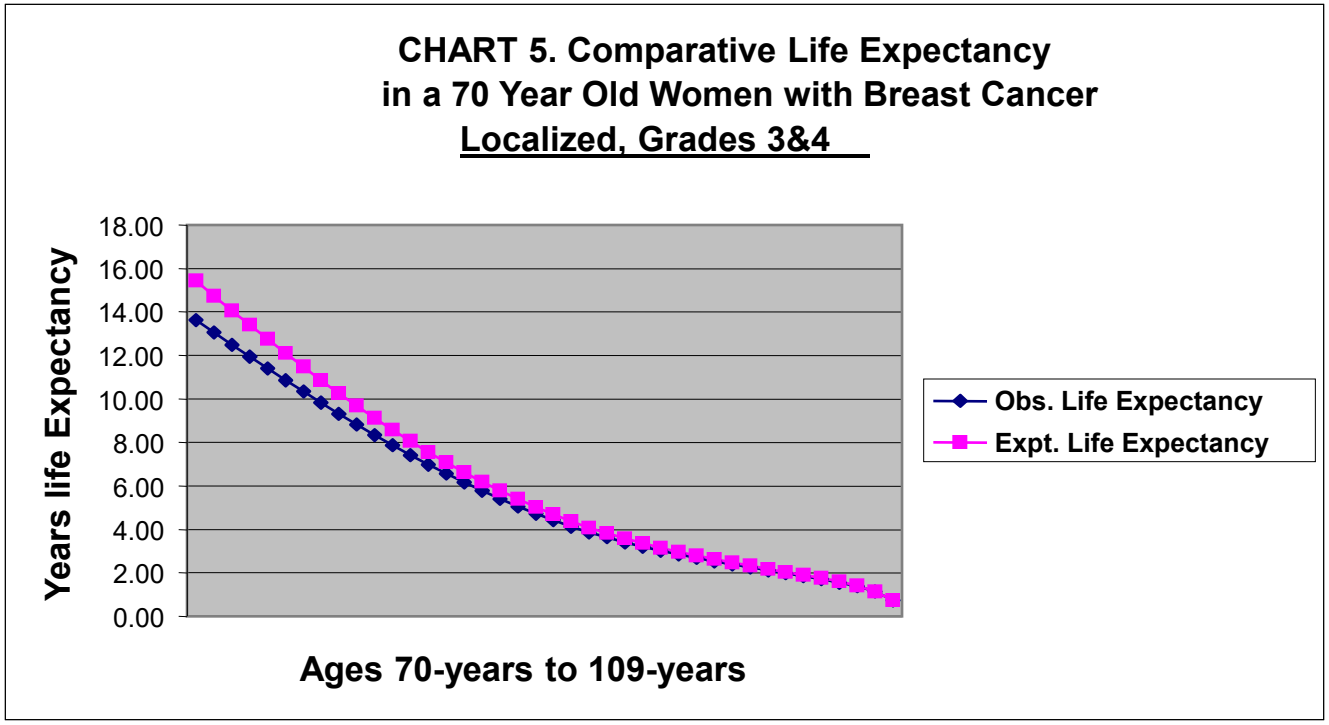
* 1989-91 U.S. Decennial Tables for White Females

TABLE 6. Comparative (Observed vs. Expected) Life Expectancy at Attained Age 70*

Age x	Obs. Life Expectancy	Expt. Life Expectancy
70	13.62	15.46
71	13.05	14.76
72	12.49	14.07
73	11.94	13.40
74	11.40	12.75
75	10.86	12.11
76	10.33	11.48
77	9.82	10.87
78	9.31	10.27
79	8.82	9.68
80	8.34	9.12
81	7.87	8.58
82	7.42	8.06
83	6.98	7.56
84	6.56	7.08
85	6.16	6.62
86	5.77	6.19
87	5.41	5.78
88	5.06	5.39
89	4.73	5.03
90	4.42	4.69
91	4.13	4.37
92	3.87	4.08
93	3.63	3.82
94	3.41	3.58
95	3.20	3.36
96	3.01	3.16
97	2.84	2.97
98	2.68	2.80
99	2.53	2.64
100	2.38	2.48
101	2.24	2.33
102	2.10	2.18
103	1.97	2.04
104	1.84	1.90
105	1.70	1.75
106	1.55	1.59
107	1.37	1.41
108	1.13	1.15
109	0.74	0.75
110		



Conclusion

On the basis of the foregoing analysis and attached life tables, I conclude with a reasonable degree of medical probability, that the life expectancy of a group of 70 year old white women with the same set of risk factors as those found in this client is 13.62 years. This is a reduction of 11.9 % below the life expectancy of 15.46 years in the 1989-91 U.S. Decennial Life Tables for a population matched by age, sex, and race.

* 1989-91 U.S. Decennial Tables for White Females

FORMAT FOR MORTALITY AND LIFE EXPECTANCY PROJECTIONS

Date: 8/14/2002

Client name: Jane Doe

Sex: Female
Height: 5' 5"
Weight: 135 lbs
Smoker Status: NS

DOB: 7/14/1932

Current Age: 70 years

Type of Insurance Applied For: Term
Policy Number:

Brief Clinical History to Include:

Diagnosis & Age at Dx: Breast carcinoma, local stage, grades 3&4; Age 70

Disease Extent: (i.e. 1-vessel, 2-vessel etc CAD); Local, Regional or Distant Stage Cancer, etc.

Disease Severity: (i.e. ejection fraction for CAD); Tumor Grade (Well, Mod., Poorly, Undifferentiated)

Treatments and Outcomes: Medical, Surgical, Radiation etc Current Med/Surg/Rad

Complications:

Comorbidities: Mild osteoarthritis

Current Risk Factors: None; recent exercise stress test normal and lab profile normal

Current Health and ADL Status:

Projected Extra Mortality: See mortality tables, excess death rates (EDRs), underwriting action.
Estimated Life Expectancy: 13.62 years
Percent (%) Life-Expectancy Years Lost: 11.90%

Medical Risk Appraisal & Life Expectancy Date: 8/14/2002
Anthony F. Milano, M.D., M.P.H.

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