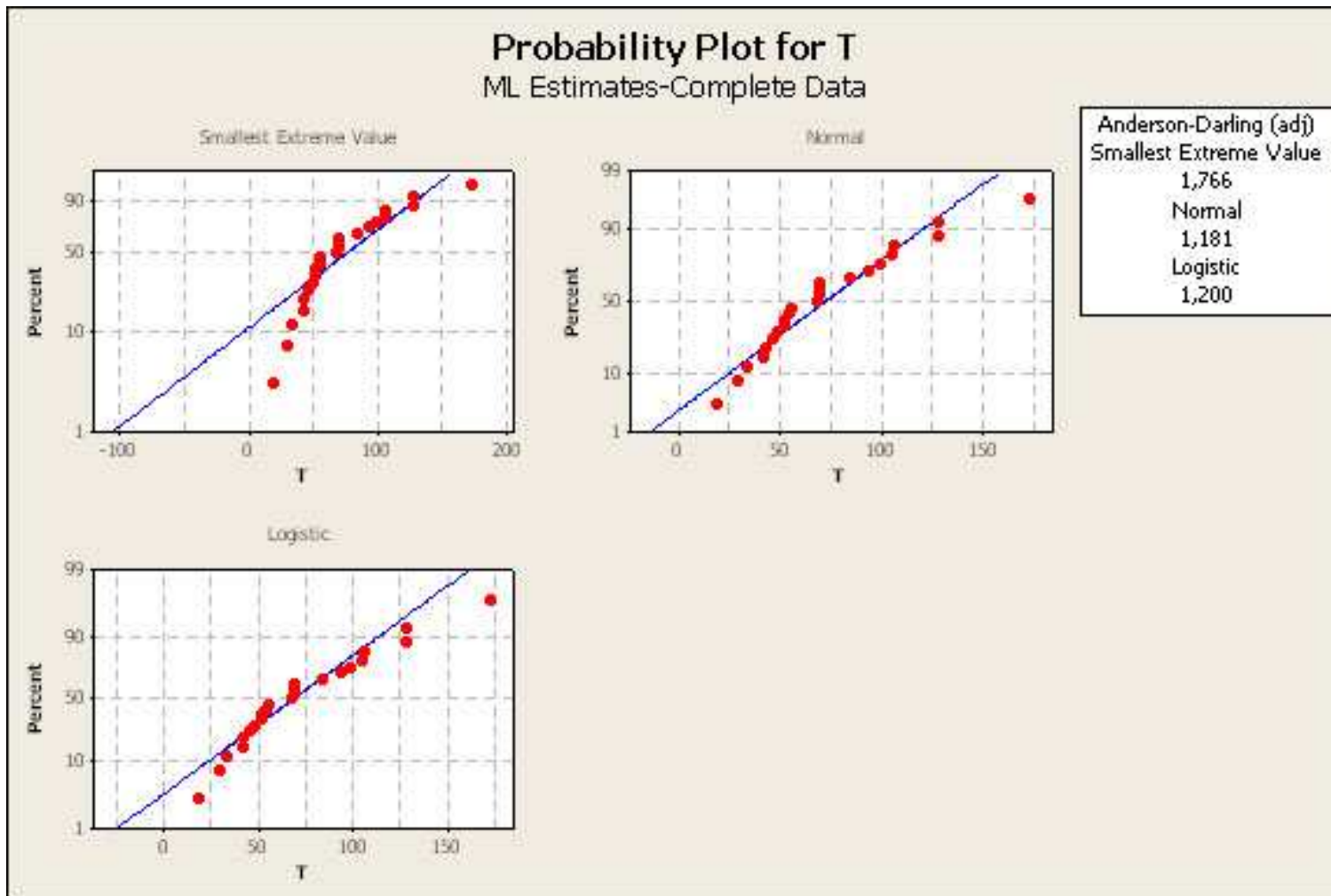
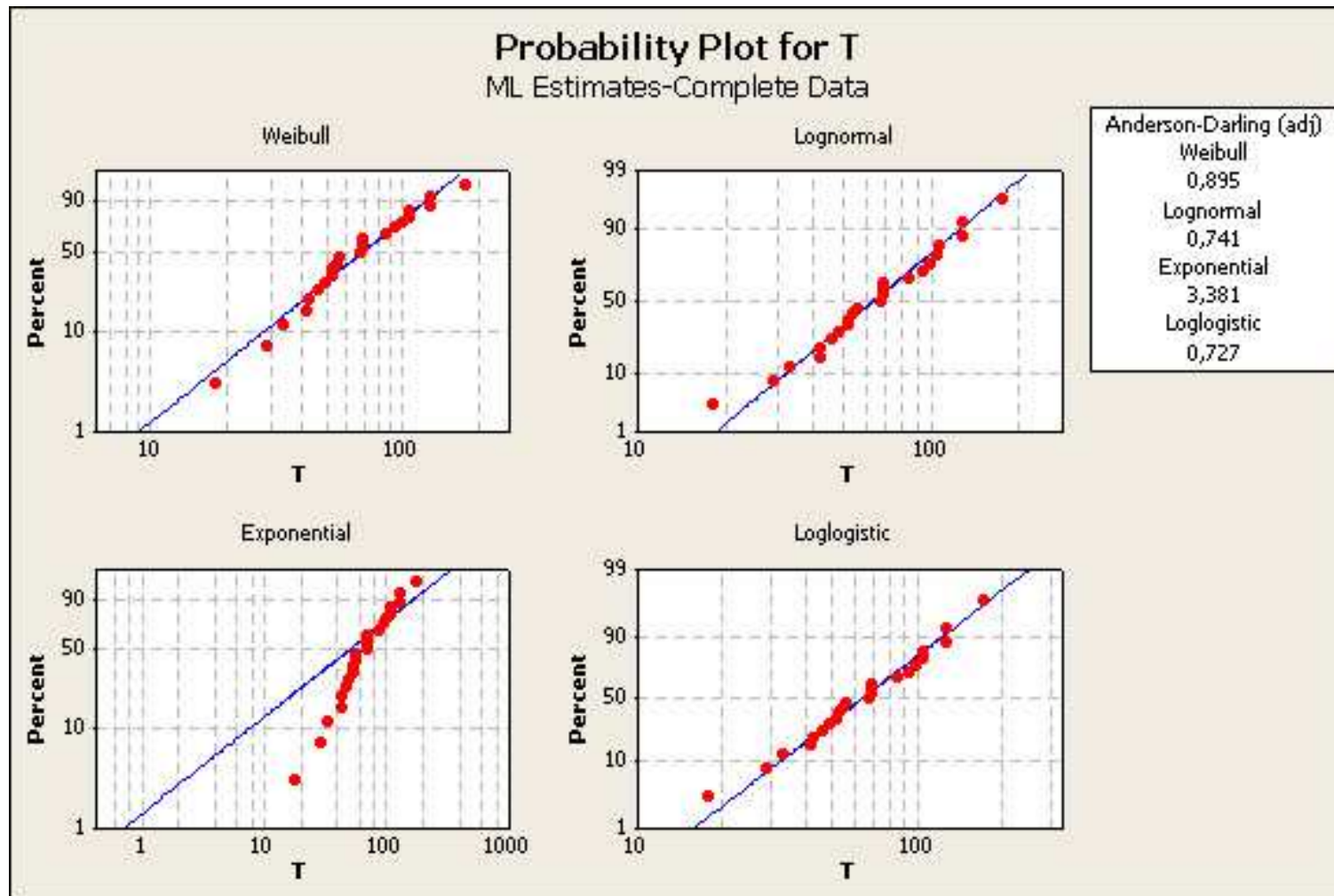


BALL BEARINGS DATA



BALL BEARINGS DATA



BALL BEARING DATA

Distribution ID Plot: T

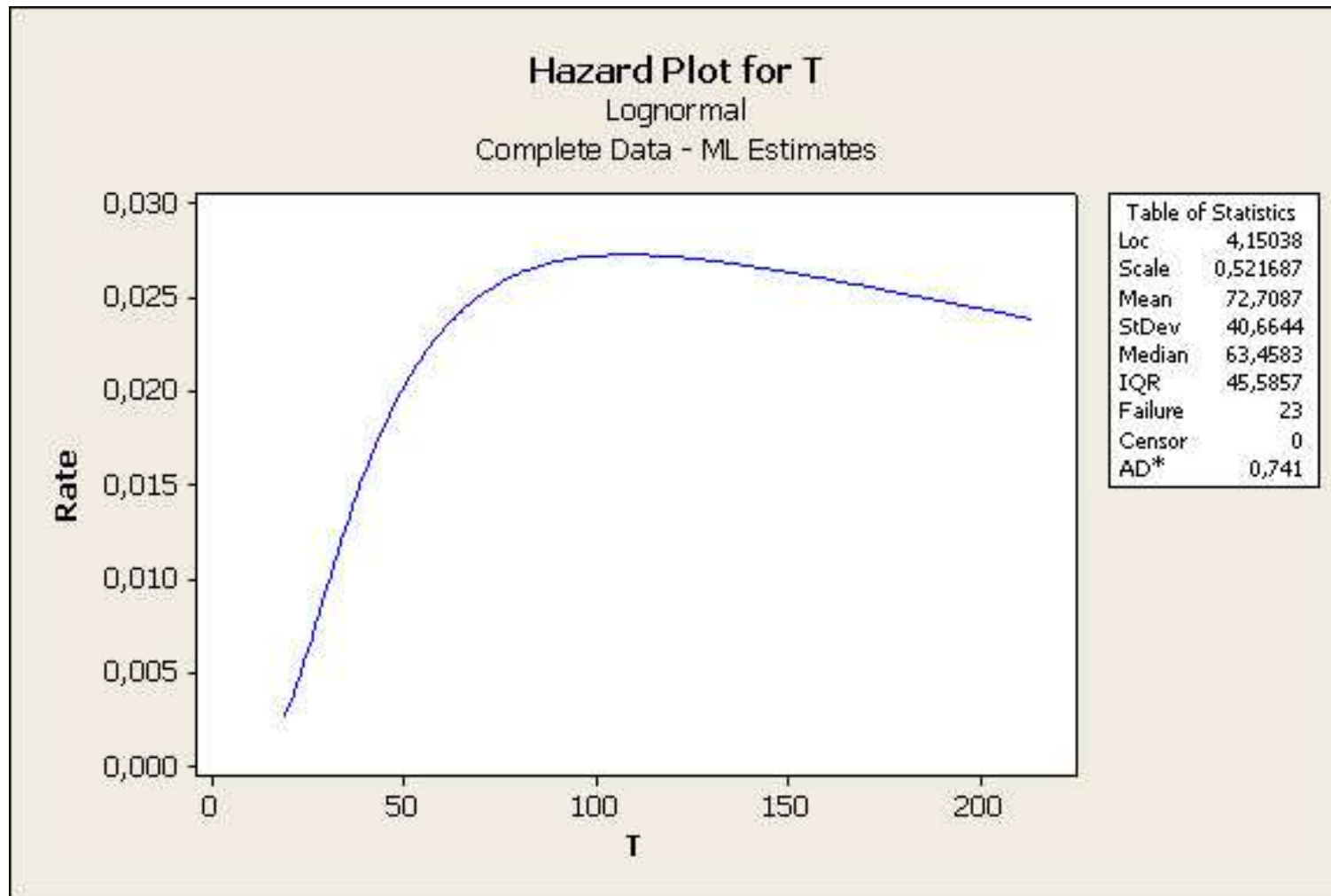
Goodness-of-Fit

	Anderson-Darling
Distribution	(adj)
Exponential	3,381
Weibull	0,895
Lognormal	0,741
Loglogistic	0,727

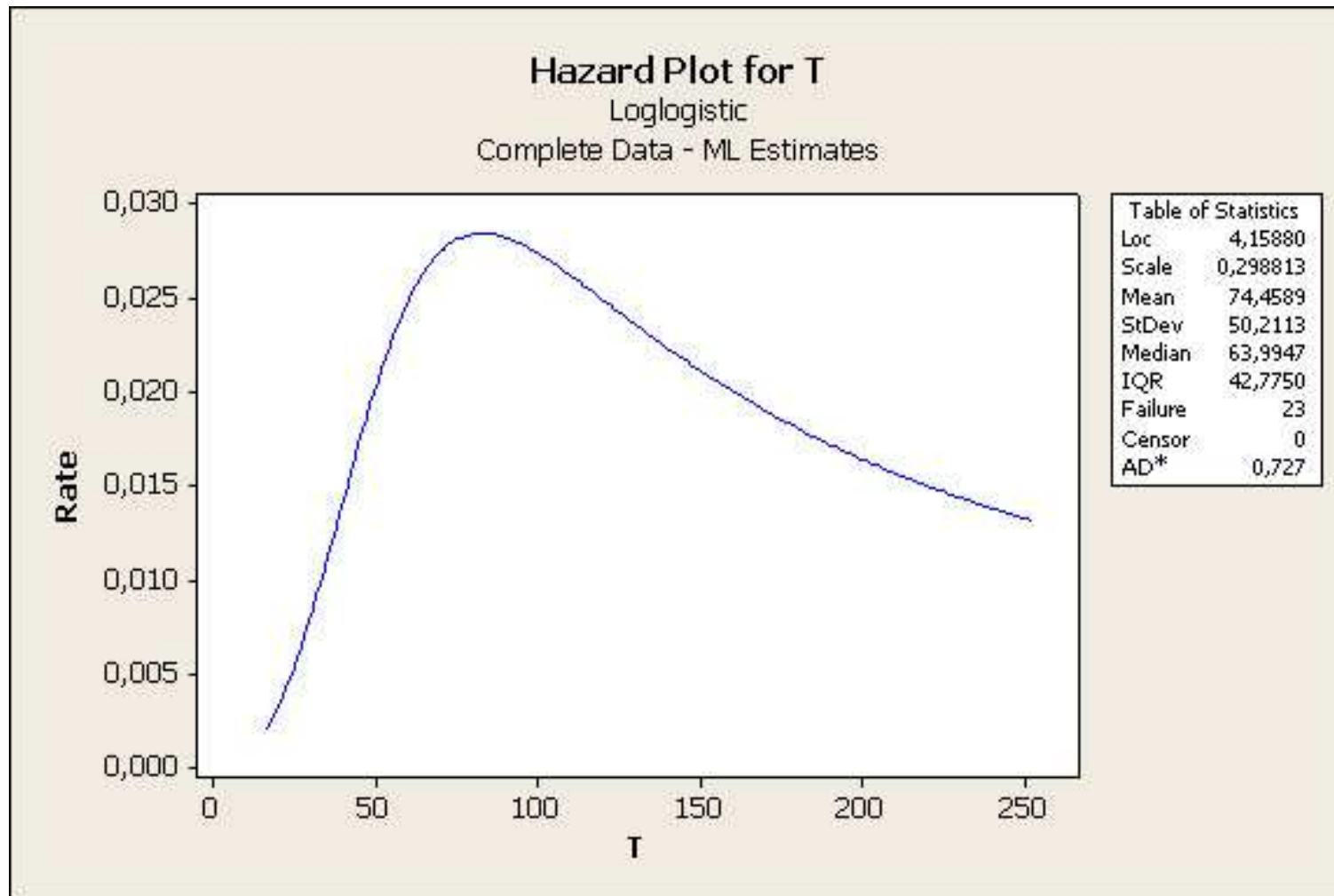
Table of MTF

Distribution	Mean	Standard Error	95% Normal CI	
			Lower	Upper
Exponential	72,2209	15,0591	47,9927	108,680
Weibull	72,5154	7,5939	59,0596	89,037
Lognormal	72,7087	8,4302	57,9288	91,260
Loglogistic	74,4589	9,0701	58,6447	94,538

BALL BEARINGS DATA



BALL BEARINGS DATA



Distribution: Loglogistic

Parameter Estimates

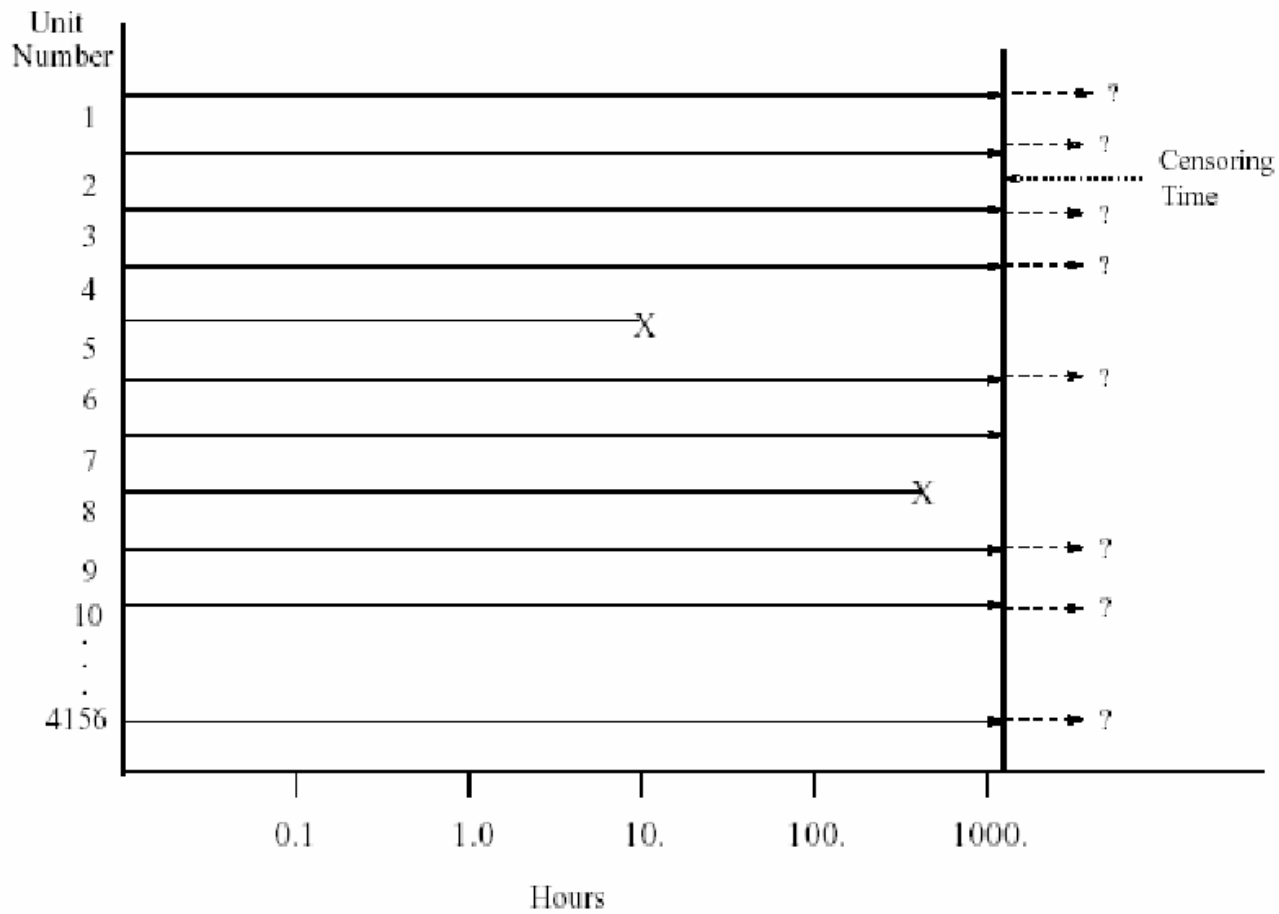
Parameter	Estimate	Standard Error	95,0% Normal CI	
			Lower	Upper
Location	4,15880	0,109047	3,94507	4,37253
Scale	0,298813	0,0515266	0,213118	0,418965

Characteristics of Distribution

	Estimate	Standard Error	95,0% Normal CI	
			Lower	Upper
Mean(MTTF)	74,4589	9,07013	58,6447	94,5377
Standard Deviation	50,2113	17,0541	25,8044	97,7034
Median	63,9947	6,97843	51,6801	79,2438
First Quartile(Q1)	46,0866	5,65417	36,2363	58,6144
Third Quartile(Q3)	88,8616	10,9338	69,8199	113,096
Interquartile Range(IQR)	42,7750	8,96475	28,3658	64,5036

EXAMPLE: CENSORING

IC Data Failure Pattern



Example of Censoring: Leukemia Data

Remission times for 42 children with acute leukemia

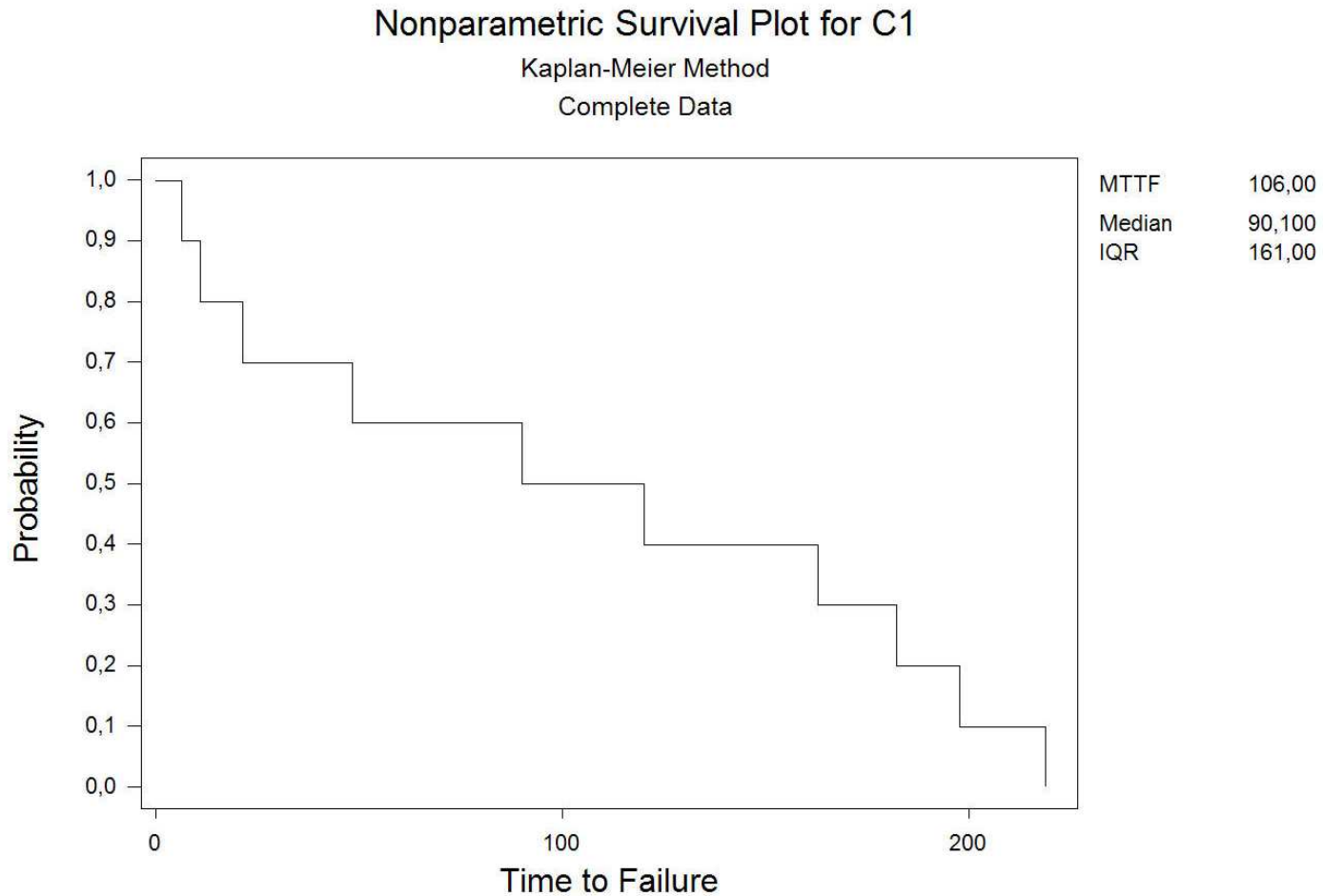
T=remission time (free of symptoms), C=censoring
(0=censored)

	Placebo		6MP treatment	
	T	C	T	C
1	1	1	6	1
2	1	1	6	1
3	2	1	6	1
4	2	1	6	0
5	3	1	7	1
6	4	1	9	0
7	4	1	10	1
8	5	1	10	0
9	5	1	11	0

	Placebo		6MP treatment	
	T	C	T	C
10	8	1	13	1
11	8	1	16	1
12	8	1	17	0
13	8	1	19	0
14	11	1	20	0
15	11	1	22	1
16	12	1	23	1
17	12	1	25	0
18	15	1	32	0
19	17	1	32	0
20	22	1	34	0
21	23	1	35	0

EMPIRICAL SURVIVAL FUNCTION – COMPLETE DATA (Example 11.8)

Data: 6.3, 11.0, 21.5, 48.4, 90.1, 120.2, 163.0, k 182.5, 198.0, 219.0

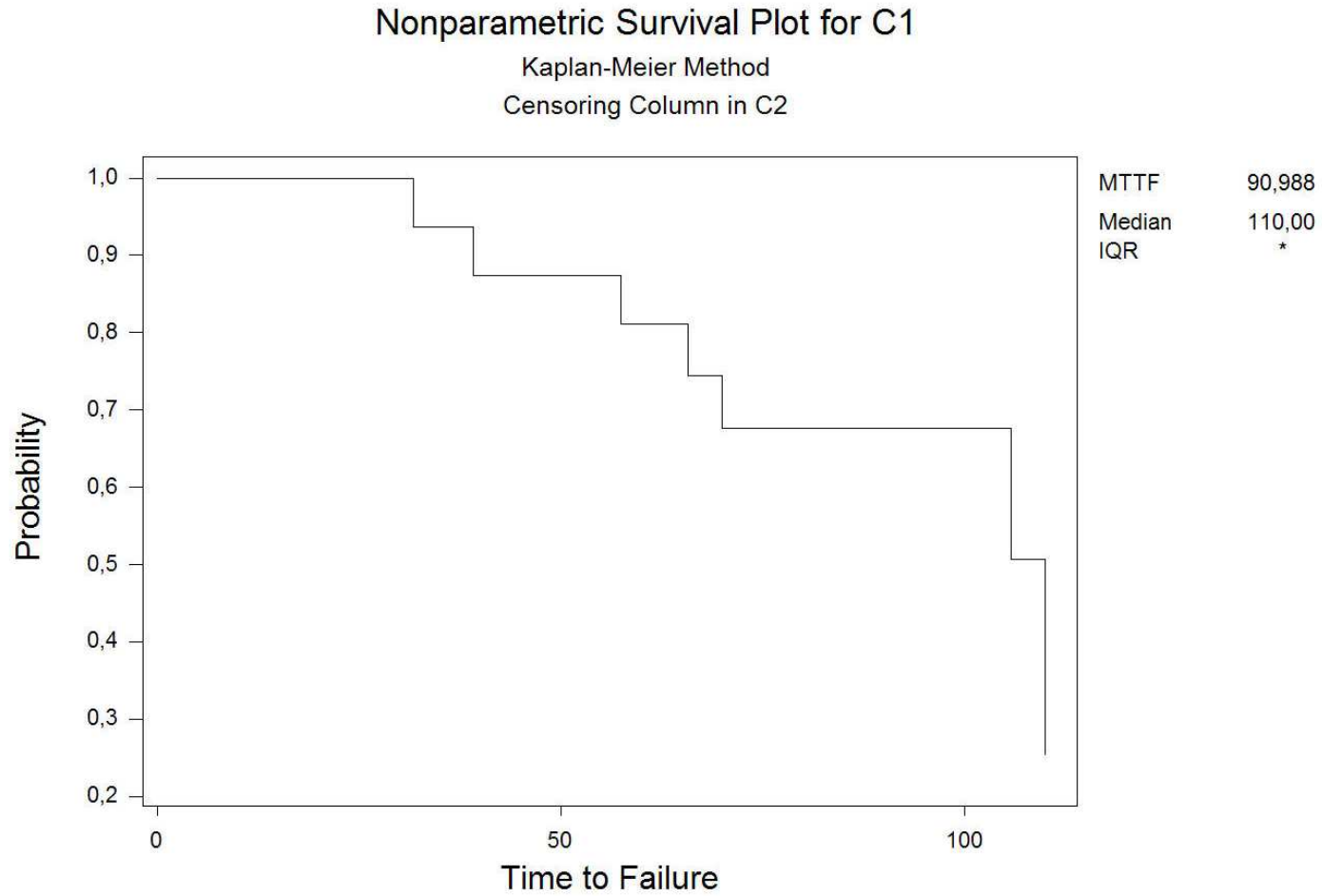


KAPLAN-MEIER ESTIMATOR – CENSORED DATA (Example 11.5)

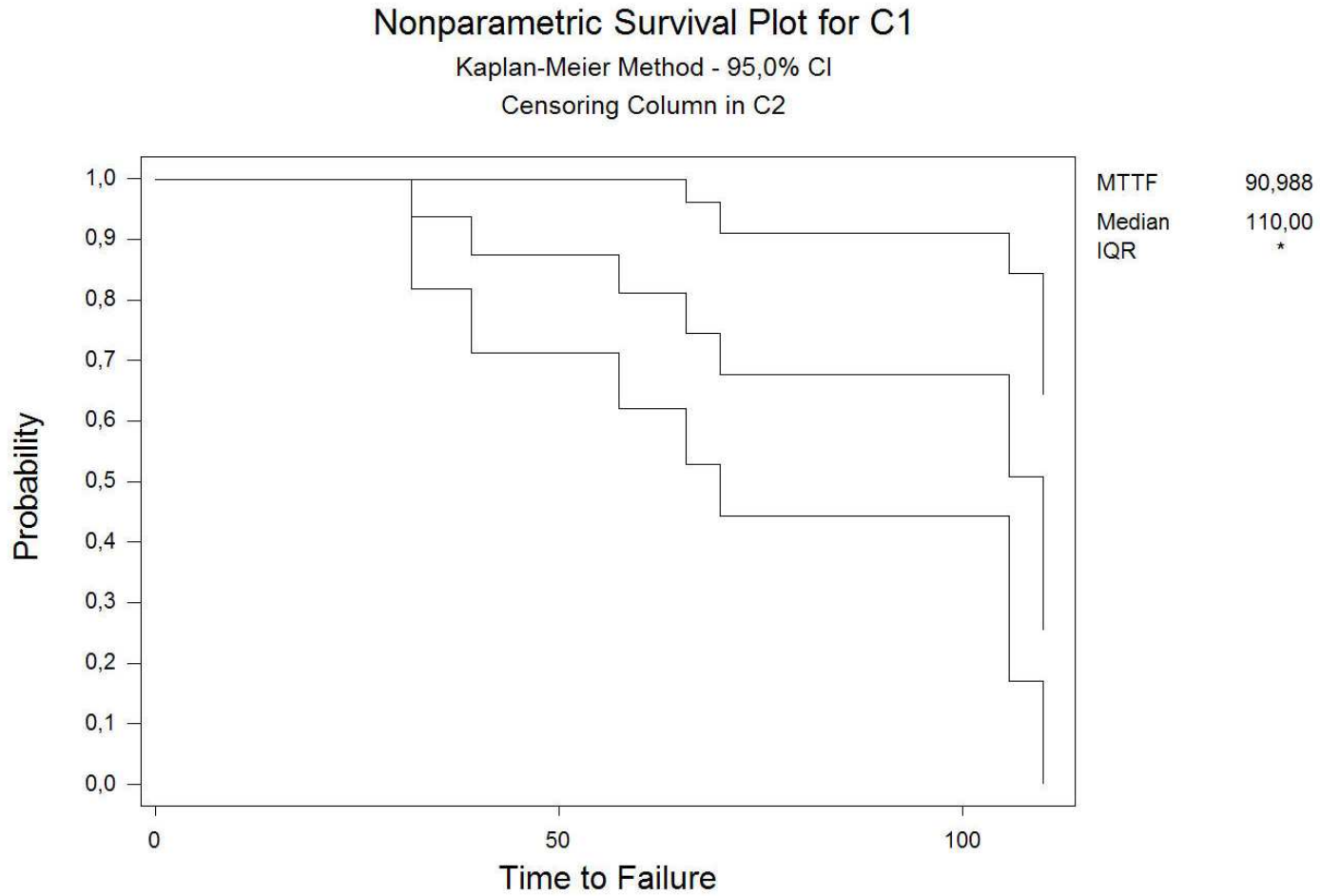
Row	C1	C2
1	31,7	1
2	39,2	1
3	57,5	1
4	65,0	0
5	65,8	1
6	70,0	1
7	75,0	0
8	75,2	0
9	87,5	0
10	88,3	0
11	94,2	0
12	101,7	0
13	105,8	1
14	109,2	0
15	110,0	1
16	130,0	0

Time	Number at Risk	Number Failed	Survival Probability	Standard Error	95,0% Normal CI Lower	Upper
31,7000	16	1	0,9375	0,0605	0,8189	1,0000
39,2000	15	1	0,8750	0,0827	0,7130	1,0000
57,5000	14	1	0,8125	0,0976	0,6213	1,0000
65,8000	12	1	0,7448	0,1105	0,5283	0,9613
70,0000	11	1	0,6771	0,1194	0,4431	0,9111
105,8000	4	1	0,5078	0,1718	0,1711	0,8445
110,0000	2	1	0,2539	0,1990	0,0000	0,6440

KM-plot (Example 11.5)



KM-plot with confidence limits (Example 11.5)



Kaplan-Meier Estimator – Leukemia Data

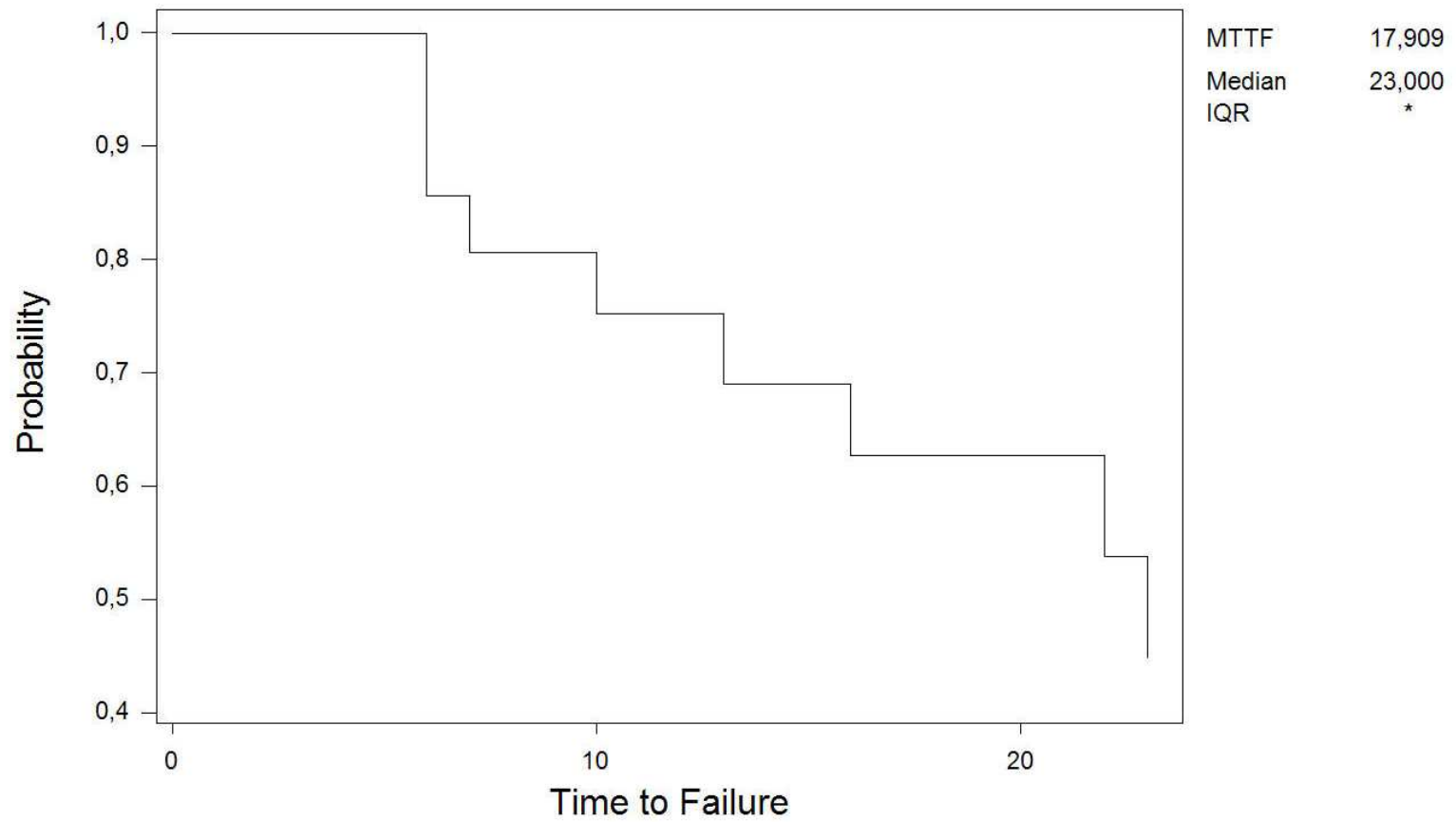
Treatment group (6MP)

Time	Number at Risk	Number Failed	Survival Probability	Standard Error
6,0000	21	3	0,8571	0,0764
7,0000	17	1	0,8067	0,0869
10,0000	15	1	0,7529	0,0963
13,0000	12	1	0,6902	0,1068
16,0000	11	1	0,6275	0,1141
22,0000	7	1	0,5378	0,1282
23,0000	6	1	0,4482	0,1346

KM-plot: Leukemia Data (Treatment group)

Nonparametric Survival Plot for TMP

Kaplan-Meier Method
Censoring Column in CMP



NELSON ESTIMATOR

Data from Example 11.5

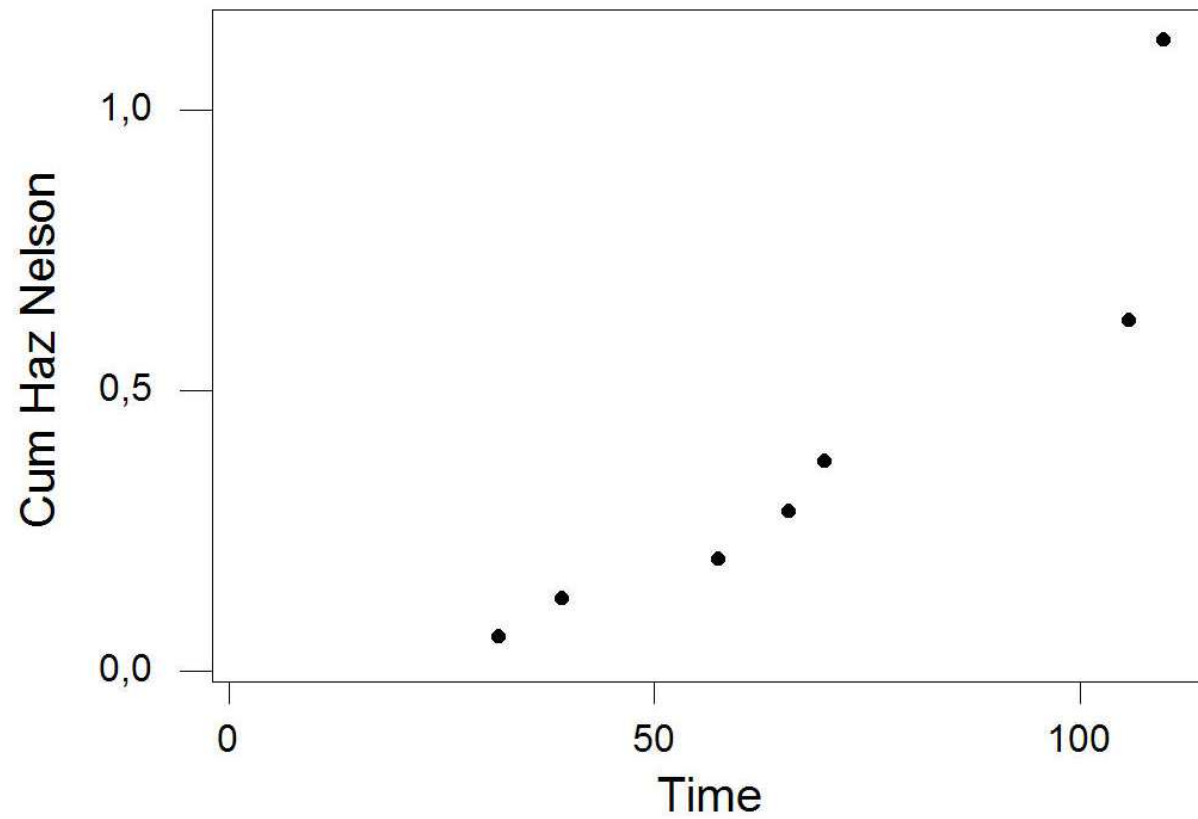
Row	Time	Numb at risk	1/Numb at risk	Cum Haz Nelson	Survival Nelson
1	31,7	16	0,062500	0,06250	0,939413
2	39,2	15	0,066667	0,12917	0,878827
3	57,5	14	0,071429	0,20060	0,818244
4	65,8	12	0,083333	0,28393	0,752820
5	70,0	11	0,090909	0,37484	0,687401
6	105,8	4	0,250000	0,62484	0,535348
7	110,0	2	0,500000	1,12484	0,324705

Survival KM

0,937500	0,875000	0,812500	0,744792	0,677083	0,507813
0,253906					

Nelson-plot: Example 11.5.

Nelson Plot



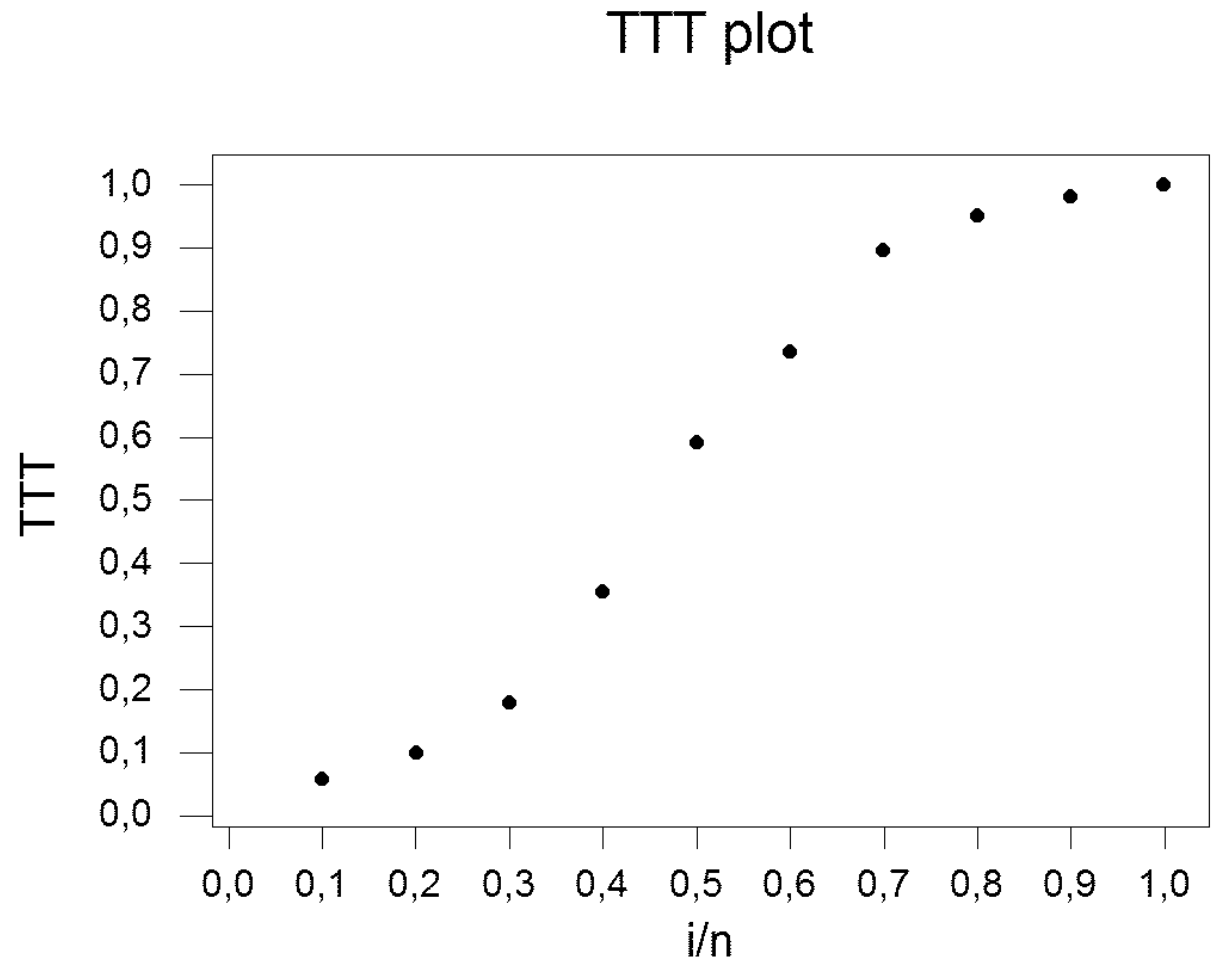
TTT-plot

See Table 11.5

Complete (i.e. uncensored) data.

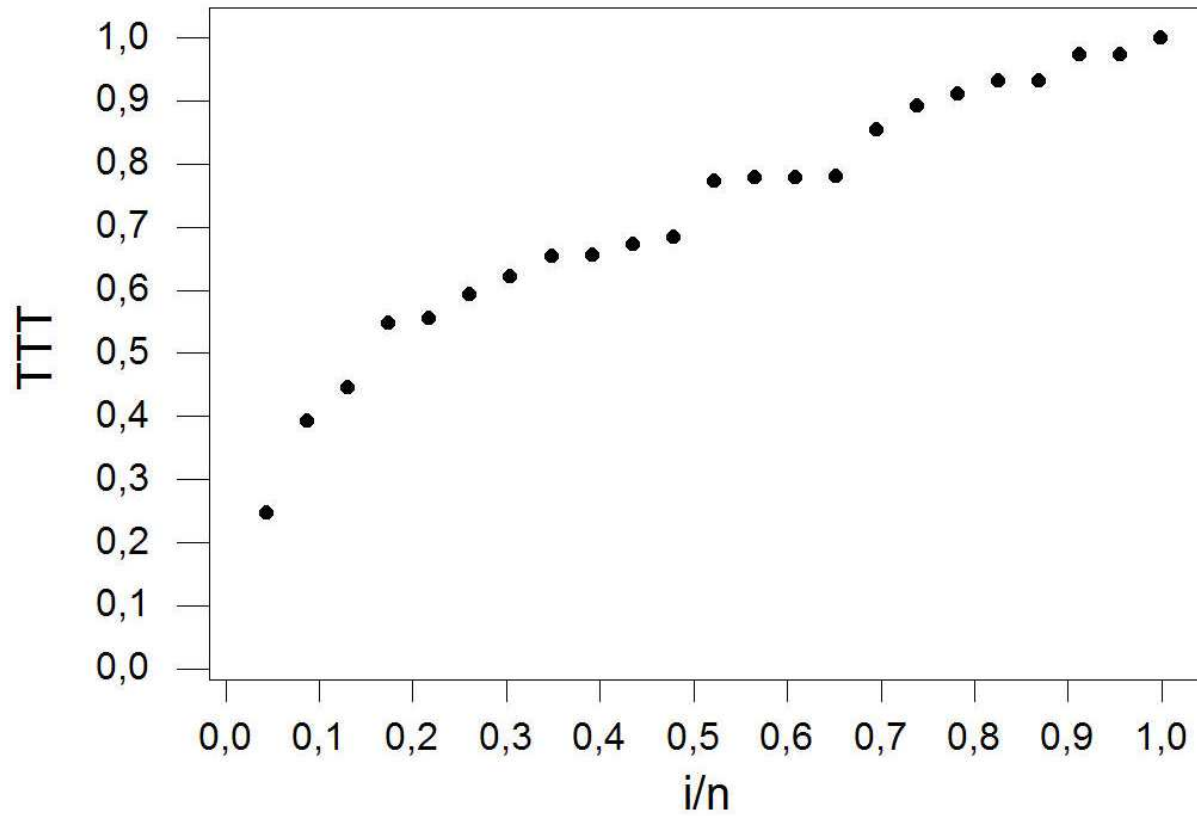
Row	Time	TTT interval	TTT cum	i/n	TTT
1	6,3	$10*6,3 = 63,0$	63,0	0,1	0,05943
2	11,0	$9*4,7 = 42,3$	105,3	0,2	0,09934
3	21,5	$8*10,5 = 84,0$	189,3	0,3	0,17858
4	48,4	$7*27,9 = 188,3$	377,6	0,4	0,35623
5	90,1	$6*41,7 = 250,2$	627,8	0,5	0,59226
6	120,2	$5*30,1 = 150,5$	778,3	0,6	0,73425
7	163,0	$4*42,8 = 171,2$	949,5	0,7	0,89575
8	182,5	$3*19,5 = 58,5$	1008,0	0,8	0,95094
9	198,0	$2*15,5 = 31,0$	1039,0	0,9	0,98019
10	219,0	$1*21,0 = 21,0$	1060,0	1,0	1,00000

TTT-plot (Data from Table 11.5)



BALL BEARINGS FAILURE DATA

TTT plot



BALL BEARINGS FAILURE DATA

Row	Time	Censor	No at risk	Total time	Cum total time	Plot total time	i/n	TTT
1	17,88	1	23	411,24	411,24	411,24	0,04348	0,24757
2	28,92	1	22	242,88	654,12	654,12	0,08696	0,39379
3	33,00	1	21	85,68	739,80	739,80	0,13043	0,44537
4	41,52	1	20	170,40	910,20	910,20	0,17391	0,54796
5	42,12	1	19	11,40	921,60	921,60	0,21739	0,55482
6	45,60	1	18	62,64	984,24	984,24	0,26087	0,59253
7	48,40	1	17	47,60	1031,84	1031,84	0,30435	0,62119
8	51,84	1	16	55,04	1086,88	1086,88	0,34783	0,65432
9	51,96	1	15	1,80	1088,68	1088,68	0,39130	0,65540
10	54,12	1	14	30,24	1118,92	1118,92	0,43478	0,67361
11	55,56	1	13	18,72	1137,64	1137,64	0,47826	0,68488
12	67,80	1	12	146,88	1284,52	1284,52	0,52174	0,77330
13	68,64	1	11	9,24	1293,76	1293,76	0,56522	0,77887
14	68,64	1	10	0,00	1293,76	1293,76	0,60870	0,77887
15	68,88	1	9	2,16	1295,92	1295,92	0,65217	0,78017
16	84,12	1	8	121,92	1417,84	1417,84	0,69565	0,85357
17	93,12	1	7	63,00	1480,84	1480,84	0,73913	0,89149
18	98,64	1	6	33,12	1513,96	1513,96	0,78261	0,91143
19	105,12	1	5	32,40	1546,36	1546,36	0,82609	0,93094
20	105,84	1	4	2,88	1549,24	1549,24	0,86957	0,93267
21	127,92	1	3	66,24	1615,48	1615,48	0,91304	0,97255
22	128,04	1	2	0,24	1615,72	1615,72	0,95652	0,97269
23	173,40	1	1	45,36	1661,08	1661,08	1,00000	1,00000

TTT AND BARLOW-PROSCHAN FOR CENSORED DATA

Example 11.15

Row	Time	Censor	No at risk	Total time	Cum total time
1	0,35	1	12	4,20	4,20
2	0,50	0	11	1,65	5,85
3	0,75	0	10	2,50	8,35
4	1,00	1	9	2,25	10,60
5	1,30	1	8	2,40	13,00
6	1,80	1	7	3,50	16,50
7	3,00	0	6	7,20	23,70
8	3,15	0	5	0,75	24,45
9	4,85	0	4	6,80	31,25
10	5,50	1	3	1,95	33,20
11	5,50	0	2	0,00	33,20
12	6,25	0	1	0,75	33,95

Row	i/n	TTT
1	0,2	0,12651
2	0,4	0,31928
3	0,6	0,39157
4	0,8	0,49699
5	1,0	1,00000

BARLOW-PROSCHAN'S TEST:

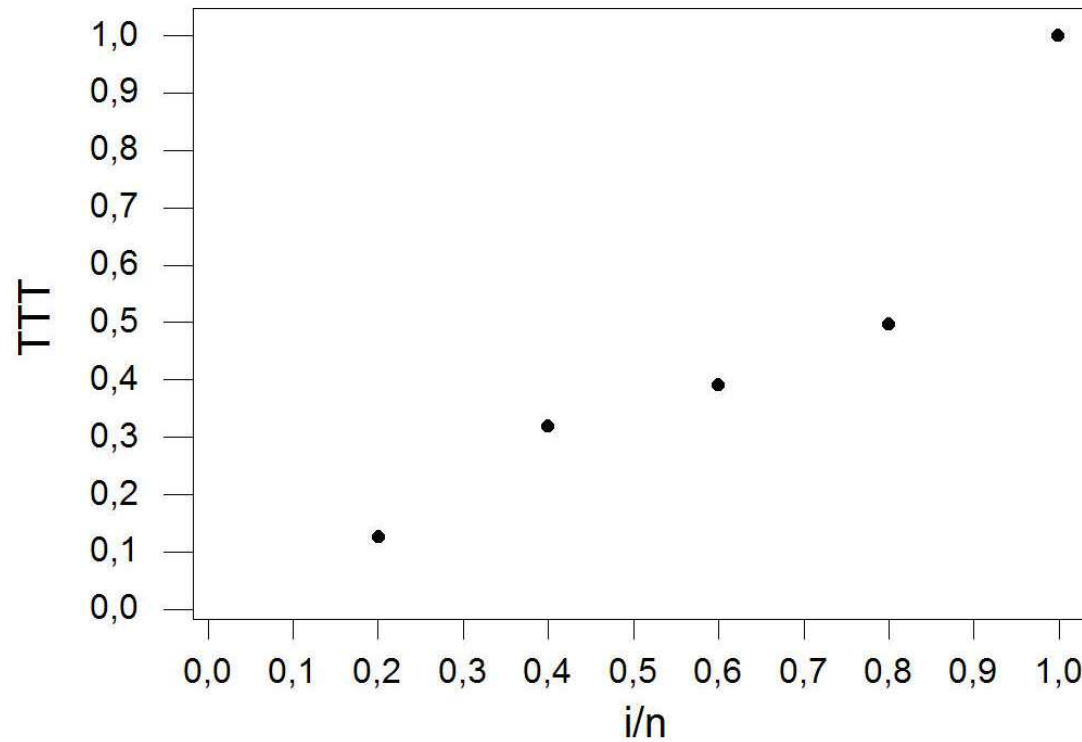
$$W = (4.2+10.6+13.0+16.5)/33.2 = 1.33$$

alt. $W = 0.13 + 0.32 + 0.39 + 0.50 = 1.34$
(k-1 = 4)

Example 11.15

NOTE! This is not the same plot as is suggested for censored data in the book (Chap. 11.3.8/p. 498)

TTT-plot censored data



Row	Time	Censor	No at risk	Total time	Cum total time	Plot total time
1	31,7	1	16	507,2	507,2	507,2
2	39,2	1	15	112,5	619,7	619,7
3	57,5	1	14	256,2	875,9	875,9
4	65,0	0	13	97,5	973,4	983,0
5	65,8	1	12	9,6	983,0	1029,2
6	70,0	1	11	46,2	1029,2	1274,3
7	75,0	0	10	50,0	1079,2	1286,1
8	75,2	0	9	1,8	1081,0	
9	87,5	0	8	98,4	1179,4	
10	88,3	0	7	5,6	1185,0	
11	94,2	0	6	35,4	1220,4	
12	101,7	0	5	37,5	1257,9	
13	105,8	1	4	16,4	1274,3	
14	109,2	0	3	10,2	1284,5	
15	110,0	1	2	1,6	1286,1	
16	130,0	0	1	20,0	1306,1	

Row	i/n	TTT
1	0,14286	0,39437
2	0,28571	0,48184
3	0,42857	0,68105
4	0,57143	0,76433
5	0,71429	0,80025
6	0,85714	0,99082
7	1,00000	1,00000

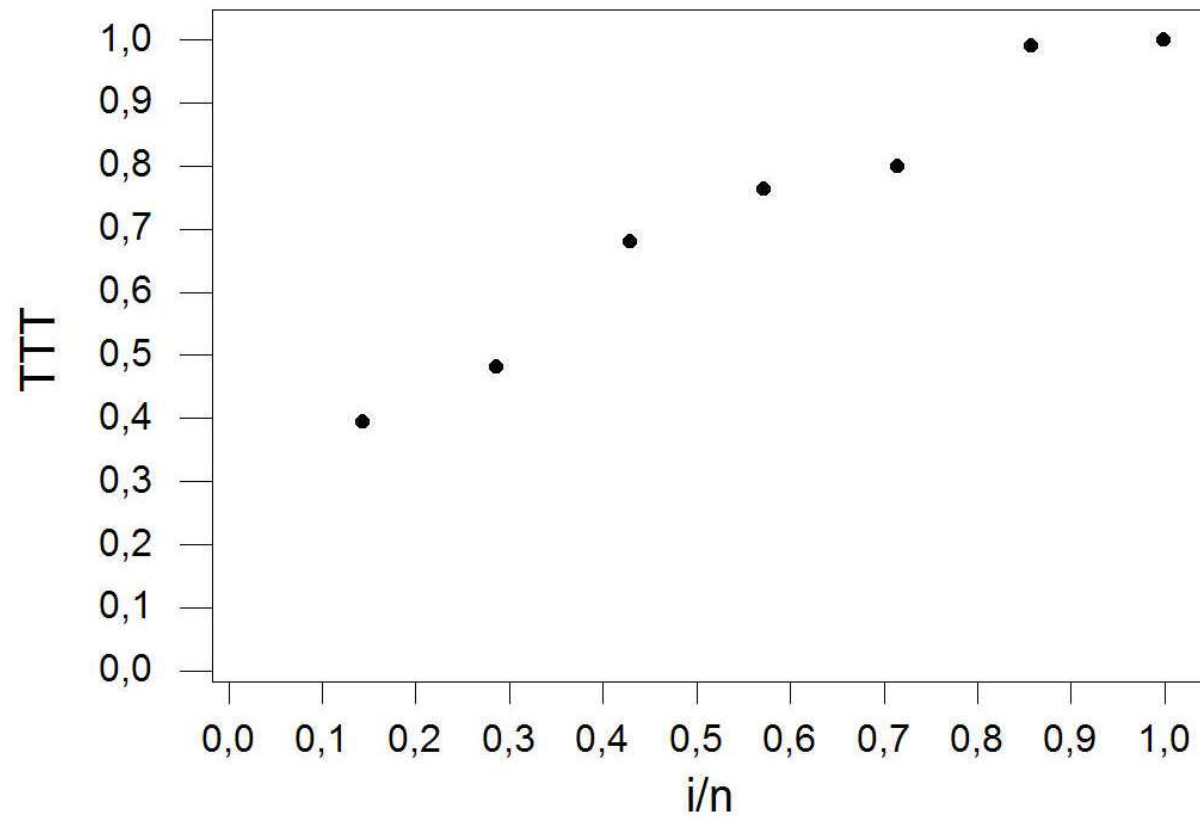
Data from Table 11.1/9.3

BARLOW-PROSCHAN'S TEST:

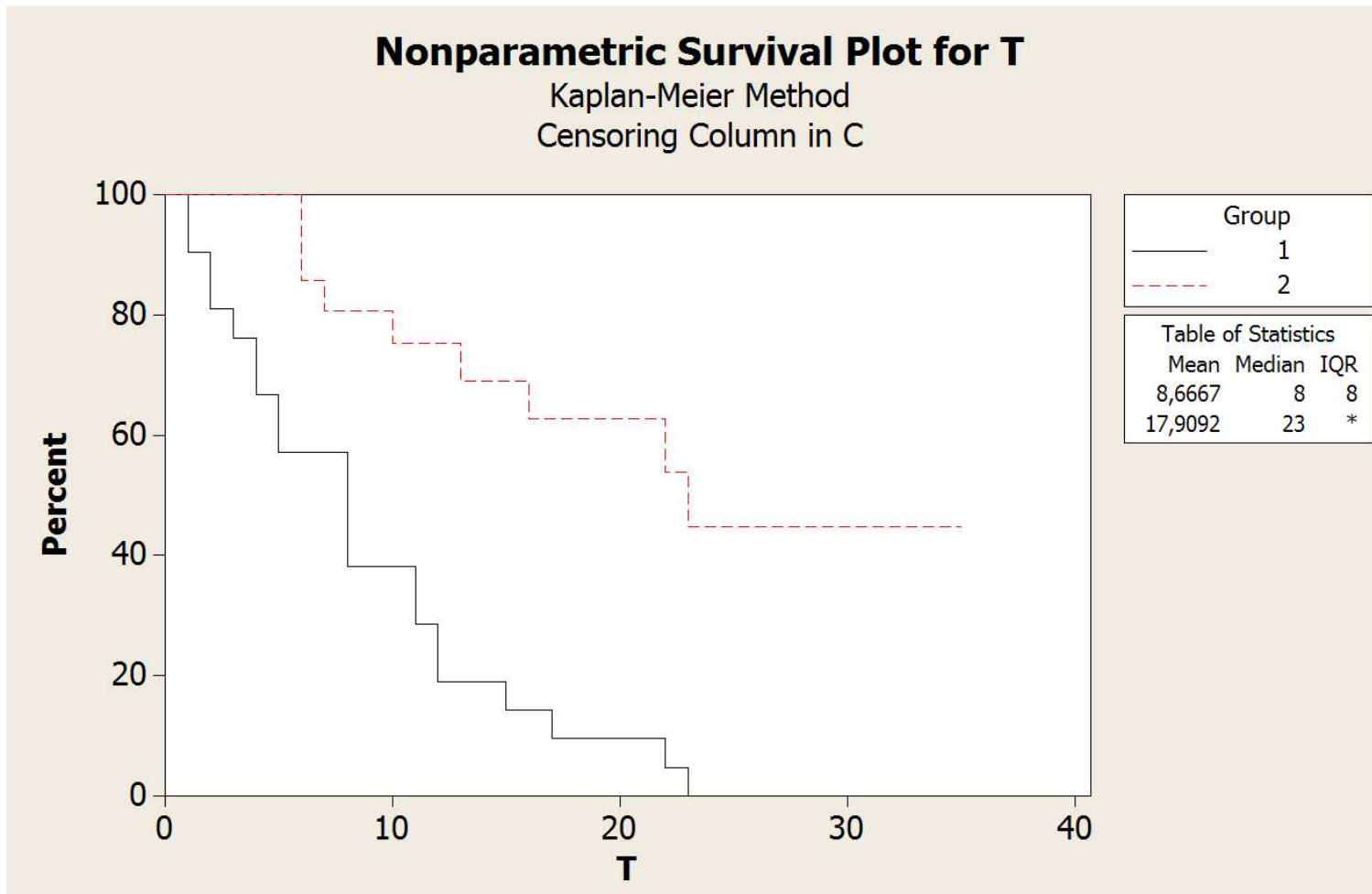
$$W = 0.39 + 0.48 + 0.68 + 0.76 + 0.80 + 0.99 = 4.10 \quad (k-1 = 6)$$

Table 11.1

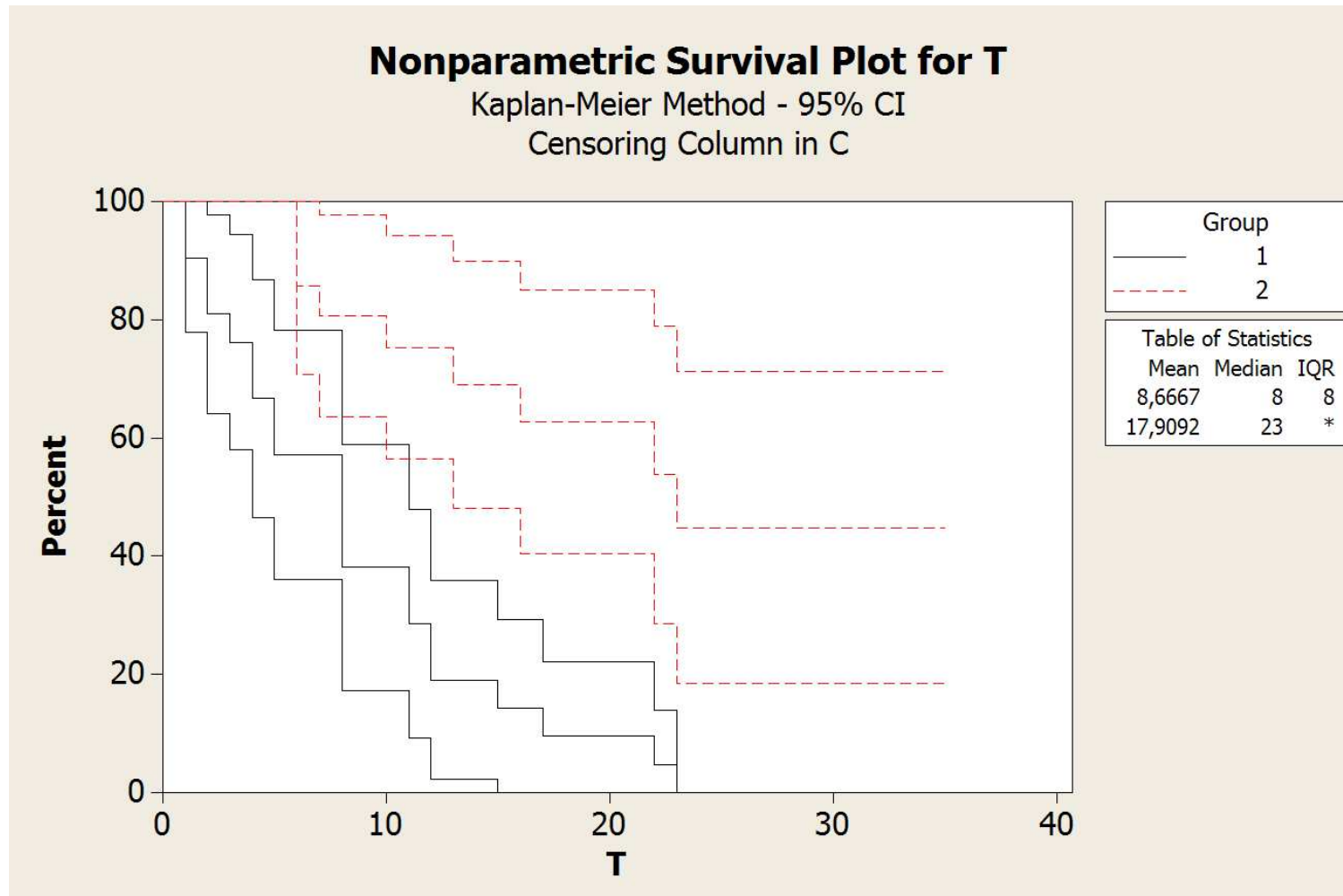
TTT-plot censored data



Example: Leukemia data (1=Placebo, 2=6MP)



Example: Leukemia data (1=Placebo, 2=6MP, with confidence limits)



Logrank Test for Leukemia Data

C = Control group (Placebo)

B = Treatment group (6MP)

Time	RiskC	RiskB	Risk	FailC	FailB	Fail	EC	EB
1	21	21	42	2	0	2	$(2/42) * 21 = 1$	$(2/42) * 21 = 1$
2	19	21	40	2	0	2	$(2/40) * 19 = 0.95$	$(2/40) * 21 = 1.05$
3	17	21	38	1	0	1	$(1/38) * 17 = 0.447$	$(1/38) * 21 = 0.553$
4	16	21	37	2	0	2	$(2/37) * 16 = 0.865$	$(2/37) * 21 = 1.135$
13	4	12	16	0	1	1	$(1/16) * 4 = 0.25$	$(1/16) * 12 = 0.75$
23	1	6	7	1	1	2	$(2/7) * 1 = 0.286$	$(2/7) * 6 = 1.714$
Total				21	9		10.749	19.251

Test statistic:

$$\frac{(O_C - E_C)^2}{E_C} + \frac{(O_B - E_B)^2}{E_B}$$

$$= \frac{(21 - 10.749)^2}{10.749} + \frac{(9 - 19.251)^2}{19.251} = 5.46 + 9.77 = 15.33$$