TECHNION – Israel Institute of Technology
The William Davidson Faculty of Industrial Engineering & Management

Center for Service Enterprise Engineering (SEE)
http://ie.technion.ac.il/Labs/Serveng/

HomeHospital (Rambam)
EDA via SEEStat 3.0

to Reproduce "Patient Flow in Hospitals:
A Data–Based Queueing–Science Perspective"
M. Armony, S. Israelit, A. Mandelbaum,Y. Marmor, Y. Tseytlin,
G. Yom–Tov
http://ie.technion.ac.il/serveng/References/Short_Patient%20flow%20main_010114.pdf

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General Remarks

Paper data period: **2004–2008** and SEELab data period: **2004–2007**

2. Emergency Department
2.2.1. Time dependency.
Fig 3. Average number of patients and arrival rate by hour of the day
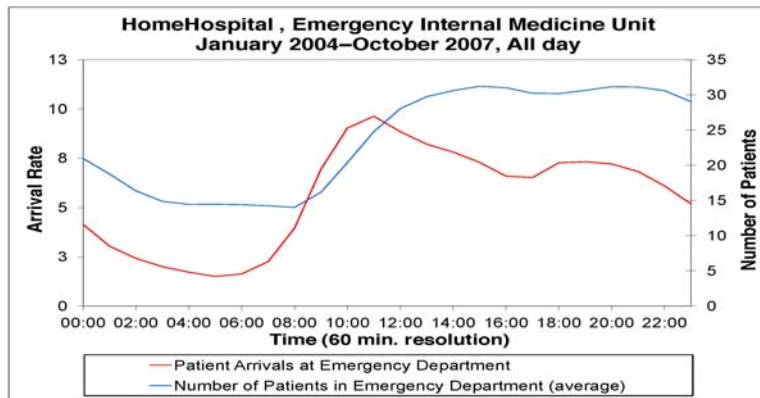
Reproducing steps:

1. Creating chart:

    Click *Main –> Statistical Models (Summaries)*. Select *Time Series*, then *Intraday*. From the variables list, select *Patient Arrivals at Emergency Department* and *Number of Patients in Emergency Department (average)*. In the *Select Categories* tab, select *Emergency Internal Medicine Unit*. Open the *X Properties* tab. Select resolution *60:00* = 1 hour. Click the *Dates –>* button. Select *Dates totals only* and all months from *January 2004* to *October 2007*. Open tab *Days* and select *All days*. Click *OK*.

Original SEEStat chart:
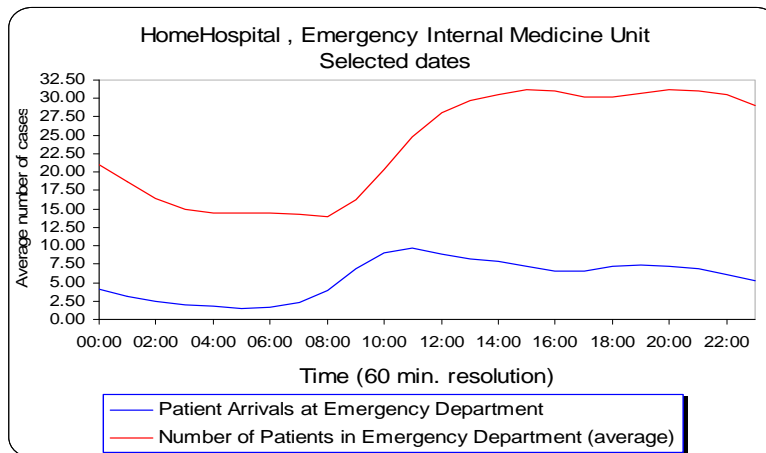
2. Design the original SEEStat chart:

    Add and format secondary vertical axis for *Number of Patients in Emergency Department (average)*, format primary vertical axis. (see in [Appendix 5](#) How to add a secondary vertical axis in Excel).Change in the chart title *Selected dates* to *January 2004 – October 2007, All days*.

2.2.2. Fitting a simple model to a complex reality.
Fig 4. Internal ED Occupancy histogram by hour of the day
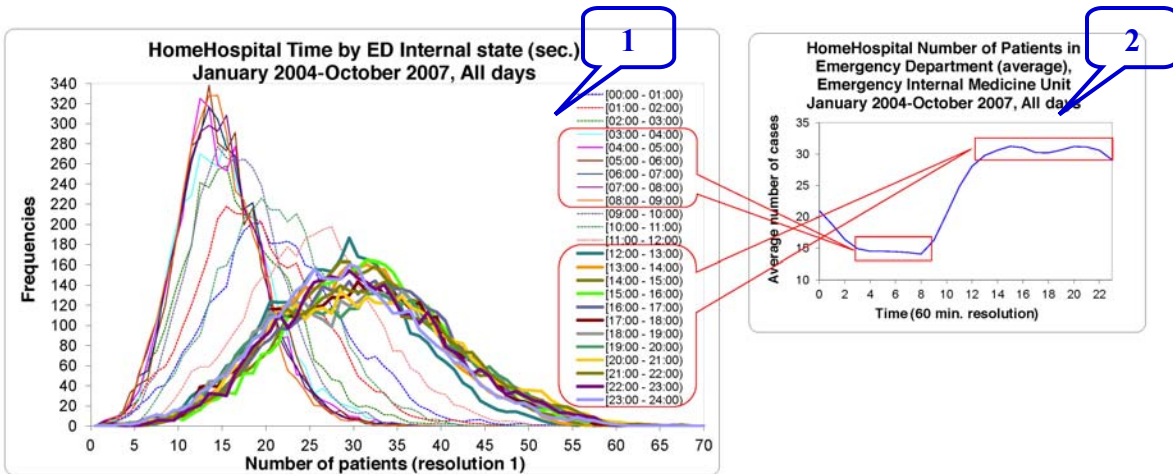
Reproducing steps for Time by ED Internal state (sec.)**(1)**

1. Creating chart:
   Click *Main –> Statistical Models (Summaries).* Select *Distributions –> Estimates.*
   From the variables list, select *Time by ED Internal state (sec.).* On tab *Options* select *Convert to Frequencies* and chart type *Polygon.* In the *Select Categories* tab, select (with shift button) all categories except *Total.* Open the *X Properties* tab. Select resolution *1* = 1 patient. Select upper display range *100%.* Click the *Dates –>* button. Select *Dates totals only* and all months from *January 2004* to *October 2007.* Open tab *Days* and select *All days.* Click *OK.*

Original SEEStat chart:
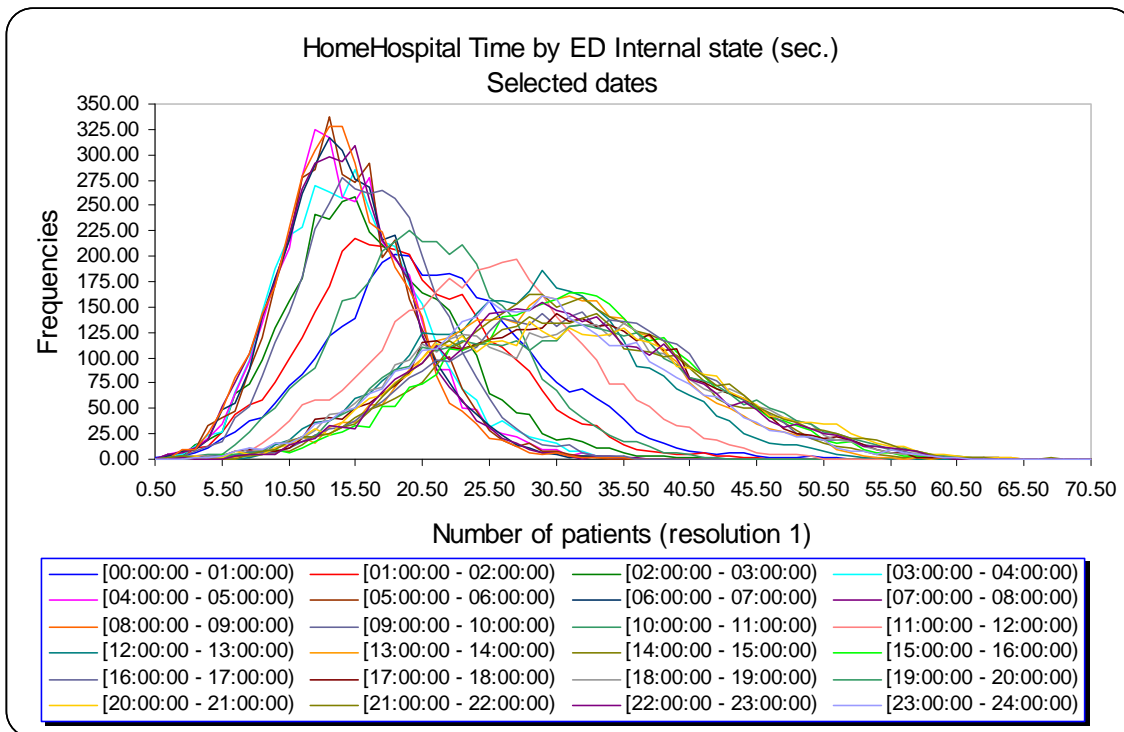
2. Design the original SEEStat chart:

Change in the chart title *Selected dates* to *January 2004 – October 2007, All days.*
Format horizontal axis: set minimum *0*, maximum *70*, major unit *5*, decimal places *0*.
And format legend.

Reproducing steps for the Number of Patients in Emergency Department (average) **(2)**

1. Creating chart:
   Click *Main –> Statistical Models (Summaries).* Select *Time Series*, then *Intraday.*
   From the variables list, select *Number of Patients in Emergency Department (average).* In the
   Select Categories tab, select *Emergency Internal Medicine Unit.* Open the *X Properties* tab. Select
   resolution *60:00* = 1 hour. Click the *Dates –>* button. Select *Dates totals only* and all months from
   January 2004 to *October 2007.* Open tab *Days* and select *All days.* Click *OK.*

Original SEEStat chart:

HomeHospital Number of Patients in Emergency Department
(average), Emergency Internal Medicine Unit
Selected dates

2. Design the original SEEStat chart:
   Change in the chart title *Selected dates* to *January 2004 – October 2007, All days.*
   Format vertical axis: set minimum *10*, maximum *35*, major unit *5*, decimal places *0*.

Fig 5. Fitting a mixture of three normal distributions to the ED occupancy distribution
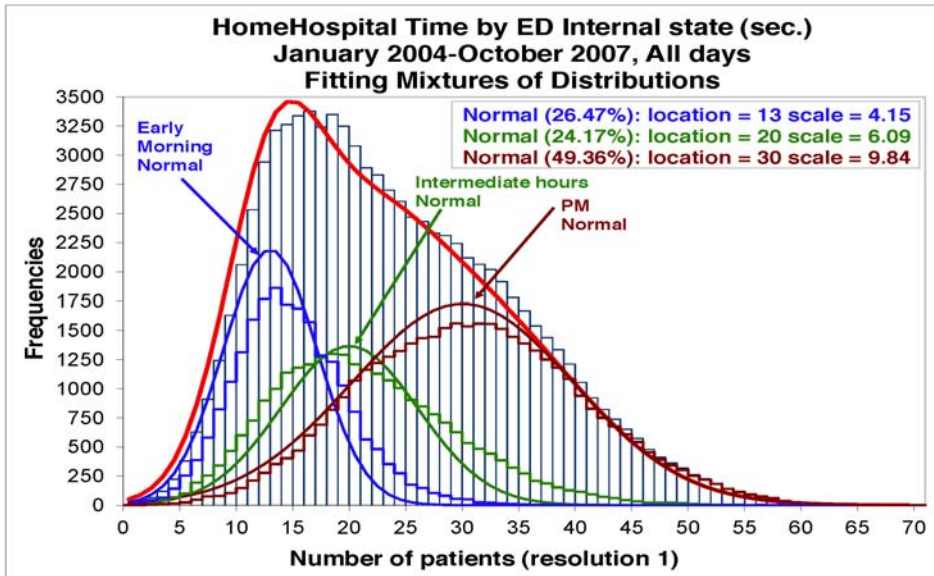
Reproducing steps for fitting mixtures of distributions
1. Creating chart:

   Click *Main –> Statistical Models (Summaries)*. Select *Distributions –> Mixture Fitting*.
   From the variables list, select *Time by ED Internal state (sec.)*. On tab *Options* select *Convert to Frequencies* and *3* components of *Normal* distribution. In the *Select Categories* tab, select *Total*. Open the *X Properties* tab. Select resolution *1 = 1 patient*. Select upper display range *100%*. Click the *Dates –>* button. Select *Dates totals only* and all months from *January 2004* to *October 2007*. Open tab *Days* and select *All days*. Click *OK*.

Original SEEStat chart:
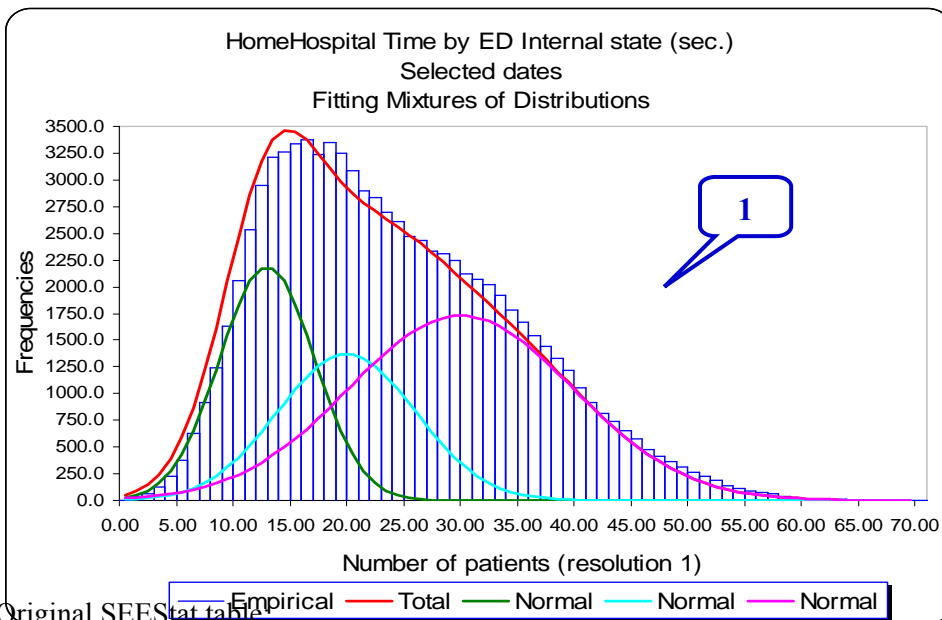
Original SEEStat table:

Parameter Estimates						
Components	Mixing Proportions (%)	Location	Scale	Shape	Mean	Standard Deviation
1. Normal	26.47	13.01	4.15		13.01	4.154397
2. Normal	24.17	20.00	6.09		20.00	6.085878
3. Normal	49.36	30.04	9.84		30.04	9.837746

Reproducing steps for fitting distributions

   2. Creating chart:

Click *New Model –> Distributions –> Estimates*. From the variables list, select *Time by ED Internal state (sec.)(by Day_time)* and *Time by ED Internal state (00:00-03:00 or 09:00-13:00, sec.)* . On tab *Options* select *Convert to Frequencies* and chart type *Histogram*. In the *Select Categories* tab, select *03:00-09:00 and 13:00-24:00*. Open the *X Properties* tab. Select resolution *1 = 1 patient*. Select upper display range *100%*. Click the *Dates –>* button. Select *Dates totals only* and all months from *January 2004* to *October 2007*. Open tab *Days* and select *All days*. Click *OK*.

Original SEEStat chart:
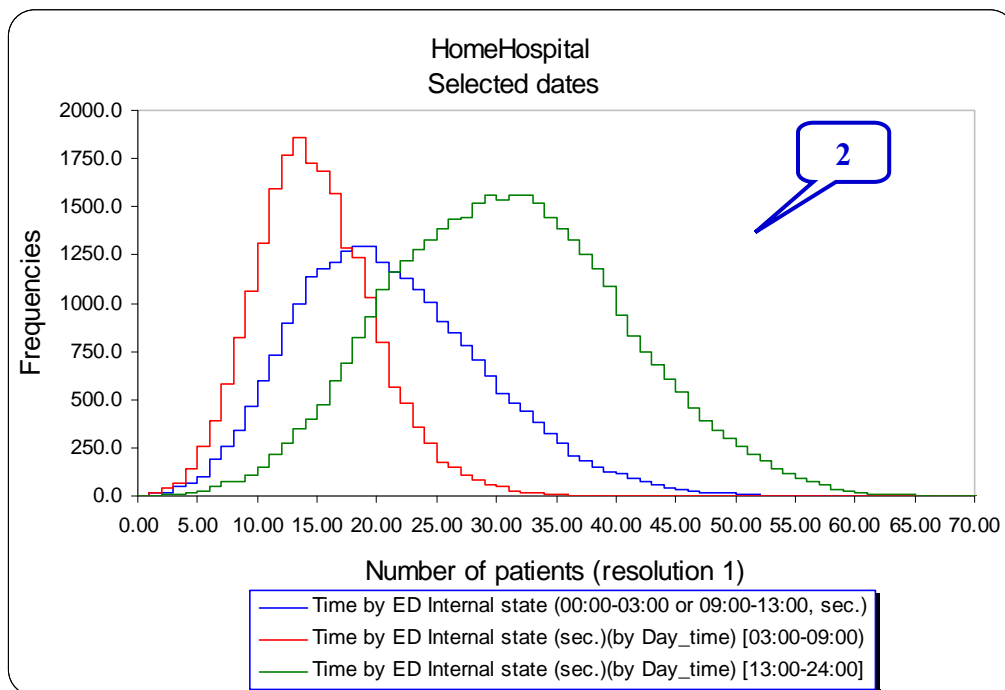
3. Combine fitted distribution (1) with empirical distribution (2)

Add series from chart (2): *Time by ED Internal state (00:00-03:00 or 09:00-13:00, sec.)*, *Time by ED Internal state (sec.)(by Day_time) [03:00-09:00)* and *Time by ED Internal state (sec.)(by Day_time) [13:00-24:00]* to chart (1).
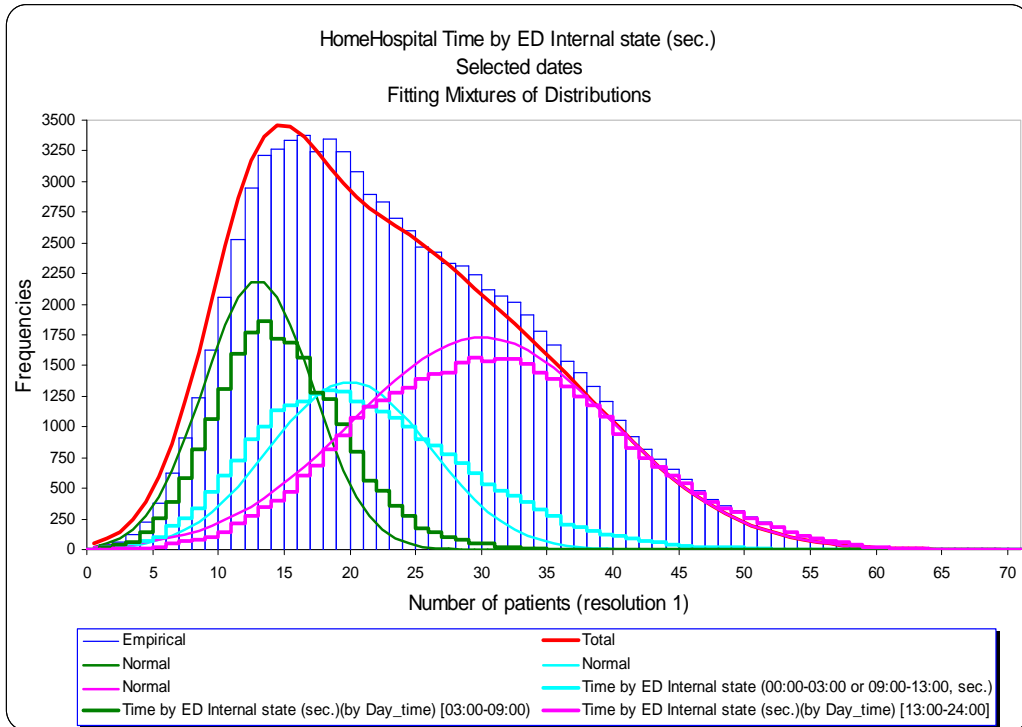
HomeHospital Time by ED Internal state (sec.)
Selected dates
Fitting Mixtures of Distributions

4. Design the original SEEStat chart:
Change in the chart title *Selected dates* to *January 2004 – October 2007, All days*.
Format vertical axis: decimal places *0*.

2.2.3. State dependency.
Fig 6. Service rate and service rate per patient as a function of L

See details in the Appendix 2.
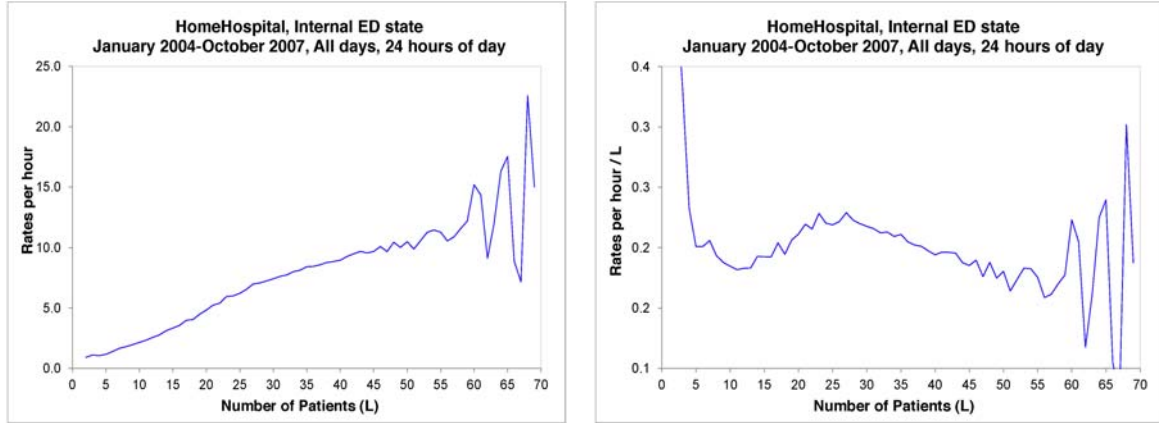
Internal ED, January 2004 - October 2007, all days, over 24 hours of day				
ED state (number of patients) L	Departures, total over all period $\sum_1^n D_i$	ED state duration in hours, total over all period $\sum_1^n T_i$	Service rate per hour (daily weighted average) μ_i	Service rate per hour/L μ_i / L
0	0	0.48		
1	2	15.07	0.13	0.133
2	23	25.56	0.90	0.450
3	51	46.41	1.10	0.366
4	91	86.74	1.05	0.262
5	170	147.29	1.15	0.231
6	335	241.86	1.39	0.231
7	585	354.40	1.65	0.236
8	856	479.19	1.79	0.223
9	1237	631.13	1.96	0.218
10	1717	800.26	2.15	0.215
11	2290	983.48	2.33	0.212
12	2913	1140.24	2.55	0.213
13	3434	1239.40	2.77	0.213
14	3965	1271.26	3.12	0.223
15	4336	1299.57	3.34	0.222
16	4666	1311.82	3.56	0.222
17	4996	1256.59	3.98	0.234
18	5255	1300.45	4.04	0.224
19	5690	1268.07	4.49	0.236
20	5756	1193.14	4.82	0.241
21	5895	1125.88	5.24	0.249
22	5929	1098.36	5.40	0.245
23	6246	1051.17	5.94	0.258
24	6084	1012.78	6.01	0.250
25	6025	968.54	6.22	0.249
26	6198	947.36	6.54	0.252
27	6342	907.15	6.99	0.259
28	6324	893.62	7.08	0.253
29	6333	873.99	7.25	0.250
30	6119	823.70	7.43	0.248
31	6161	808.70	7.62	0.246
32	6073	783.64	7.75	0.242
33	5996	747.95	8.02	0.243

34	5652	695.00	8.13	0.239
35	5470	648.70	8.43	0.241
36	5066	599.18	8.45	0.235
37	4788	557.43	8.59	0.232
38	4588	522.62	8.78	0.231
39	4166	470.01	8.86	0.227
40	3710	413.97	8.96	0.224
41	3321	358.01	9.28	0.226
42	3039	320.07	9.49	0.226
43	2796	288.37	9.70	0.225
44	2446	255.55	9.57	0.218
45	2169	223.90	9.69	0.215
46	1883	186.44	10.10	0.220
47	1562	161.37	9.68	0.206
48	1477	141.28	10.45	0.218
49	1248	124.41	10.03	0.205
50	1076	102.37	10.51	0.210
51	860	86.91	9.90	0.194
52	766	72.29	10.60	0.204
53	629	55.73	11.29	0.213
54	518	45.14	11.48	0.213
55	406	35.94	11.30	0.205
56	302	28.59	10.56	0.189
57	258	23.65	10.91	0.191
58	171	14.75	11.60	0.200
59	125	10.22	12.23	0.207
60	101	6.65	15.18	0.253
61	71	4.96	14.33	0.235
62	41	4.48	9.14	0.147
63	35	2.90	12.06	0.191
64	29	1.78	16.31	0.255
65	10	0.57	17.52	0.270
66	7	0.79	8.89	0.135
67	4	0.56	7.17	0.107
68	2	0.09	22.57	0.332
69	1	0.07	15.00	0.217
70	1	0.07	13.38	0.191

Fig 7. Service rate per patient as a function of L by occupancy regime

See details in the [Appendix 2](#).

HomeHospital, Internal ED state
January 2004-October 2007, All days
03:00-08:59

HomeHospital, Internal ED state
January 2004-October 2007, All days
09:00-11:59

HomeHospital, Internal ED state
January 2004-October 2007, All days
12:00-21:59

HomeHospital, Internal ED state
January 2004-October 2007, All days
22:00-02:59
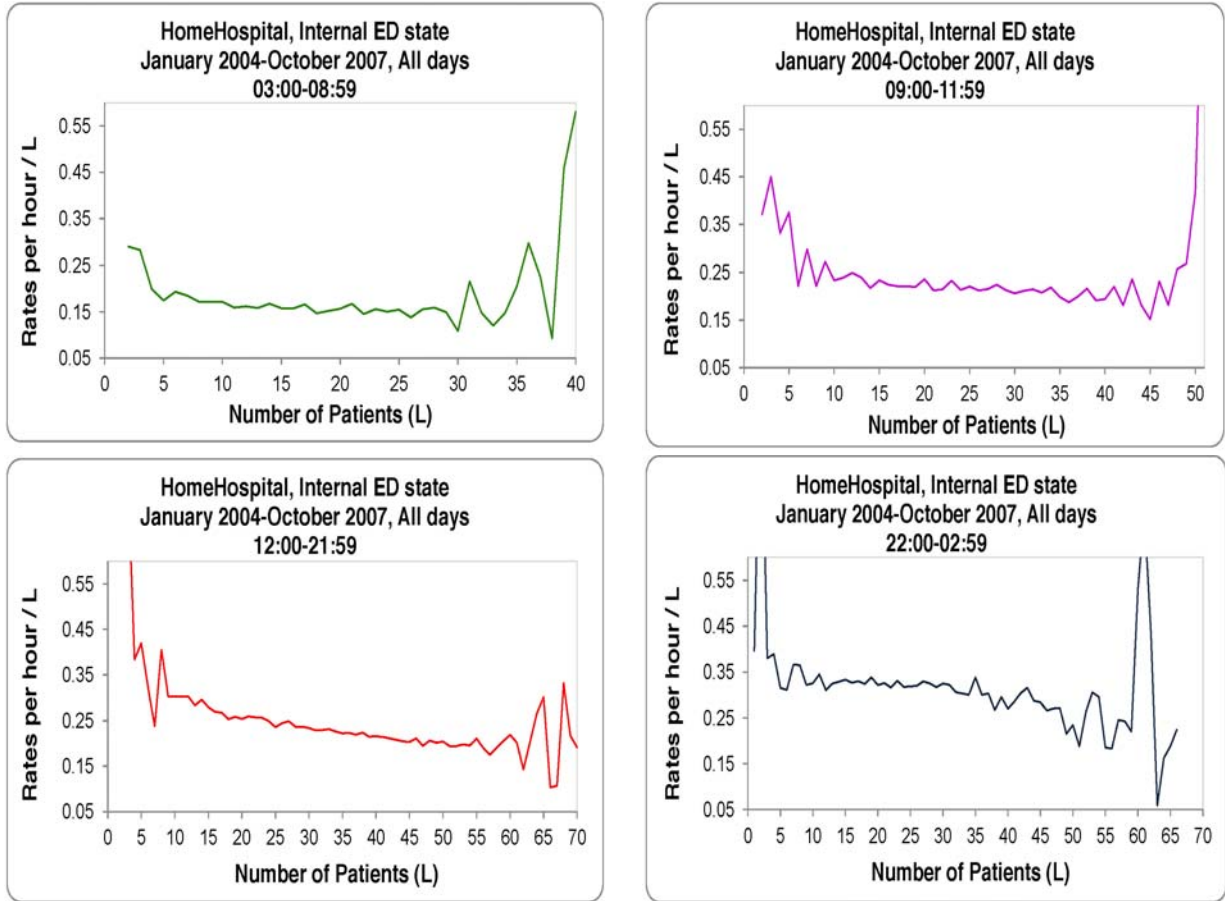
Internal ED, January 2004 - October 2007, all days, over 6 hours of day, from 03:00:00 to 08:59:59				
ED state (number of patients) L	Departures, total over all period $\sum_1^n D_i$	ED state duration in hours, total over all period $\sum_1^n T_i$	Service rate per hour (daily weighted average) μ_i	Service rate per hour/L μ_i / L
1	0	7.89	0.00	0.000
2	10	17.18	0.58	0.291
3	21	24.68	0.85	0.284
4	44	55.25	0.80	0.199
5	86	98.68	0.87	0.174
6	173	149.15	1.16	0.193
7	293	225.92	1.30	0.185
8	436	317.00	1.38	0.172
9	634	409.60	1.55	0.172
10	877	511.20	1.72	0.172
11	1083	618.36	1.75	0.159
12	1331	684.93	1.94	0.162
13	1473	716.02	2.06	0.158
14	1584	674.03	2.35	0.168
15	1554	656.59	2.37	0.158
16	1540	612.33	2.51	0.157

17	1407	497.55	2.83	0.166
18	1267	479.57	2.64	0.147
19	1164	402.51	2.89	0.152
20	978	311.77	3.14	0.157
21	780	221.72	3.52	0.168
22	598	187.13	3.20	0.145
23	503	140.13	3.59	0.156
24	385	106.55	3.61	0.151
25	279	72.02	3.87	0.155
26	205	57.23	3.58	0.138
27	172	40.98	4.20	0.155
28	140	31.41	4.46	0.159
29	94	21.73	4.33	0.149
30	65	19.95	3.26	0.109
31	60	8.96	6.69	0.216
32	38	8.01	4.74	0.148
33	22	5.54	3.97	0.120
34	21	4.18	5.03	0.148
35	14	1.95	7.17	0.205
36	10	0.93	10.74	0.298
37	5	0.60	8.34	0.225
38	2	0.57	3.52	0.093
39	2	0.11	17.87	0.458
40	2	0.09	23.23	0.581

Internal ED, January 2004 - October 2007, all days, over 3 hours of day, from 09:00:00 to 11:59:59				
ED state (number of patients) L	Departures, total over all period $\sum_i^n D_i$	ED state duration in hours, total over all period $\sum_i^n T_i$	Service rate per hour (daily weighted average) μ_i	Service rate per hour/L μ_i / L
1	0	1.56	0.00	0.000
2	2	2.70	0.74	0.371
3	7	5.18	1.35	0.450
4	11	8.28	1.33	0.332
5	18	9.59	1.88	0.375
6	30	22.58	1.33	0.221
7	70	33.40	2.10	0.299
8	96	54.20	1.77	0.221
9	182	74.02	2.46	0.273
10	226	96.82	2.33	0.233
11	323	122.82	2.63	0.239
12	435	145.28	2.99	0.250
13	518	166.28	3.12	0.240
14	593	194.87	3.04	0.217
15	691	197.05	3.51	0.234
16	746	207.79	3.59	0.224
17	845	224.34	3.77	0.222
18	929	233.67	3.98	0.221
19	1002	239.68	4.18	0.220
20	1033	218.57	4.73	0.236
21	939	210.44	4.46	0.212
22	954	201.99	4.72	0.215
23	1010	188.50	5.36	0.233
24	922	179.80	5.13	0.214
25	880	159.50	5.52	0.221
26	827	149.61	5.53	0.213
27	833	143.27	5.81	0.215
28	746	118.56	6.29	0.225
29	619	100.15	6.18	0.213
30	528	85.38	6.18	0.206
31	487	74.22	6.56	0.212
32	432	62.80	6.88	0.215
33	353	51.51	6.85	0.208
34	295	39.66	7.44	0.219
35	260	37.41	6.95	0.199
36	200	29.57	6.76	0.188

37	189	25.55	7.40	0.200
38	146	17.76	8.22	0.216
39	116	15.52	7.47	0.192
40	106	13.65	7.77	0.194
41	82	9.08	9.03	0.220
42	58	7.63	7.60	0.181
43	61	6.02	10.13	0.236
44	35	4.37	8.01	0.182
45	17	2.49	6.83	0.152
46	20	1.88	10.64	0.231
47	16	1.87	8.55	0.182
48	19	1.54	12.35	0.257
49	14	1.06	13.17	0.269
50	6	0.29	20.85	0.417
51	4	0.08	52.94	1.038
52	0	0.03	0.00	0.000
53	0	0.13	0.00	0.000

Internal ED, January 2004 - October 2007, all days, over 10 hours of day, from 12:00:00 to 21:59:59				
ED state (number of patients) L	Departures, total over all period $\sum_i^n D_i$	ED state duration in hours, total over all period $\sum_i^n T_i$	Service rate per hour (daily weighted average) μ_i	Service rate per hour/L μ_i / L
1	0	0.57	0.00	0.00
2	3	1.75	1.72	0.859
3	8	3.38	2.37	0.789
4	9	5.86	1.54	0.384
5	18	8.59	2.10	0.419
6	28	14.42	1.94	0.324
7	40	23.98	1.67	0.238
8	86	26.56	3.24	0.405
9	103	37.72	2.73	0.303
10	159	52.48	3.03	0.303
11	263	78.74	3.34	0.304
12	365	100.20	3.64	0.304
13	457	123.71	3.69	0.284
14	598	143.90	4.16	0.297
15	730	173.82	4.20	0.280
16	908	210.16	4.32	0.270
17	1107	242.98	4.56	0.268
18	1319	288.71	4.57	0.254
19	1631	331.77	4.92	0.259
20	1954	384.29	5.08	0.254
21	2253	413.00	5.46	0.260
22	2457	433.29	5.67	0.258
23	2663	450.64	5.91	0.257
24	2784	464.71	5.99	0.250
25	2882	487.89	5.91	0.236
26	3233	508.23	6.36	0.245
27	3397	504.92	6.73	0.249
28	3574	538.88	6.63	0.237
29	3845	559.07	6.88	0.237
30	3803	541.64	7.02	0.234
31	4006	564.58	7.10	0.229
32	4131	562.56	7.34	0.229
33	4188	547.74	7.65	0.232
34	4034	523.63	7.70	0.227
35	3879	498.02	7.79	0.223
36	3747	466.11	8.04	0.223
37	3589	441.67	8.13	0.220
38	3538	415.42	8.52	0.224
39	3177	378.85	8.39	0.215
40	2881	333.49	8.64	0.216
41	2556	290.57	8.80	0.215

42	2310	260.01	8.88	0.212
43	2124	237.36	8.95	0.208
44	1896	210.47	9.01	0.205
45	1705	186.48	9.14	0.203
46	1529	157.28	9.72	0.211
47	1241	135.51	9.16	0.195
48	1159	116.82	9.92	0.207
49	1007	101.85	9.89	0.202
50	867	84.77	10.23	0.205
51	721	72.75	9.91	0.194
52	629	62.24	10.11	0.194
53	500	47.64	10.50	0.198
54	397	37.57	10.57	0.196
55	326	28.10	11.60	0.211
56	240	22.54	10.65	0.190
57	182	18.22	9.99	0.175
58	134	12.12	11.06	0.191
59	107	8.83	12.11	0.205
60	78	5.93	13.15	0.219
61	57	4.63	12.32	0.202
62	39	4.41	8.84	0.143
63	34	2.64	12.90	0.205
64	27	1.59	17.03	0.266
65	8	0.41	19.63	0.302
66	4	0.59	6.83	0.104
67	4	0.56	7.17	0.107
68	2	0.09	22.57	0.332
69	1	0.07	15.00	0.217
70	1	0.07	13.38	0.191

Internal ED, January 2004 - October 2007, all days, over 5 hours of day, from 22:00:00 to 02:59:59				
ED state (number of patients) L	Departures, total over all period $\sum_i^n D_i$	ED state duration in hours, total over all period $\sum_i^n T_i$	Service rate per hour (daily weighted average) μ_i	Service rate per hour/L μ_i / L
0	0	0.48	0.00	
1	2	5.05	0.40	0.396
2	8	3.93	2.04	1.018
3	15	13.17	1.14	0.380
4	27	17.35	1.56	0.389
5	48	30.42	1.58	0.316
6	104	55.72	1.87	0.311
7	182	71.10	2.56	0.366
8	238	81.42	2.92	0.365
9	318	109.79	2.90	0.322
10	455	139.76	3.26	0.326
11	621	163.56	3.80	0.345
12	782	209.84	3.73	0.311
13	986	233.39	4.22	0.325
14	1190	258.46	4.60	0.329
15	1361	272.11	5.00	0.333
16	1472	281.54	5.23	0.327
17	1637	291.72	5.61	0.330
18	1740	298.51	5.83	0.324
19	1893	294.11	6.44	0.339
20	1791	278.52	6.43	0.322
21	1923	280.72	6.85	0.326
22	1920	275.95	6.96	0.316
23	2070	271.90	7.61	0.331
24	1993	261.72	7.62	0.317
25	1984	249.12	7.96	0.319
26	1933	232.28	8.32	0.320
27	1940	217.98	8.90	0.330
28	1864	204.77	9.10	0.325
29	1775	193.04	9.19	0.317
30	1723	176.72	9.75	0.325

31	1608	160.93	9.99	0.322
32	1472	150.27	9.80	0.306
33	1433	143.17	10.01	0.303
34	1302	127.53	10.21	0.300
35	1317	111.32	11.83	0.338
36	1109	102.56	10.81	0.300
37	1005	89.61	11.22	0.303
38	902	88.87	10.15	0.267
39	871	75.53	11.53	0.296
40	721	66.75	10.80	0.270
41	683	58.36	11.70	0.285
42	671	52.43	12.80	0.305
43	611	44.99	13.58	0.316
44	515	40.71	12.65	0.287
45	447	34.93	12.80	0.284
46	334	27.28	12.24	0.266
47	305	23.99	12.72	0.271
48	299	22.92	13.05	0.272
49	227	21.50	10.56	0.216
50	203	17.31	11.73	0.235
51	135	14.08	9.59	0.188
52	137	10.02	13.67	0.263
53	129	7.96	16.21	0.306
54	121	7.57	15.99	0.296
55	80	7.84	10.20	0.185
56	62	6.04	10.26	0.183
57	76	5.44	13.98	0.245
58	37	2.63	14.08	0.243
59	18	1.39	12.98	0.220
60	23	0.72	31.83	0.531
61	14	0.33	42.71	0.700
62	2	0.07	27.07	0.437
63	1	0.27	3.76	0.060
64	2	0.19	10.40	0.163
65	2	0.16	12.24	0.188
66	3	0.20	14.84	0.225

Fig 8. Service rate as a function of 10 ≤ L ≤ 20 and Relative frequency (weight) of occupancy regime per L

See details in the [Appendix 2 (part 2.2)](#).

Internal ED, January 2004 - October 2007, all days																						
number of patients	over 6 hours of day, from 03:00:00 to 08:59:59				over 3 hours of day, from 09:00:00 to 11:59:59				over 10 hours of day, from 12:00:00 to 21:59:59				over 5 hours of day, from 22:00:00 to 02:59:59				over 24 hours of day		
	departures	state duration (hours)	service rate per hour/L	state duration (hours) percent to 24 hours	departures	state duration (hours)	service rate per hour/L	state duration (hours) percent to 24 hours	departures	state duration (hours)	service rate per hour/L	state duration (hours) percent to 24 hours	departures	state duration (hours)	service rate per hour/L	state duration (hours) percent to 24 hours	departures	state duration (hours)	service rate per hour/L
10	877	511.2	0.172	0.639	226	96.8	0.233	0.121	159	52.5	0.303	0.066	455	139.8	0.326	0.175	1717	800.3	0.215
20	978	311.8	0.157	0.261	1033	218.6	0.236	0.183	1954	384.3	0.254	0.322	1791	278.5	0.322	0.233	5756	1193.1	0.241

Internal ED, January 2004 - October 2007, all days					
number of patients	service rate per hour/L over 6 hours of day, from 03:00:00 to 08:59:59	service rate per hour/L over 3 hours of day, from 09:00:00 to 11:59:59	service rate per hour/L over 10 hours of day, from 12:00:00 to 21:59:59	service rate per hour/L over 5 hours of day, from 22:00:00 to 02:59:59	service rate per hour/L over 24 hours of day
10	0.172	0.233	0.303	0.326	0.215
20	0.157	0.236	0.254	0.322	0.241

Internal ED, January 2004 - October 2007, all days				
number of patients	state duration (hours) percent to 24 hours over 6 hours of day, from 03:00:00 to 08:59:59	state duration (hours) percent to 24 hours over 3 hours of day, from 09:00:00 to 11:59:59	state duration (hours) percent to 24 hours over 10 hours of day, from 12:00:00 to 21:59:59	state duration (hours) percent to 24 hours over 5 hours of day, from 22:00:00 to 02:59:59
10	0.639	0.121	0.066	0.175
20	0.261	0.183	0.322	0.233

3. Internal Wards
3.2. EDA: LOS - a story of multiple time scales.
## Fig 9. LOS distribution of IW A in two time-scales: daily and hourly
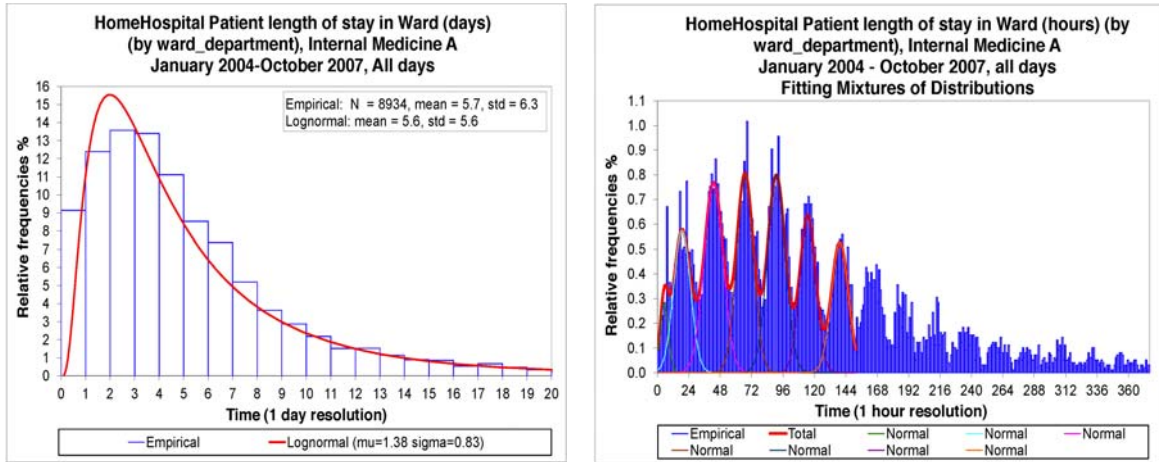
Reproducing steps:

1. Creating chart:
    Click *Main –> Statistical Models (Summaries)*. Select *Distribution*, then *Fitting.*From the variables list, select *Patient length of stay in Ward (days) (by ward_department)*. In the *Options* tab, select *Lognormal* distribution. In the *Select Categories* tab, select *Internal Medicine A*. Open the *X Properties* tab. Select resolution *1* day; range to display: low limit – minimal value, upper limit–97.5%, and range to compute: low limit 1, upper limit 100%. Click the *Dates –>* button. Select *Dates totals only* and all months from *January 2004* to *October 2007*. Open tab *Days* and select *All days*. Click *OK*.
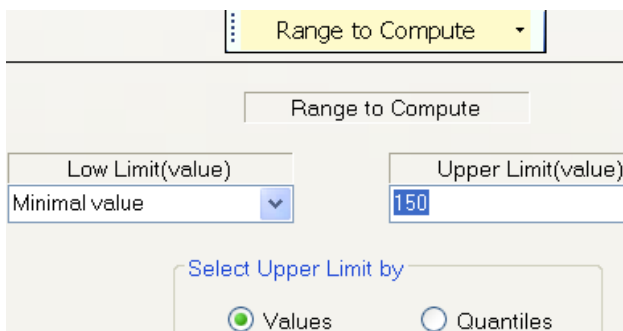
Original SEEStat chart:
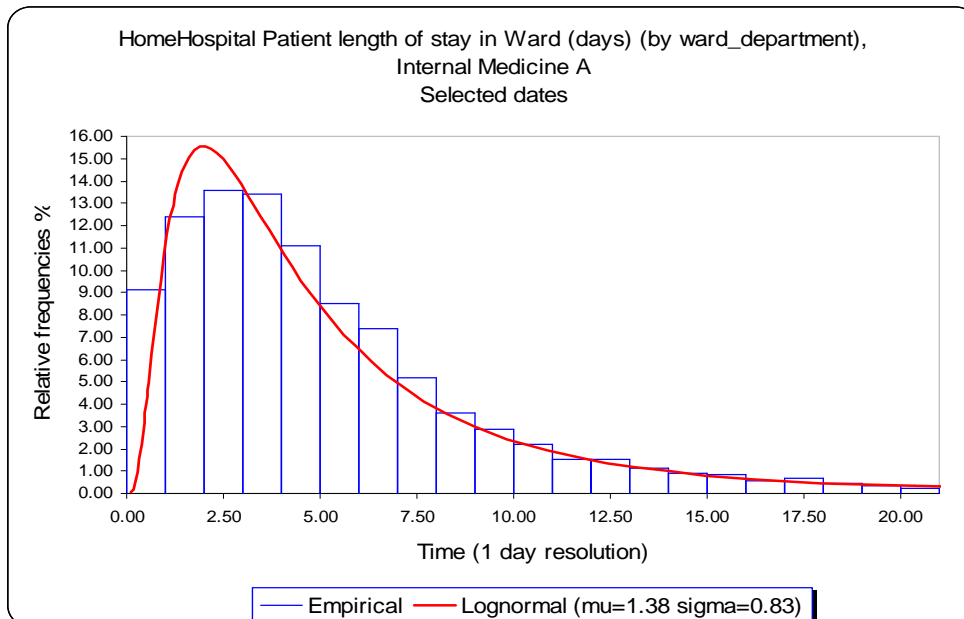
Original SEEStat table:

Statistics	
	Patient length of stay in Ward (days) (by ward_department)
N	8934
N(average per day)	6.381428571
Mean	5.665
Standard Deviation	6.284
Variance	39.49
Median	4
Minimum	1
Maximum	151
Skewness	6.026
Kurtosis	76.67
Standard Error Mean	0.0665
Interquartile Range	5
Mean Absolute Deviation	3.688
Median Absolute Deviation(MAD)	2
Coefficient of Variation(CV) (%)	110.92
L-moment 2 (half of Gini's Mean Difference)	2.552
L-Skewness	0.411
L-Kurtosis	0.271
Coefficient of L-variation(L-CV)(%) (Gini's Coefficient)	45.05

Parameters for Lognormal Distribution	
Parameter	Estimate
mu	1.38
sigma	0.83
mean	5.593
std	5.579

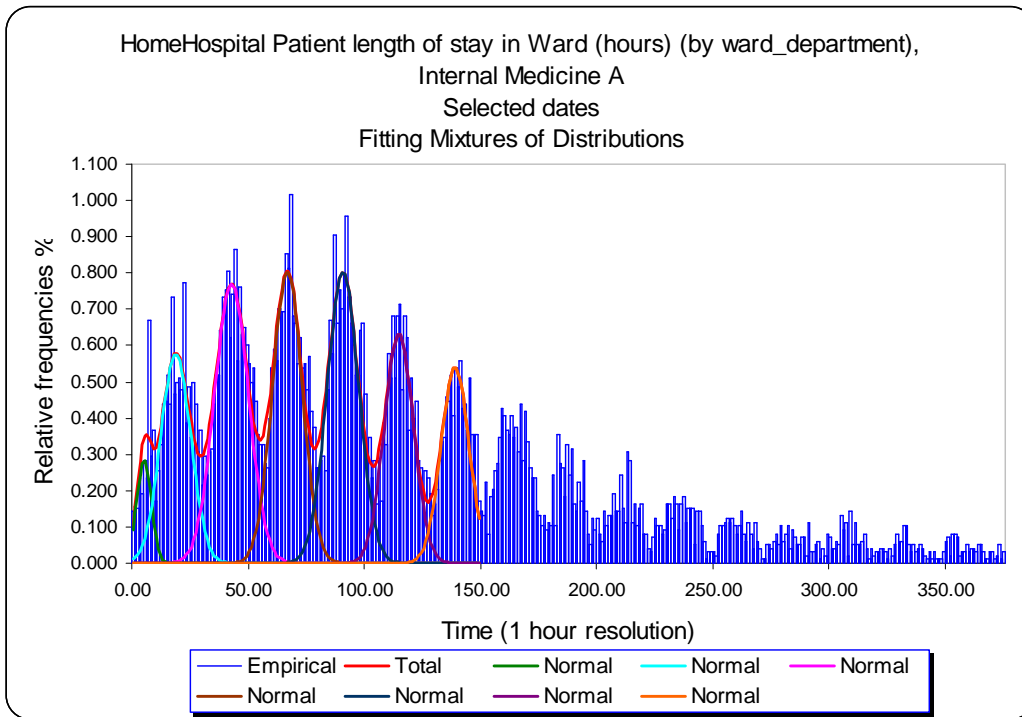2. Design the original SEEStat chart:
   Change in the chart title *Selected dates* to January 2004–October 2007, All days.

3. Click *<–New Model* button. Select *Distribution*, then *Mixture fitting.*From the variables list, select *Patient length of stay in Ward (hours) (by ward_department).*In the *Options* tab, select *Normal* distribution. Set the number of mixture components to *7.* In the *Select Categories* tab, select *Internal Medicine A.* Open the *X Properties* tab, select resolution *1* hour, click on *Range to Compute* button, then *Select Range*, mark *Values* and set upper limit *150* = 150 hours, range to display: low limit – minimal value, upper limit – 95%.

Click the *Dates –>* button. Select *Dates totals only* and all months from *January 2004* to *October 2007.* Open tab *Days* and select *All days.* Click *OK.*

Original SEEStat chart:

HomeHospital Patient length of stay in Ward (hours) (by ward_department),
Internal Medicine A
Selected dates
Fitting Mixtures of Distributions

4. Design the original SEEStat chart:
    Change in the chart title *Selected dates* to *January 2004 – October 2007, All days.*
    Format horizontal axis: set major unit *24*, decimal places *0.*

Fig 10. Arrivals, departures, and average number of patients in Internal wards by hour of day

Reproducing steps:

1. Creating chart:

   Click *Main –> Statistical Models (Summaries).* Select *Time Series*, then *Intraday.*
   From the variables list, select *Patient Arrivals to Ward (by_ward_department), Patient Discharges from Ward (by ward_department)* and *Number of Patients in Ward (average) (by ward_department).* In the *Select Categories* tab, select *Internal Medicine A.* Open the *X Properties* tab. Select resolution *60:00* = 1 hour. Click the *Dates –>* button. Select *Dates totals only* and all months from *January 2004* to *October 2007.* Open tab *Days* and select *Sundays.* Click *OK.*
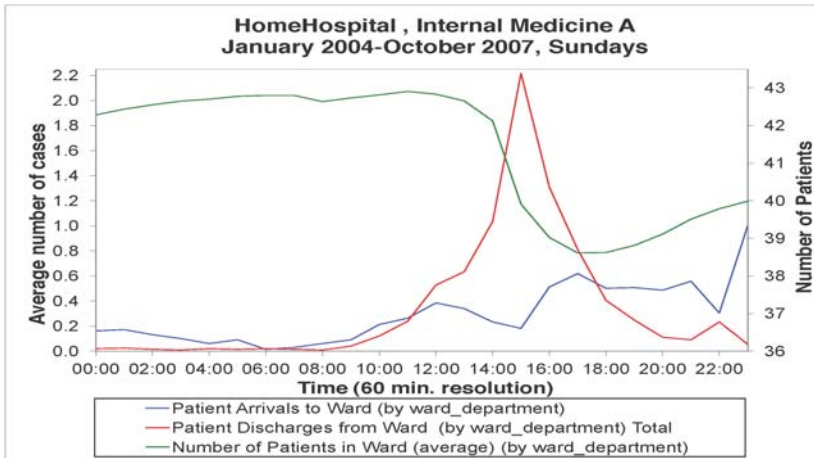
Original SEEStat chart:
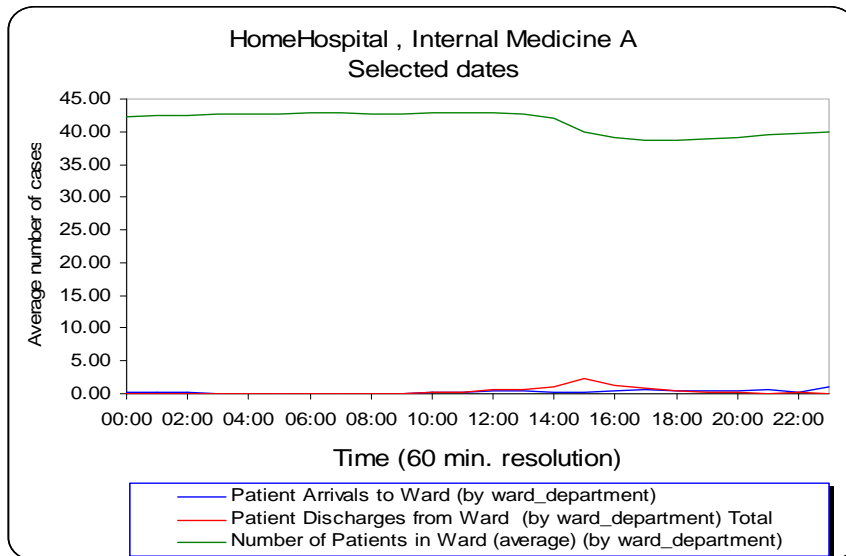
2. Design the original SEEStat chart:

   Add and format secondary vertical axis for *Number of Patients in Ward (average) (by ward_department)*, format primary vertical axis. (see in Appendix 5 How to add a secondary vertical axis in Excel). Change in the chart title *Selected dates* to *January 2004 – October 2007, Sundays.*

3.3.3. Diseconomies of scale (or how does ward size affect LOS)
Fig 11. Average LOS and number of patients in Internal wards B and D by year
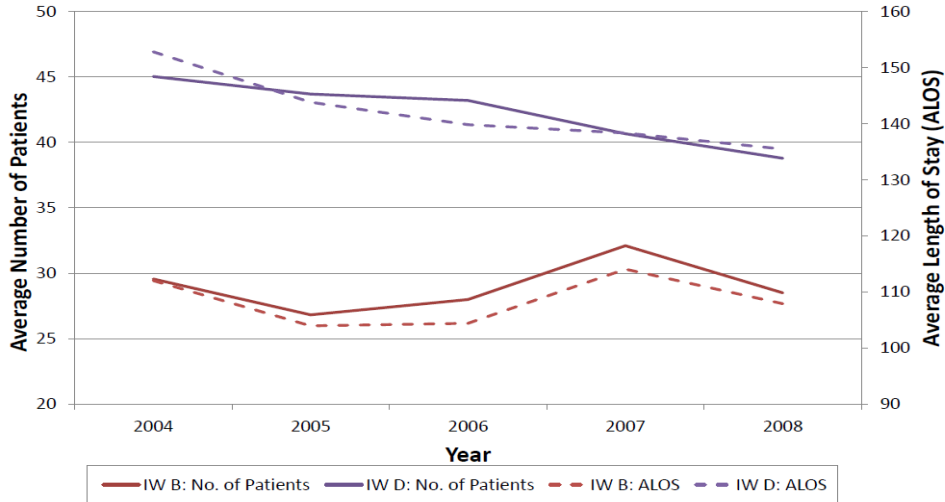
Remark: Figure 11 presents data of years 2004-2008, reproducing by SEEStat is available only till 2007 using the following procedure.

Reproducing steps:
1. Creating chart:
    Click *Main –> Statistical Models (Summaries)*. Select *Time Series,* then *Daily Totals.*
    From the variables list, select *Average Length of Stay in Ward (hours, by physical location).* In the *Select Categories* tab, select *Internal Medicine B* and *Internal Medicine D.*
    Click the *Dates –>* button. Click on *Select all* button. Open tab *Days* and select *All days.* Click *OK.*

Original SEEStat chart and table:
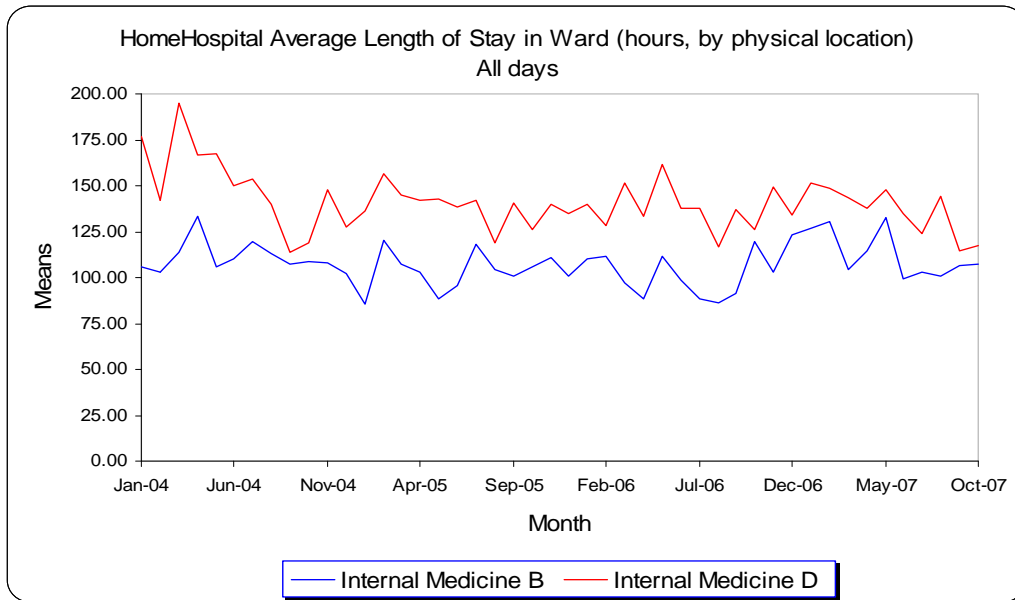
Time Series		
HomeHospital Average Length of Stay in Ward (hours, by physical location)		
All days		
Means		
Date	*Internal Medicine B*	*Internal Medicine D*
Jan-04	106.09	177.05
Feb-04	103.06	141.81
Mar-04	113.41	194.95
Apr-04	133.40	166.72
May-04	105.98	167.11
Jun-04	110.13	149.88
Jul-04	119.74	153.79
Aug-04	113.39	139.61
Sep-04	106.96	114.04
Oct-04	108.83	118.73
Nov-04	108.12	148.13
Dec-04	101.97	127.77
Jan-05	85.61	136.28
Feb-05	120.28	156.48
Mar-05	107.52	145.23
Apr-05	102.87	141.76
May-05	88.39	142.89
Jun-05	95.93	138.12
Jul-05	118.14	141.80
Aug-05	104.28	119.08
Sep-05	101.07	140.31
Oct-05	105.89	126.00
Nov-05	111.01	139.81
Dec-05	100.42	134.96
Jan-06	109.79	139.99
Feb-06	111.90	127.98
Mar-06	97.05	151.47
Apr-06	88.35	133.29
May-06	111.28	161.75
Jun-06	98.43	137.51
Jul-06	88.71	137.76
Aug-06	86.17	117.01
Sep-06	91.46	136.67
Oct-06	119.36	125.94
Nov-06	102.61	149.11
Dec-06	122.83	134.36
Jan-07	126.95	151.27
Feb-07	130.53	148.54
Mar-07	104.61	143.65
Apr-07	114.50	137.85
May-07	132.50	147.47
Jun-07	99.13	134.64
Jul-07	103.07	124.04
Aug-07	100.45	144.54
Sep-07	106.69	114.79
Oct-07	107.16	117.21

2. Creating chart:

Click *New Model.* Select *Time Series,* then *Intraday.*

From the variables list, select *Number of Patients in Ward (by physical location).* In the *Select Categories* tab, in subcategory *physical_hospital_unit* select *Internal Medicine B* and *Internal Medicine D.* Open the *X Properties* tab. Select resolution *60:00* = 1 hour. Click the *Dates –>* button. Select *Dates totals only* and select all months of 2004 year. Open tab *Days* and select *All days.* Click *OK.*

3. Repeat step 2 for 2005, 2006 and 2007 years.

Original SEEStat chart and table:

HomeHospital Number of Patients in Ward (by physical location)
Total for January2004 February2004 March2004 April2004 May2004 June2004 July2004 August2004 September2004 October2004 November2004 December2004,All days
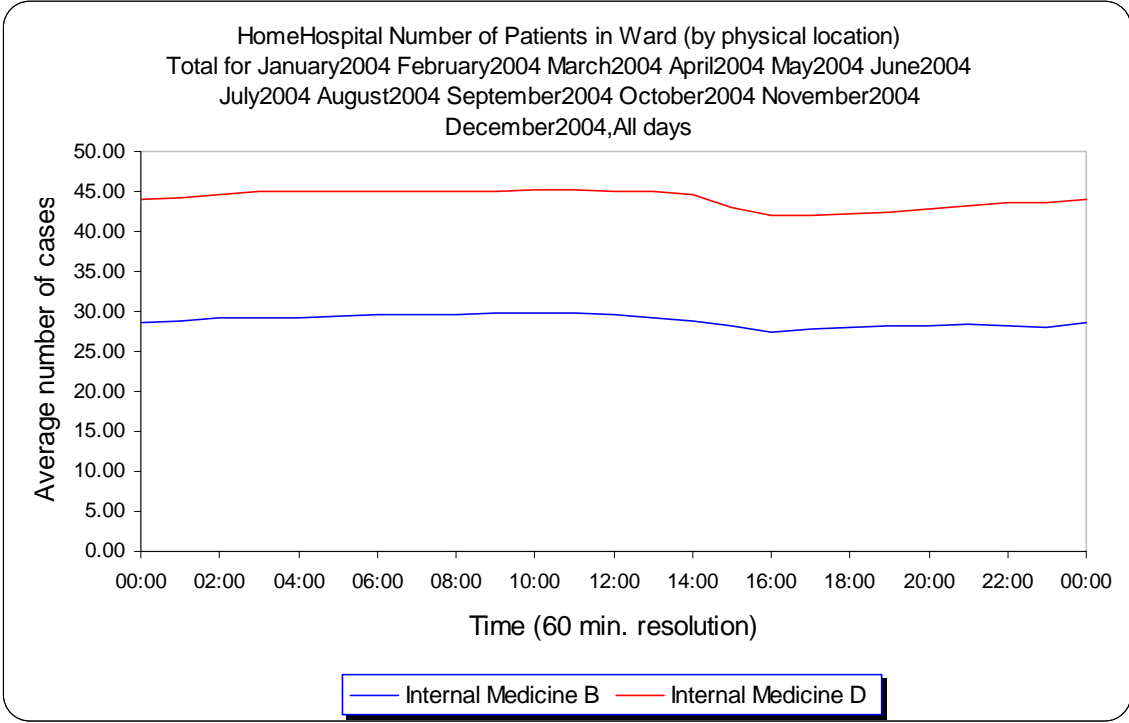
Data		
Time	Internal Medicine B	Internal Medicine D
00:00	28.615	43.984
01:00	28.858	44.246
02:00	29.131	44.639
03:00	29.243	44.962
04:00	29.273	45.049
05:00	29.344	45.063
06:00	29.566	45.055
07:00	29.675	45.052
08:00	29.697	45.068
09:00	29.760	45.052
10:00	29.822	45.104
11:00	29.724	45.148
12:00	29.530	45.093
13:00	29.260	44.934
14:00	28.869	44.628
15:00	28.287	43.087
16:00	27.473	41.954
17:00	27.754	42.063
18:00	27.929	42.197
19:00	28.197	42.484
20:00	28.172	42.792
21:00	28.301	43.172
22:00	28.265	43.508
23:00	27.997	43.519
00:00	28.694	44.098

HomeHospital Number of Patients in Ward (by physical location)
Total for January2005 February2005 March2005 April2005 May2005 June2005
July2005 August2005 September2005 October2005 November2005
December2005,All days
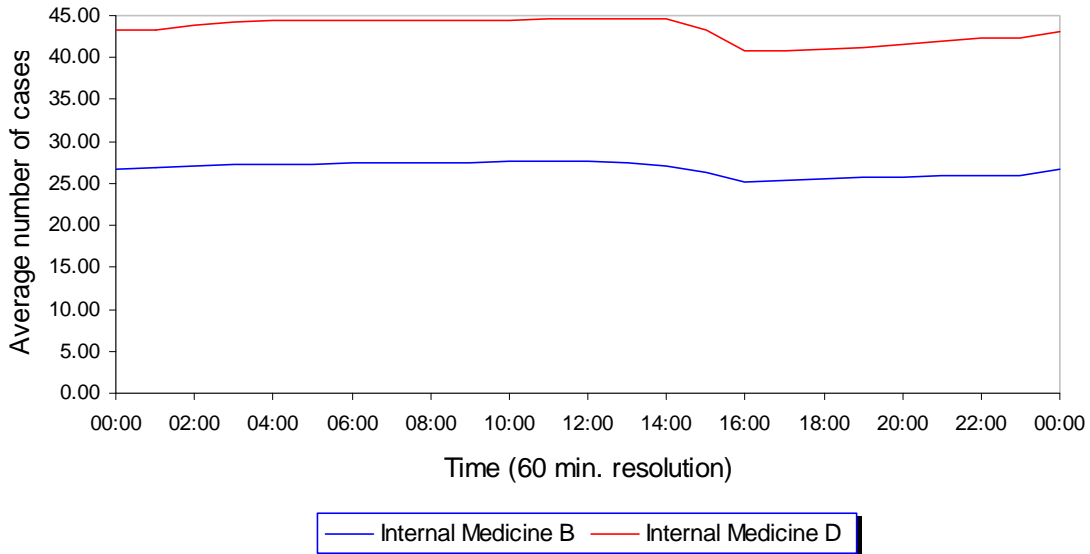
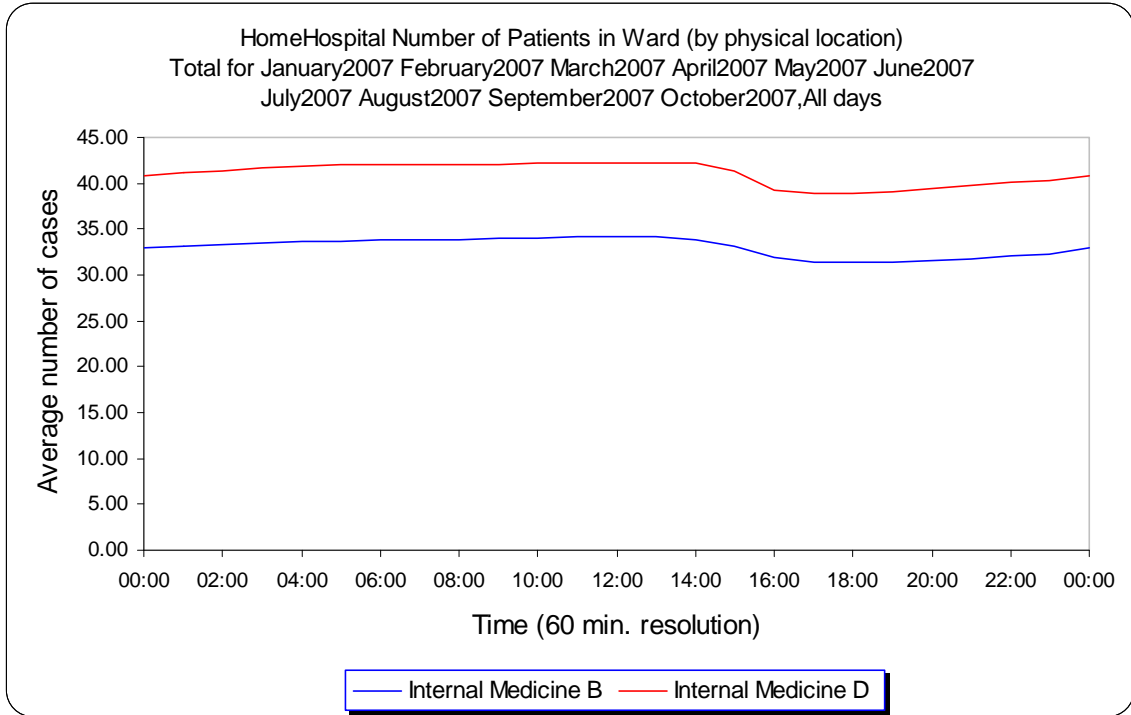|	Data	
Time	*Internal Medicine B*	*Internal Medicine D*
00:00	26.690	43.192
01:00	26.912	43.378
02:00	27.101	43.915
03:00	27.173	44.285
04:00	27.175	44.414
05:00	27.203	44.436
06:00	27.403	44.400
07:00	27.477	44.375
08:00	27.471	44.359
09:00	27.501	44.384
10:00	27.564	44.468
11:00	27.570	44.584
12:00	27.573	44.655
13:00	27.414	44.707
14:00	27.099	44.619
15:00	26.326	43.258
16:00	25.241	40.882
17:00	25.307	40.814
18:00	25.515	40.967
19:00	25.699	41.258
20:00	25.759	41.545
21:00	25.912	41.907
22:00	26.019	42.345
23:00	25.855	42.386
00:00	26.685	43.186

HomeHospital Number of Patients in Ward (by physical location)
Total for January2006 February2006 March2006 April2006 May2006 June2006 July2006 August2006 September2006 October2006 November2006 December2006,All days
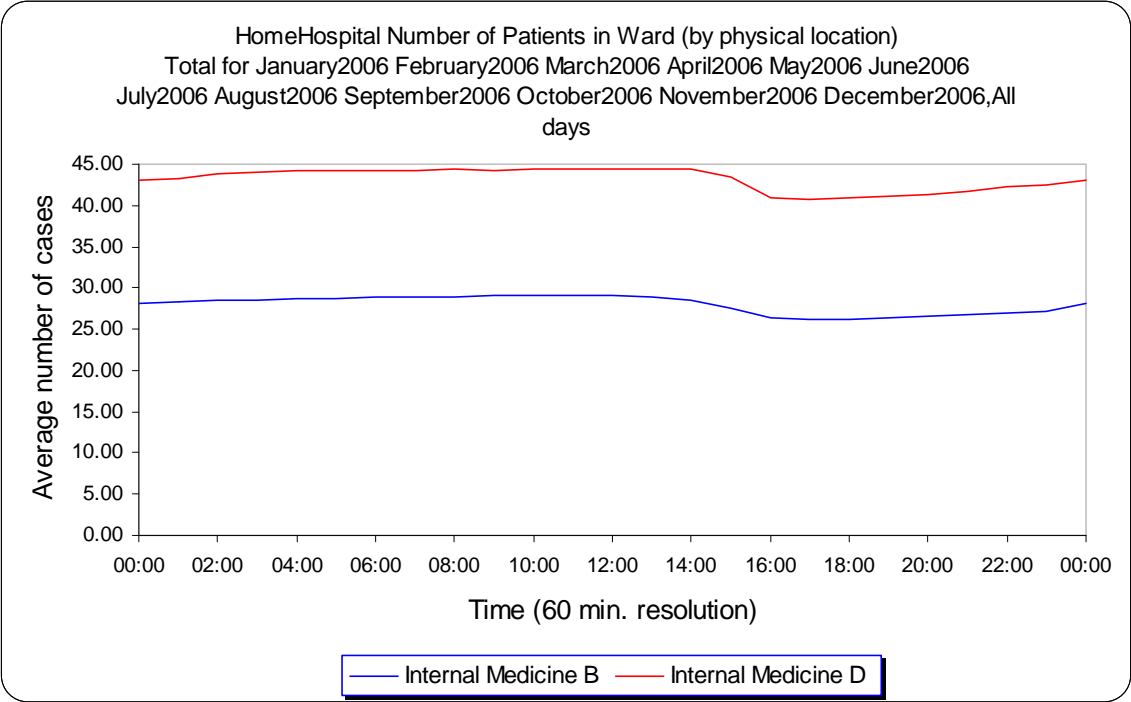
	Data	
Time	Internal Medicine B	Internal Medicine D
00:00	28.049	43.058
01:00	28.258	43.332
02:00	28.471	43.740
03:00	28.600	44.082
04:00	28.630	44.260
05:00	28.696	44.279
06:00	28.847	44.282
07:00	28.940	44.293
08:00	28.959	44.326
09:00	29.030	44.321
10:00	29.129	44.400
11:00	29.162	44.474
12:00	29.003	44.447
13:00	28.921	44.405
14:00	28.466	44.449
15:00	27.567	43.364
16:00	26.436	40.855
17:00	26.222	40.732
18:00	26.268	40.847
19:00	26.389	41.134
20:00	26.573	41.400
21:00	26.751	41.759
22:00	27.025	42.192
23:00	27.249	42.389
00:00	28.063	43.085

HomeHospital Number of Patients in Ward (by physical location)
Total for January2007 February2007 March2007 April2007 May2007 June2007
July2007 August2007 September2007 October2007,All days

	Data	
Time	Internal Medicine B	Internal Medicine D
00:00	32.895	40.878
01:00	33.105	41.076
02:00	33.352	41.405
03:00	33.516	41.740
04:00	33.622	41.888
05:00	33.688	41.957
06:00	33.760	41.974
07:00	33.796	42.000
08:00	33.832	42.056
09:00	33.928	42.049
10:00	34.033	42.164
11:00	34.164	42.266
12:00	34.214	42.280
13:00	34.115	42.257
14:00	33.888	42.174
15:00	33.188	41.296
16:00	31.957	39.220
17:00	31.414	38.918
18:00	31.359	38.852
19:00	31.398	38.997
20:00	31.493	39.342
21:00	31.681	39.720
22:00	32.010	40.125
23:00	32.243	40.319
00:00	32.878	40.829

4. Compute averages by department and by year.

	ALOS in Ward (hours, by physical location), Internal Medicine B	ALOS in Ward (hours, by physical location), Internal Medicine D	Number of Patients in Ward, Internal Medicine B (by physical location)	Number of Patients in Ward, Internal Medicine D (by physical location)
2004	110.92	149.97	28.86	44.08
2005	103.45	138.56	26.71	43.31
2006	102.33	137.74	27.99	43.20
2007	112.56	136.40	33.02	41.03

5. Create a line chart.
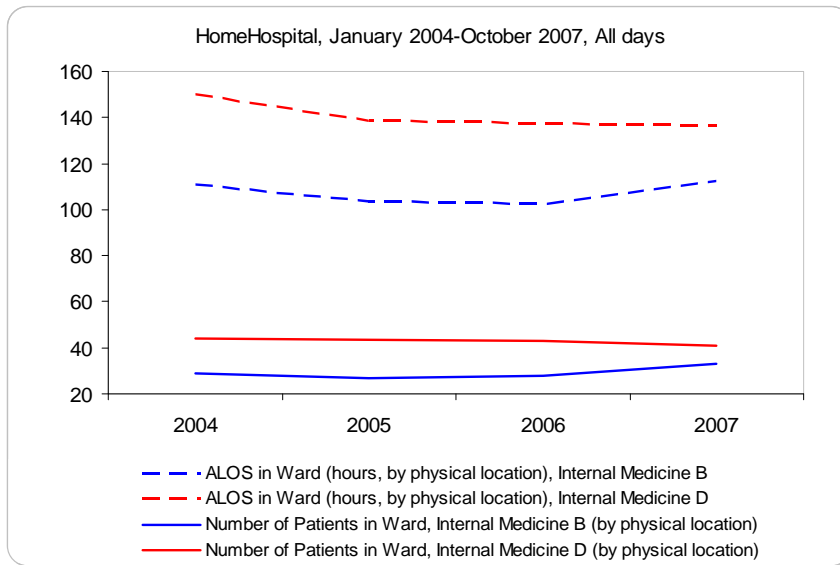
6. Add secondary vertical axis for ALOS and add axis titles.
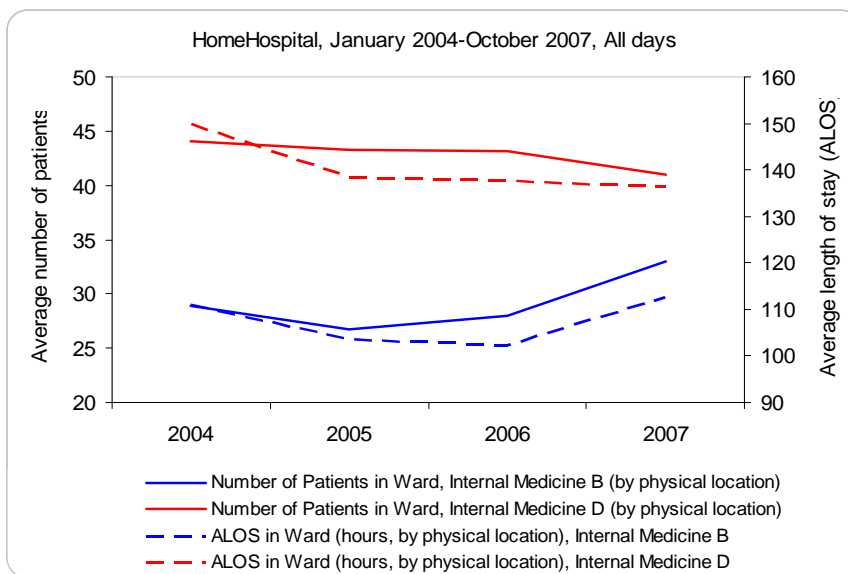
4. Transfer from the ED to IWs

4.2. Delays in transfer.
Fig 12. Transfer time by patient type, in hours

Remark: Figure 12 was based on the "justice table" from 2006 to 2008. However, due to technical problems this data could not be integrated to the rest of the database completely. Using SEEStat one can create the total distribution of transfer time, as will be demonstrated here based on data of years X-Y; the partition to patient type: Ventilated, Special Care and Regular is not available through SEEStat.
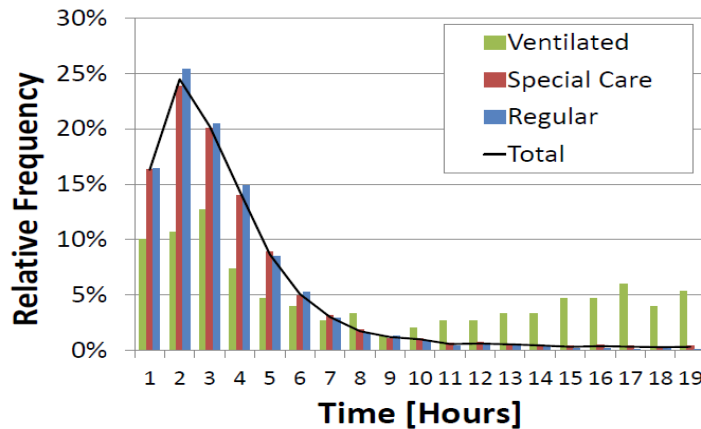
Creating chart:

Click *Main –> Statistical Models (Summaries).* Select *Distribution,* then *Estimates.*
From the variables list, select *Waiting time in ED-to-Ward (Internal A-D) transfer (by physical location).* Open the *X Properties* tab. Select resolution *60:00* minutes; range to display: low limit – minimal value, upper limit – *100%.* Click the *Dates –>* button. Select *Dates totals only* and months from *May 2006* to *December 2006* and from *April 2007 to October 2007.* Open tab *Days* and select *All days.* Click *OK.*

Original SEEStat chart
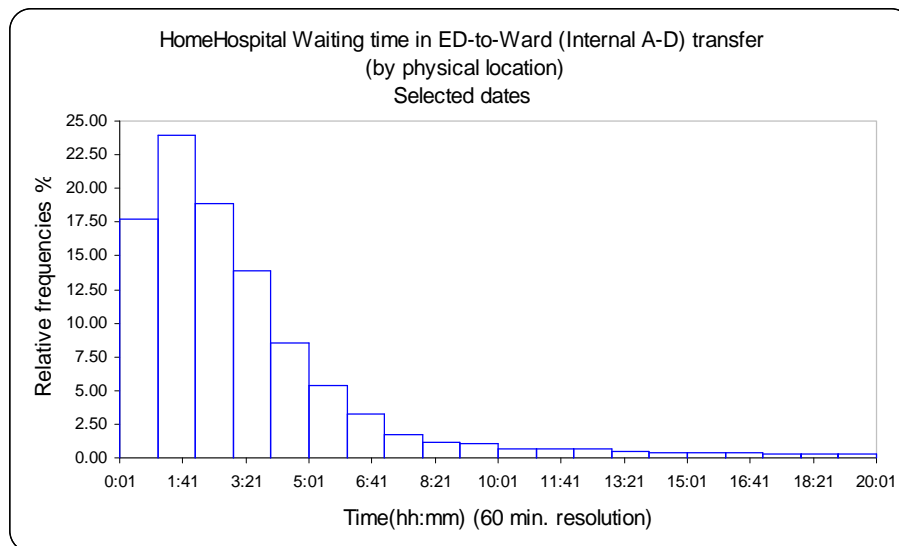
Statistics	
	Waiting time in ED-to-Ward (Internal A-D) transfer (by physical location)
N	10755
N(average per day)	23.43
Mean	3 hours 15 min
Standard Deviation	3 hours 6 min
Median	2 hours 25 min
Minimum	1 min
Maximum	19 hours 56 min

4.3. Influence of transfer delays on the ED

Fig 13. Number of patients in ED-to-IW transfer and the fraction of time that ED physicians devote to these patients
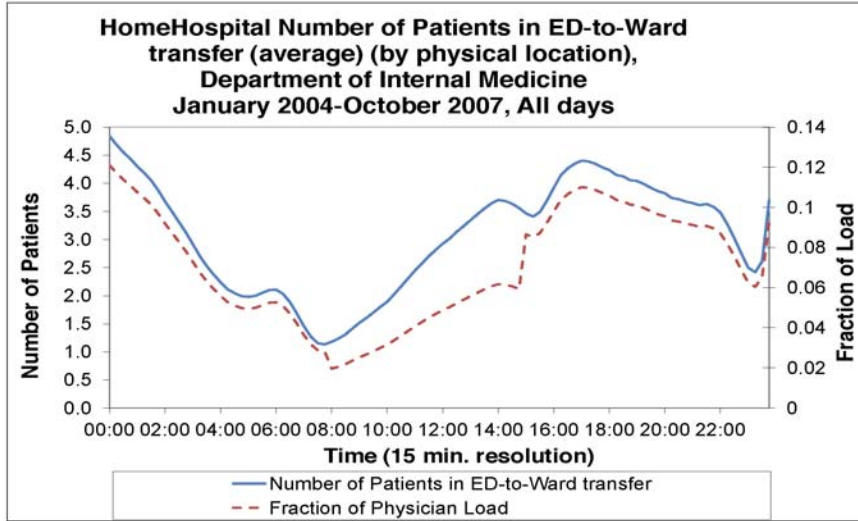
Reproducing steps:
1. Creating chart:
   Click *Main –> Statistical Models (Summaries)*. Select *Time Series*, then *Intraday*. From the variables list, select *Number of Patients in ED-to-Ward transfer (average) (by physical location)*. In the *Select Categories* tab, select *Department of Internal Medicine*. Open the *X Properties* tab. Select resolution *15:00* = 15 min. Click the *Dates –>* button. Select *Dates totals only* and all months from *January 2004* to *October 2007*. Open tab *Days* and select *All days*. Click *OK*.

Original SEEStat chart:
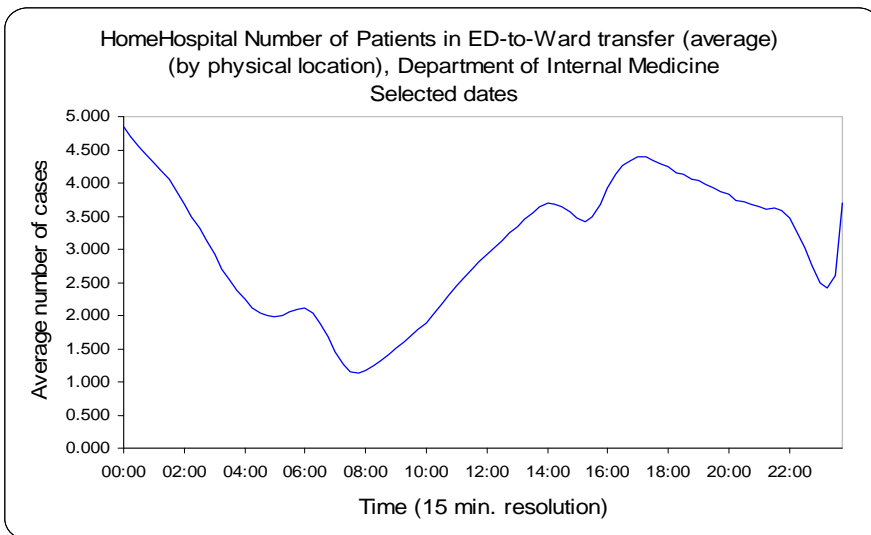
2. Design the original SEEStat chart:
   Change in the chart title *Selected dates* to *January 2004 – October 2007, All days*.

3. Calculate fraction of physician load:
   Estimates of the fraction of time that ED physicians spent caring for the transfer patients, assuming (the Rambam experience) that every such patient requires 1.5 minutes of physician's time every 15 minutes:

   Fraction of physician load in 15 minute interval i = (number of patients in ED-to-IW transfer * 1.5 minute) / (number of physicians in interval i * 15 minute)

time	number of physician in Internal ED
08:00-15:00	6
15:00-23:00	4
23:00-08:00	4

5. A system view
## Fig 16. ED-to-IW transfer delays and number of patients in IW
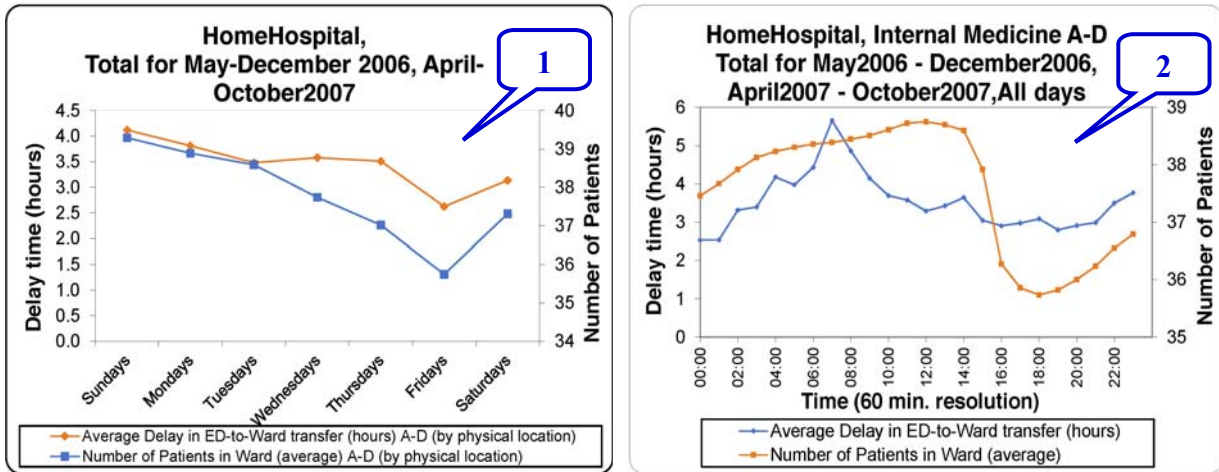
Reproducing steps **(1):**
1. Creating data table: click *Main –> Statistical Models (Summaries).* Select *Time Series*, then *Intraday*. From the variables list, select *Average Delay in ED-to-Ward transfer (hours)(by physical location)*. In the *Categories* tab, select *Internal Medicine A, Internal Medicine B, Internal Medicine C, Internal Medicine D*. Open the *X Properties* tab. Select resolution *60:00* minutes. Click the *Dates –>* button. Select *Dates totals only* and months from *May 2006* to *December 2006* and from *April 2007* to *October 2007*. Open tab *Days* and select *Sundays*. Click *OK*.
2. Repeat step 1 for other days of week.

HomeHospital Average Delay in ED-to-Ward transfer (hours)(by physical location), May 2006–December 2006 and April 2007-October 2007																					
	Sundays					Mondays					Tuesdays					Wednesdays					
Time	Internal Medicine A	Internal Medicine B	Internal Medicine C	Internal Medicine D	Average per A-D	Internal Medicine A	Internal Medicine B	Internal Medicine C	Internal Medicine D	average per A-D	Internal Medicine A	Internal Medicine B	Internal Medicine C	Internal Medicine D	Average per A-D	Internal Medicine A	Internal Medicine B	Internal Medicine C	Internal Medicine D	average per A-D
00:00	3.2	2.2	3.3	2.0	2.7	4.7	2.9	3.1	2.6	3.3	4.4	3.1	1.6	2.7	2.9	2.4	1.8	1.4	1.6	1.8
01:00	2.8	3.6	2.7	5.2	3.6	3.0	2.3	2.5	3.0	2.7	3.0	3.1	2.3	2.5	2.7	4.1	2.8	2.0	2.6	2.9
02:00	4.9	3.4	5.5	4.1	4.5	3.1	3.8	3.1	4.0	3.5	2.5	4.9	3.3	3.0	3.4	3.6	4.7	3.8	1.5	3.4
03:00	6.5	5.3	2.2	4.8	4.7	2.6	5.2	4.5	3.4	3.9	4.3	4.4	4.2	1.2	3.5	3.8	2.7	3.0	3.4	3.2
04:00	3.0	4.2	5.5	6.8	4.9	3.3	5.3	4.9	7.0	5.1	3.0	2.6	2.6	5.8	3.5	5.6	2.8	2.9	5.0	4.1
05:00	3.4	3.0	4.7	4.0	3.8	5.7	1.4	4.0	6.0	4.3	3.8	3.2	5.7	6.3	4.8	5.0	3.5	6.0	3.7	4.5
06:00	11.0	2.5	5.6	7.0	6.5	1.0	3.7	4.8	5.0	3.6	0.0	0.3	0.0	5.0	1.3	7.2	2.5	2.5	8.0	5.0
07:00	7.8	6.0	8.0	4.8	6.6	7.0	4.5	4.8	6.7	5.8	7.8	4.5	3.0	4.6	5.0	5.0	4.4	4.8	6.0	5.1
08:00	8.8	2.8	7.3	4.7	5.9	8.0	3.0	6.7	5.4	5.8	5.4	2.0	4.5	4.3	4.1	5.0	3.6	5.0	4.3	4.5
09:00	6.2	2.7	7.5	3.8	5.0	3.0	3.7	4.6	3.7	3.7	4.8	4.1	5.6	4.6	4.8	5.5	2.0	4.6	3.7	4.0
10:00	4.9	2.2	3.7	3.5	3.6	4.7	2.3	5.7	3.8	4.1	4.1	2.5	4.4	3.9	3.7	4.3	2.7	4.4	3.4	3.7
11:00	4.8	3.4	3.2	3.8	3.8	4.6	3.9	3.2	3.7	3.9	4.3	2.6	5.4	3.7	4.0	5.0	3.3	3.8	4.5	4.1
12:00	4.7	2.7	4.0	3.2	3.7	3.5	3.0	3.1	2.7	3.1	3.2	3.8	3.9	3.1	3.5	4.0	2.8	4.5	4.0	3.8
13:00	4.2	4.9	3.4	3.1	3.9	4.0	3.6	3.1	3.0	3.5	4.5	3.3	5.0	3.1	4.0	2.9	2.2	3.7	3.1	3.0
14:00	5.5	4.2	4.1	3.8	4.4	3.7	3.6	3.8	4.2	3.8	4.6	3.9	3.6	3.3	3.9	3.7	2.9	4.2	2.9	3.4
15:00	3.5	3.2	4.0	3.0	3.4	3.4	2.9	3.2	2.6	3.0	4.7	3.0	3.6	3.5	3.7	3.0	2.0	3.4	3.5	2.9
16:00	3.1	2.4	2.9	2.6	2.8	3.8	3.6	2.8	3.0	3.3	4.4	1.6	3.1	3.3	3.1	3.9	1.4	3.6	2.3	2.8
17:00	3.2	5.4	2.7	1.8	3.2	5.1	2.6	3.1	3.2	3.5	3.0	2.1	3.3	2.7	2.8	3.6	2.9	3.0	2.2	2.9
18:00	3.9	4.0	3.2	3.6	3.7	4.8	3.1	2.8	3.2	3.5	3.2	2.6	2.4	2.7	2.7	4.4	6.4	2.6	2.7	4.0
19:00	3.2	3.0	3.2	2.1	2.9	3.2	3.7	3.4	2.7	3.2	3.9	2.4	2.2	2.5	2.7	2.9	3.1	3.5	2.9	3.1
20:00	2.7	4.6	4.8	2.4	3.6	3.6	4.3	2.6	3.1	3.4	4.3	3.4	2.3	3.5	3.4	3.0	2.0	3.0	2.2	2.6
21:00	3.3	3.8	3.2	4.4	3.6	3.8	2.8	3.3	3.6	3.4	3.0	2.7	3.0	3.2	3.0	2.7	1.9	2.5	3.2	2.6
22:00	3.9	2.8	4.8	4.7	4.0	3.4	3.6	2.5	5.0	3.6	3.2	3.0	2.4	4.0	3.2	4.6	4.3	4.6	5.1	4.6
23:00	4.7	3.6	3.5	4.6	4.1	3.8	5.3	3.6	5.3	4.5	4.4	2.7	3.3	5.4	4.0	5.0	2.7	2.7	4.8	3.8

	Thursdays					Fridays					Saturdays				
Time	Internal Medicine A	Internal Medicine B	Internal Medicine C	Internal Medicine D	average per A-D	Internal Medicine A	Internal Medicine B	Internal Medicine C	Internal Medicine D	Average per A-D	Internal Medicine A	Internal Medicine B	Internal Medicine C	Internal Medicine D	Average per A-D
00:00	2.7	1.6	1.8	4.6	2.7	2.3	2.0	1.5	2.8	2.1	2.2	4.2	1.7	2.0	2.5
01:00	3.2	2.3	2.2	1.8	2.4	2.5	2.1	1.8	1.9	2.1	2.3	2.8	2.5	1.7	2.3
02:00	4.3	3.6	3.9	3.7	3.9	3.1	3.7	2.6	1.7	2.8	2.4	3.3	2.7	1.1	2.4
03:00	3.7	3.9	3.1	2.8	3.4	2.4	2.6	2.6	1.8	2.3	1.3	3.0	3.8	1.2	2.3
04:00	5.8	4.3	5.7	4.5	5.1	3.4	5.0	4.7	1.0	3.5	2.3	2.0	3.3	3.0	2.6
05:00	5.4	1.5	4.7	10.0	5.4	6.3	1.4	5.3	3.5	4.1	4.0	3.7	3.8	0.5	3.0
06:00	3.0	4.0	1.0	5.3	3.3	2.5	1.5	3.0	0.0	1.8	5.7	0.3	4.0	6.0	4.0
07:00	7.5	4.6	6.8	0.0	4.7	6.8	4.3	5.8	2.7	4.9	6.0	4.3	6.0	7.7	6.0
08:00	8.3	3.0	5.3	4.8	5.4	6.6	2.3	2.0	5.6	4.1	4.5	3.6	4.8	4.8	4.4
09:00	6.0	2.2	4.9	3.0	4.0	4.4	2.9	3.8	3.0	3.5	4.5	2.5	4.0	4.4	3.9
10:00	5.7	2.7	4.0	4.3	4.2	4.2	2.4	3.6	2.5	3.2	3.1	1.4	3.8	2.6	2.7
11:00	5.3	2.8	3.6	3.2	3.7	3.6	1.9	2.4	2.2	2.5	3.2	1.4	2.7	2.1	2.3
12:00	4.2	2.8	4.6	3.4	3.7	2.8	1.8	2.8	1.8	2.3	3.1	3.2	2.3	2.4	2.7
13:00	4.1	4.4	4.6	3.8	4.2	3.3	3.2	2.3	2.3	2.8	2.2	2.8	1.7	2.3	2.2
14:00	4.1	3.5	3.3	3.9	3.7	3.6	1.8	2.8	3.1	2.8	3.4	1.8	3.5	2.4	2.8
15:00	3.2	2.8	3.3	2.7	3.0	2.3	1.5	1.8	2.0	1.9	2.4	3.5	3.1	3.2	3.0
16:00	3.2	2.3	3.7	2.2	2.9	1.6	2.4	1.8	1.5	1.8	1.8	4.0	3.8	4.3	3.5
17:00	3.0	3.5	2.3	2.0	2.7	2.6	1.2	2.4	1.5	1.9	4.5	2.5	3.6	3.1	3.4
18:00	3.0	2.5	2.5	1.5	2.4	1.9	1.5	2.5	1.5	1.9	2.6	3.9	3.0	3.6	3.3
19:00	3.2	2.3	2.8	1.6	2.5	2.3	1.3	2.2	1.7	1.9	4.3	2.2	3.0	2.8	3.1
20:00	3.4	2.4	2.5	1.3	2.4	2.0	2.1	2.4	1.3	1.9	1.9	2.3	2.6	1.8	2.1
21:00	4.0	2.0	2.0	3.1	2.8	2.9	1.0	2.2	2.4	2.1	2.0	3.7	4.1	2.1	3.0
22:00	2.7	2.4	2.8	3.8	2.9	2.8	1.7	1.8	3.1	2.3	2.6	2.9	1.6	5.7	3.2
23:00	3.6	2.2	2.9	3.5	3.0	2.4	2.2	2.7	2.5	2.4	4.9	3.3	4.6	4.9	4.4

Table title: HomeHospital Average Delay in ED-to-Ward transfer (hours)(by physical location), May 2006–December 2006 and April 2007-October 2007

3. Creating data table: click *Main –> Statistical Models (Summaries)*. Select *Time Series*, then *Intraday*. From the variables list, select *Number of Patients in Ward (by physical location).*In the *Categories* tab, in subcategory *physical_hospital_unit* select *Internal Medicine A, Internal Medicine B, Internal Medicine C, Internal Medicine D.* Open the *X Properties* tab. Select resolution *60:00* minutes. Click the *Dates –>* button. Select *Dates totals only* and months from *May 2006* to *December 2006 and from April 2007 to October 2007.* Open tab *Days* and select *Sundays.* Click *OK.*

4. Repeat step 3 for other days of week.

	Sundays					Mondays					Tuesdays					Wednesdays				
Time	Internal Medicine A	Internal Medicine B	Internal Medicine C	Internal Medicine D	Average per A-D	Internal Medicine A	Internal Medicine B	Internal Medicine C	Internal Medicine D	average per A-D	Internal Medicine A	Internal Medicine B	Internal Medicine C	Internal Medicine D	Average per A-D	Internal Medicine A	Internal Medicine B	Internal Medicine C	Internal Medicine D	average per A-D
00:00	46.1	30.1	39.7	42.8	39.7	45.5	29.1	39.1	41.6	38.8	45.4	29.3	38.8	41.3	38.7	44.0	28.7	38.0	40.8	37.9
01:00	46.3	30.1	39.8	42.9	39.8	45.8	29.4	39.3	41.8	39.1	45.6	29.4	39.0	41.8	38.9	44.3	28.9	38.2	41.0	38.1
02:00	46.4	30.3	40.0	43.1	39.9	46.0	29.6	39.5	42.1	39.3	45.9	29.7	39.2	42.0	39.2	44.4	29.1	38.5	41.3	38.3
03:00	46.5	30.5	40.1	43.2	40.1	46.2	29.8	39.7	42.5	39.6	46.2	29.8	39.4	42.4	39.4	44.6	29.1	38.7	41.6	38.5
04:00	46.6	30.5	40.2	43.4	40.2	46.4	29.9	39.7	42.7	39.7	46.3	29.9	39.5	42.5	39.6	44.7	29.2	38.8	41.8	38.6
05:00	46.6	30.6	40.2	43.4	40.2	46.5	30.0	39.8	42.7	39.8	46.4	30.1	39.6	42.6	39.7	44.8	29.3	38.9	41.8	38.7
06:00	46.7	30.6	40.3	43.4	40.3	46.7	30.2	39.8	42.8	39.8	46.5	30.1	39.7	42.6	39.7	44.9	29.4	38.9	41.9	38.8
07:00	46.7	30.7	40.3	43.5	40.3	46.7	30.3	39.8	42.7	39.9	46.4	30.2	39.7	42.7	39.7	45.0	29.5	38.9	41.9	38.8
08:00	46.7	30.7	40.5	43.6	40.4	46.8	30.3	39.8	42.8	39.9	46.5	30.2	39.7	42.8	39.8	45.0	29.5	38.9	42.0	38.9
09:00	46.8	30.8	40.6	43.5	40.4	46.8	30.3	39.9	42.8	40.0	46.6	30.3	39.8	42.8	39.9	45.1	29.8	39.0	42.1	39.0
10:00	47.0	30.9	40.6	43.7	40.6	46.8	30.3	40.1	43.0	40.1	46.6	30.5	40.0	42.9	40.0	45.2	29.8	39.2	42.3	39.1
11:00	47.3	31.1	40.8	43.8	40.8	46.8	30.4	40.3	43.2	40.2	46.7	30.6	40.2	43.0	40.1	45.3	29.9	39.4	42.5	39.3
12:00	47.3	31.2	41.1	43.9	40.9	47.0	30.6	40.4	43.1	40.3	46.4	30.5	40.4	43.0	40.1	45.3	30.0	39.6	42.4	39.3
13:00	47.4	31.2	41.4	43.9	41.0	47.1	30.5	40.5	43.1	40.3	46.3	30.3	40.6	43.0	40.0	45.1	29.9	39.5	42.4	39.2
14:00	47.4	31.0	41.6	44.1	41.0	47.0	29.9	40.3	43.2	40.1	46.3	30.3	40.6	43.0	40.1	45.0	29.6	39.7	42.3	39.2
15:00	47.0	30.5	40.8	42.8	40.2	46.0	29.5	39.9	42.0	39.3	45.7	29.2	39.6	41.7	39.1	44.4	28.6	39.1	40.8	38.2
16:00	44.4	28.2	38.4	38.9	37.5	44.5	28.5	38.2	39.1	37.6	43.5	27.8	37.5	39.2	37.0	42.2	27.1	37.3	38.2	36.2
17:00	43.4	27.6	37.8	38.4	36.8	43.7	28.0	37.6	38.8	37.0	42.8	27.1	37.1	38.7	36.4	41.6	26.6	36.8	38.0	35.8

Table title: HomeHospital Number of Patients in Ward (by physical location), May 2006–December 2006 and April 2007-October 2007

Time																				
18:00	43.0	27.6	37.3	38.7	36.6	43.4	27.8	37.3	38.7	36.8	42.6	26.7	36.9	38.5	36.2	41.4	26.6	36.2	37.8	35.5
19:00	43.1	27.7	37.5	39.0	36.8	43.3	27.7	37.1	38.6	36.7	42.7	26.8	36.8	38.8	36.3	41.4	26.4	36.0	37.9	35.4
20:00	43.4	27.7	37.7	39.4	37.0	43.7	27.8	36.9	39.1	36.9	42.9	26.9	36.9	39.1	36.4	41.4	26.5	35.9	38.3	35.5
21:00	43.7	27.9	37.8	40.0	37.3	44.0	27.9	37.2	39.6	37.2	43.0	27.2	36.8	39.3	36.6	41.7	26.8	35.9	38.6	35.8
22:00	44.0	28.3	38.1	40.5	37.7	44.5	28.3	37.8	40.1	37.6	43.0	27.5	37.0	39.8	36.8	42.0	27.1	36.2	39.0	36.1
23:00	44.4	28.5	38.3	40.8	38.0	44.6	28.3	38.1	40.5	37.9	43.3	27.8	37.1	40.1	37.1	42.3	27.3	36.4	39.3	36.3
00:00	45.3	29.1	39.0	41.6	38.8	45.3	29.1	38.8	41.1	38.6	44.2	28.8	37.9	40.8	37.9	43.1	27.9	37.0	39.8	36.9

HomeHospital Number of Patients in Ward (by physical location), May 2006–December 2006 and April 2007-October 2007															
	Thursdays					Fridays					Saturdays				
Time	Internal Medicine A	Internal Medicine B	Internal Medicine C	Internal Medicine D	average per A-D	Internal Medicine A	Internal Medicine B	Internal Medicine C	Internal Medicine D	Average per A-D	Internal Medicine A	Internal Medicine B	Internal Medicine C	Internal Medicine D	Average per A-D
00:00	43.7	28.2	37.5	40.4	37.5	41.1	27.0	36.2	38.2	35.6	41.8	26.1	36.8	38.8	35.9
01:00	43.8	28.5	37.8	40.6	37.7	41.4	27.3	36.6	38.5	35.9	42.1	26.2	36.9	38.9	36.0
02:00	44.2	28.8	38.1	41.0	38.0	41.6	27.5	36.8	38.9	36.2	42.3	26.4	37.0	39.3	36.3
03:00	44.4	29.0	38.3	41.4	38.3	41.8	27.7	37.0	39.3	36.5	42.4	26.5	37.2	39.5	36.4
04:00	44.4	29.1	38.4	41.6	38.4	41.9	27.8	37.2	39.5	36.6	42.5	26.5	37.2	39.5	36.4
05:00	44.5	29.2	38.5	41.6	38.5	42.0	27.7	37.2	39.5	36.6	42.6	26.6	37.3	39.7	36.5
06:00	44.6	29.3	38.5	41.6	38.5	42.0	27.8	37.3	39.5	36.7	42.6	26.6	37.4	39.7	36.6
07:00	44.6	29.4	38.5	41.7	38.5	42.0	27.9	37.4	39.5	36.7	42.7	26.6	37.4	39.7	36.6
08:00	44.6	29.4	38.6	41.7	38.6	42.1	28.0	37.4	39.6	36.8	42.7	26.7	37.4	39.7	36.6
09:00	44.7	29.5	38.6	41.5	38.6	42.2	28.0	37.4	39.6	36.8	42.8	26.8	37.6	40.0	36.8
10:00	44.8	29.5	38.8	41.5	38.6	42.2	28.1	37.5	39.7	36.9	42.9	26.8	37.6	40.0	36.9
11:00	45.0	29.7	38.9	41.7	38.8	42.3	28.0	37.6	39.6	36.9	43.0	26.9	37.7	40.2	37.0
12:00	45.0	29.5	39.0	41.8	38.8	42.3	27.3	37.3	39.5	36.6	43.1	27.1	37.7	40.3	37.0
13:00	45.0	29.5	39.0	41.8	38.8	42.0	26.7	36.7	39.2	36.1	43.3	27.2	37.6	40.4	37.1
14:00	44.9	29.0	38.9	41.9	38.7	41.7	25.8	36.2	38.7	35.6	43.5	27.3	37.7	40.6	37.3
15:00	44.5	28.1	38.2	40.7	37.9	41.3	25.0	35.4	38.0	34.9	43.7	27.5	37.6	40.6	37.4
16:00	41.6	26.1	36.4	37.2	35.4	40.3	24.3	34.9	36.9	34.1	43.7	27.7	37.7	40.7	37.4
17:00	40.1	25.4	35.2	36.8	34.4	40.1	24.1	35.0	37.0	34.0	44.1	28.0	37.8	40.9	37.7
18:00	39.7	25.2	34.6	36.5	34.0	40.3	24.2	35.1	37.2	34.2	44.4	28.2	37.9	41.1	37.9
19:00	39.6	25.3	34.5	36.7	34.0	40.5	24.4	35.2	37.3	34.3	44.7	28.5	38.2	41.3	38.2
20:00	39.7	25.4	34.5	36.8	34.1	40.7	24.7	35.5	37.7	34.6	45.0	28.8	38.3	41.6	38.4
21:00	39.9	25.5	34.7	37.2	34.3	40.9	24.7	35.7	37.9	34.8	45.3	29.0	38.6	41.8	38.7
22:00	40.1	25.8	34.9	37.5	34.5	41.1	25.0	35.9	38.3	35.1	45.7	29.3	38.8	42.0	39.0
23:00	40.3	26.0	35.2	37.5	34.8	41.3	25.3	36.3	38.5	35.3	45.9	29.4	39.0	42.2	39.1
00:00	41.2	26.9	36.2	38.2	35.6	41.7	25.8	36.8	38.8	35.8	46.2	30.0	39.5	42.6	39.6

5. Compute averages per day and per IW.

	Average Delay in ED-to-Ward transfer (hours) A-D (by physical location)	Number of Patients in Ward (average) A-D (by physical location)
Sundays	4.12	39.29
Mondays	3.81	38.89
Tuesdays	3.48	38.59
Wednesdays	3.58	37.74
Thursdays	3.51	37.01
Fridays	2.62	35.75
Saturdays	3.14	37.31

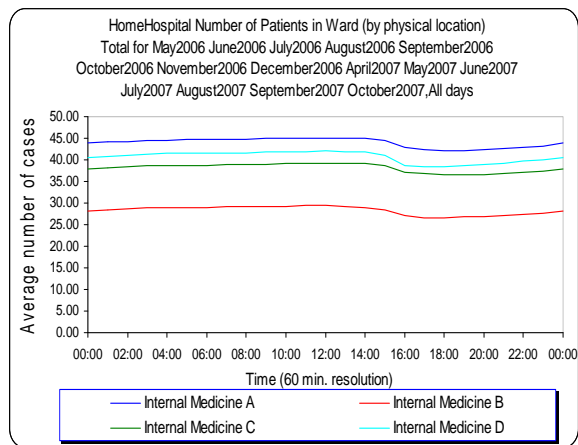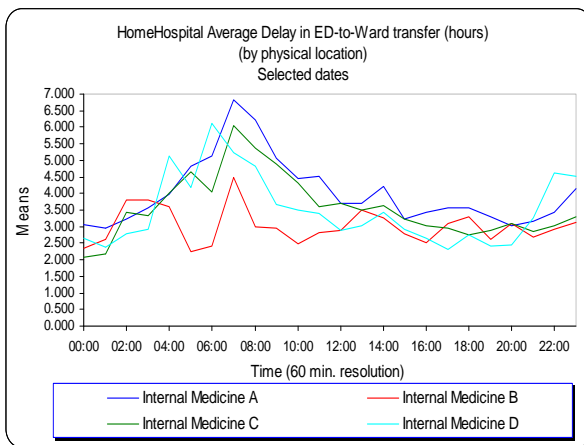6. Create chart of averages per day of week.

Reproducing steps **(2):**
1. Creating data table: click *Main –> Statistical Models (Summaries)*. Select *Time Series*, then *Intraday*. From the variables list, select *Average Delay in ED-to-Ward transfer (hours)(by physical location)*. In the *Categories* tab, select *Internal Medicine A, Internal Medicine B, Internal Medicine C, Internal Medicine D*. Open the *X Properties* tab. Select resolution *60:00* minutes.

Click the *Dates –>* button. Select *Dates totals only* and months from *May 2006* to *December 2006 and from April 2007 to October 2007.* Open tab *Days* and select *All days.* Click *OK.*

2. Repeat step 1 for *Number of Patients in Ward (by physical location)* variable.
3. Compute averages per IW A–D.

Time	\multicolumn{5}{c}{Average Delay in ED-to-Ward transfer (hours)(by physical location)}	\multicolumn{5}{c}{Number of Patients in Ward (by physical location)}
	Internal Medicine A	Internal Medicine B	Internal Medicine C	Internal Medicine D	average per A–D	Internal Medicine A	Internal Medicine B	Internal Medicine C	Internal Medicine D	average per A–D
00:00	3.1	2.3	2.1	2.6	2.5	43.9	28.3	38.0	40.5	37.7
01:00	3.0	2.6	2.2	2.4	2.5	44.1	28.5	38.2	40.8	37.9
02:00	3.2	3.8	3.4	2.8	3.3	44.3	28.7	38.4	41.1	38.1
03:00	3.6	3.8	3.3	2.9	3.4	44.5	28.8	38.6	41.4	38.3
04:00	4.0	3.6	4.0	5.1	4.2	44.6	28.9	38.7	41.5	38.4
05:00	4.8	2.2	4.7	4.2	4.0	44.7	29.0	38.8	41.6	38.5
06:00	5.1	2.4	4.0	6.1	4.4	44.7	29.1	38.8	41.6	38.6
07:00	6.8	4.5	6.1	5.2	5.7	44.8	29.1	38.8	41.6	38.6
08:00	6.2	3.0	5.4	4.8	4.9	44.8	29.2	38.9	41.7	38.6
09:00	5.1	3.0	4.9	3.7	4.1	44.9	29.2	39.0	41.7	38.7
10:00	4.5	2.5	4.3	3.5	3.7	45.0	29.3	39.1	41.8	38.8
11:00	4.5	2.8	3.6	3.4	3.6	45.1	29.4	39.2	42.0	38.9
12:00	3.7	2.9	3.7	2.9	3.3	45.1	29.4	39.3	42.0	38.9
13:00	3.7	3.5	3.5	3.0	3.4	45.1	29.3	39.3	41.9	38.9
14:00	4.2	3.3	3.6	3.4	3.6	45.0	28.9	39.3	42.0	38.8
15:00	3.2	2.8	3.2	2.9	3.1	44.6	28.3	38.6	41.0	38.1
16:00	3.4	2.5	3.0	2.7	2.9	42.9	27.1	37.2	38.7	36.5
17:00	3.6	3.1	3.0	2.3	3.0	42.3	26.7	36.8	38.5	36.1
18:00	3.6	3.3	2.8	2.7	3.1	42.1	26.6	36.5	38.5	35.9
19:00	3.3	2.6	2.9	2.4	2.8	42.2	26.7	36.5	38.6	36.0
20:00	3.0	3.1	3.1	2.5	2.9	42.4	26.9	36.6	39.0	36.2
21:00	3.2	2.7	2.9	3.3	3.0	42.6	27.1	36.7	39.3	36.4
22:00	3.4	2.9	3.0	4.6	3.5	42.9	27.4	37.0	39.7	36.8
23:00	4.1	3.1	3.3	4.5	3.8	43.2	27.6	37.3	39.9	37.0

HomeHospital, May 2006–December 2006 and April 2007-October 2007, All days

Original SEEStat charts:

4. Create chart of averages. Add and format secondary vertical axis for *Number of Patients in Ward (by physical location),* format primary vertical axis. (see in Appendix 5 How to add a secondary vertical axis in Excel).

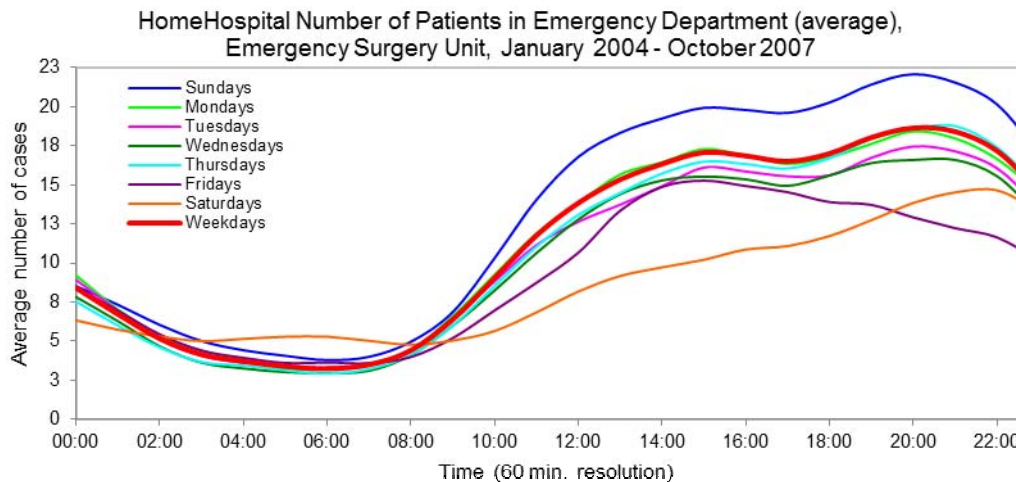34

Appendix 1: Number of patients in ED by day-of-week

Average number of Patients in ED Total, by day-of-week

HomeHospital Number of Patients in Emergency Department (average)
January 2004 - October 2007
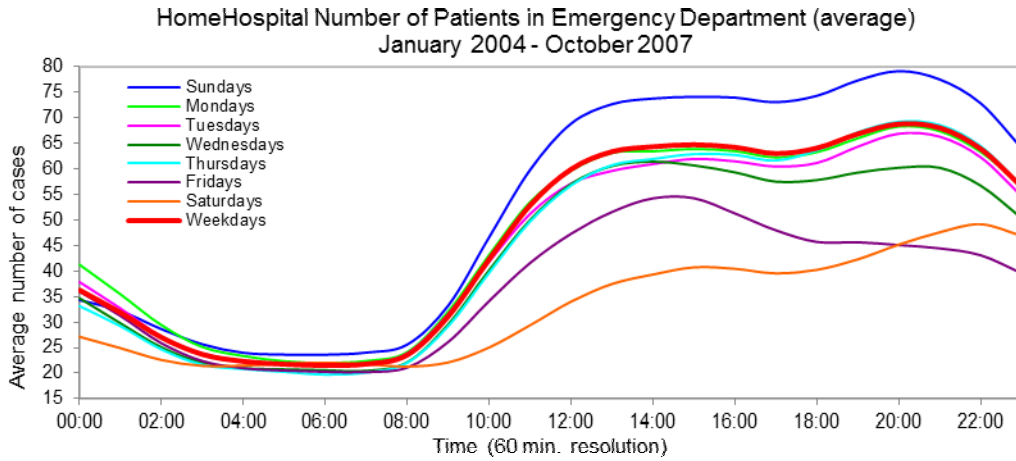
Average number of Patients in ED Internal Medicine, by day-of-week

HomeHospital Number of Patients in Emergency Department (average),
Emergency Internal Medicine Unit, January 2004 - October 2007
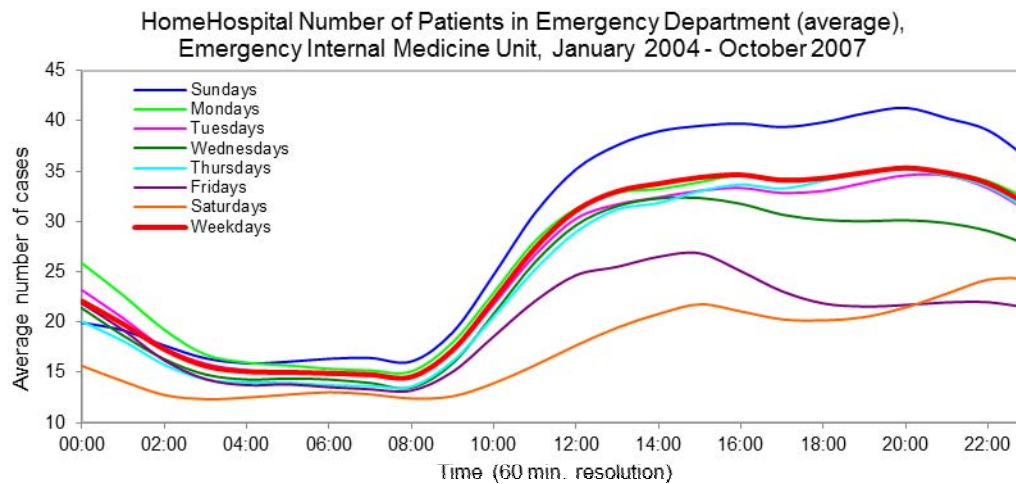
Average number of Patients in ED Surgery, by day-of-week

HomeHospital Number of Patients in Emergency Department (average),
Emergency Surgery Unit, January 2004 - October 2007

Appendix 2: Arrivals and service rates

2.1 Short description

Reference: Whitt W., *Fitting birth-and-death queueing models to data*, Statistics and Probability Letters 82 (2012) 998–1004 http://www.columbia.edu/~ww2040/FitBD021112.pdf

3. Fitting the BD model to queueing system data

Consider a queueing system in which arrivals and departures occur one at a time. Let $X(s)$ be the number of customers in the system at time s. We now consider fitting a BD model to data collected over an interval $[0, t]$.

Let $\bar{\lambda}_i(t)$ and $\bar{\mu}_i(t)$ be natural direct estimates of the birth rates and death rates based on sample averages over the time interval $[0, t]$. Similarly, let $\bar{\alpha}_i(t)$ be natural direct estimates of the stationary distribution based on sample averages over the time interval $[0, t]$.

In particular, let $A_i(t)$ be the number of arrivals during the interval $[0, t]$ when the system is in state i; let $D_i(t)$ be the number of departures during the interval $[0, t]$ when the system is in state i; and let $T_i(t)$ be the total time during the interval $[0, t]$ in which the system is in state i; i.e.,

$$T_i(t) \equiv \int_0^t 1_{\{X(s)=i\}}\, ds, \quad t \geq 0, \tag{6}$$

where 1_A is the indicator function of the set A, equal to 1 on A and equal to 0 otherwise. Then let

$$\bar{\lambda}_i(t) \equiv \frac{A_i(t)}{T_i(t)}, \quad \bar{\mu}_i(t) \equiv \frac{D_i(t)}{T_i(t)} \quad \text{and} \quad \bar{\alpha}_i(t) \equiv \frac{T_i(t)}{t}, \quad t \geq 0. \tag{7}$$

time interval – over 24 hours of day or 10 hours from 12:00:00 to 21:59:59
state i – Internal ED and Surgical ED and Traumatology ED state or Internal ED state (number of patients)

Weighted average arrival and service rates for each system state over the entire period:

$$\bar{\lambda}_i = \frac{\sum_1^n (\lambda_i * T_i)}{\sum_1^n T_i} = \frac{\sum_1^n (A_i / T_i * T_i)}{\sum_1^n T_i} = \frac{\sum_1^n A_i}{\sum_1^n T_i}$$

$$\bar{\mu}_i = \frac{\sum_1^n (\mu_i * T_i)}{\sum_1^n T_i} = \frac{\sum_1^n (D_i / T_i * T_i)}{\sum_1^n T_i} = \frac{\sum_1^n D_i}{\sum_1^n T_i}$$

n - number of days over the entire period when the system was in state *i*

Computing steps:
1. For each time interval (e.g. over 24 hours of day, over 6 hours from 03:00:00 to 08:59:59, over 3 hours from 09:00:00 to 11:59:59, over 10 hours from 12:00 to 21:59:59, over 5 hours from 22:00:00 to 02:59:59) compute the number of patients in ED, duration of ED state, number of arrivals, number of departures.
2. Aggregate data by number of patients in the ED for each day of each month.
3. Append the calculations of all time-periods (from step 2), between January 2004 to October 2007.
4. Sum the duration of ED state, number of arrivals, number of departures for each ED state over the entire period and compute the arrival rate and departures rate.

The following table demonstrates the application of Steps 1, 2 and 3.

year month	Day of month (time interval)	Internal ED state (# of patients) state i	Arrivals A_i	Departures D_i	state duration (seconds) T_i
200401	1	4	1	0	360
200401	1	5	1	0	2700
200401	1	6	2	0	6780
200401	1	7	2	1	2760
200401	1	8	2	1	1680
200401	1	9	3	1	5880
200401	1	10	4	3	2340
200401	1	11	5	2	5940
200401	1	12	3	4	1800
200401	1	13	1	2	1380
200401	1	14	2	0	540
200401	1	15	1	1	1619
200401	1	16	3	0	1080
200401	1	17	2	2	660
200401	1	18	1	1	120
200401	1	19	2	5	660
200401	1	20	2	0	420
200401	1	21	2	1	1080
200401	1	22	5	0	1440
200401	1	23	4	8	1920
200401	1	24	3	0	2280
200401	1	25	3	6	1680
200401	1	26	9	6	3900
200401	1	27	8	5	5640
200401	1	28	8	8	4860
200401	1	29	6	9	2880
200401	1	30	13	3	6390
200401	1	31	4	18	4770
200401	1	32	2	4	2100
200401	1	33	6	3	4260
200401	1	34	3	4	1920
200401	1	35	4	4	1500
200401	1	36	0	2	360
200401	1	37	1	3	300
200401	2	15	1	0	421
200401	2	16	2	0	1380
200401	2	17	2	0	960
200401	2	18	6	3	5081
200401	2	19	5	4	5771
200401	2	20	2	4	5092
200401	2	21	3	1	6941
200401	2	22	2	4	1248
200401	2	23	3	1	2990
200401	2	24	2	2	3380
200401	2	25	2	1	2407
200401	2	26	7	1	1965
200401	2	27	7	11	5057
200401	2	28	12	7	8185
200401	2	29	9	12	6634
200401	2	30	3	9	4339
200401	2	31	2	3	2200
200401	2	32	3	3	886
200401	2	33	2	2	1056
200401	2	34	3	2	602

…

The following table demonstrates the application of Step 4.

Internal ED state (# of patients) state i	arrivals over all period $\sum_{1}^{n} A_i$	departures over all period $\sum_{1}^{n} D_i$	state duration in seconds over all period $\sum_{1}^{n} T_i$	arrival rate per hour $\overline{\lambda}_i = \dfrac{\sum_{i}^{n} A_i}{\sum_{i}^{n} T_i / 3600}$	service rate per hour $\overline{\mu}_i = \dfrac{\sum_{i}^{n} D_i}{\sum_{i}^{n} T_i / 3600}$
0	3	0	1715	6.30	0.00
1	25	2	54248	1.66	0.13
2	52	23	92002	2.03	0.90
3	95	51	167062	2.05	1.10
4	173	91	312275	1.99	1.05
5	341	170	530234	2.32	1.15
6	589	335	870706	2.44	1.39
7	880	585	1275834	2.48	1.65
8	1250	856	1725071	2.61	1.79
9	1740	1237	2272070	2.76	1.96
10	2326	1717	2880951	2.91	2.15
11	2942	2290	3540511	2.99	2.33
12	3496	2913	4104873	3.07	2.55
13	4033	3434	4461837	3.25	2.77
14	4417	3965	4576525	3.47	3.12
15	4750	4336	4678464	3.66	3.34
16	5089	4666	4722544	3.88	3.56
17	5382	4996	4523729	4.28	3.98
18	5759	5255	4681622	4.43	4.04
19	5898	5690	4565042	4.65	4.49
20	5997	5756	4295319	5.03	4.82
21	6034	5895	4053159	5.36	5.24
22	6259	5929	3954108	5.70	5.40
23	6162	6246	3784202	5.86	5.94
24	6085	6084	3646008	6.01	6.01
25	6264	6025	3486727	6.47	6.22
26	6338	6198	3410481	6.69	6.54
27	6328	6342	3265748	6.98	6.99
28	6322	6324	3217029	7.07	7.08
29	6079	6333	3146357	6.96	7.25
30	6135	6119	2965311	7.45	7.43
31	6042	6161	2911314	7.47	7.62
32	5974	6073	2821100	7.62	7.75
33	5617	5996	2692626	7.51	8.02
34	5309	5652	2501983	7.64	8.13
35	5009	5470	2335307	7.72	8.43
36	4714	5066	2157050	7.87	8.45
37	4548	4788	2006762	8.16	8.59
38	4168	4588	1881416	7.98	8.78
39	3682	4166	1692032	7.83	8.86
40	3257	3710	1490277	7.87	8.96
41	2944	3321	1288820	8.22	9.28
42	2682	3039	1152253	8.38	9.49
43	2354	2796	1038116	8.16	9.70
44	2089	2446	919989	8.17	9.57
45	1853	2169	806044	8.28	9.69
46	1504	1883	671176	8.07	10.10
47	1418	1562	580918	8.79	9.68
48	1236	1477	508598	8.75	10.45
49	1061	1248	447889	8.53	10.03
50	866	1076	368520	8.46	10.51
51	749	860	312870	8.62	9.90
52	604	766	260244	8.36	10.60
53	481	629	200618	8.63	11.29
54	391	518	162505	8.66	11.48
55	308	406	129398	8.57	11.30

56	234	302	102914	8.19	10.56
57	166	258	85152	7.02	10.91
58	126	171	53084	8.54	11.60
59	91	125	36794	8.90	12.23
60	60	101	23950	9.02	15.18
61	41	71	17842	8.27	14.33
62	35	41	16145	7.80	9.14
63	29	35	10449	9.99	12.06
64	10	29	6401	5.62	16.31
65	7	10	2055	12.26	17.52
66	4	7	2835	5.08	8.89
67	2	4	2007	3.59	7.17
68	1	2	319	11.29	22.57
69	1	1	240	15.00	15.00
70	0	1	269	0.00	13.38

The following is a demonstration for calculating arrival/departure rates over one day (from Step 2) for the emphasized (blue) record:

$\mu_{30,\ January\ 1,\ 2004} = 3/(6390sec/3600sec) = 1.69$ per hour

$\lambda_{30,\ January\ 1,\ 2004} = 13/(6390sec/3600sec) = 7.32$ per hour

$\mu_{30,\ January\ 2,\ 2004} = 9/(4339sec/3600sec) = 7.47$ per hour

$\lambda_{30,\ January\ 2,\ 2004} = 3/(4339sec/3600sec) = 2.49$ per hour

The following demonstrates the weighted average arrivals and service rates per hour, over two days, given that the Internal ED was populated by 30 patients (similarly to Step 4):

$\mu_{30} = (D_{30,\ January\ 1,\ 2004} + D_{30,\ January\ 2,\ 2004}) / ((T_{30,\ January\ 1,\ 2004} + T_{30,\ January\ 2,\ 2004})/3600) =$
$(3+9) / ((6390sec+4339sec)/3600sec) = 4.03$ per hour

$\lambda_{30} = (A_{30,\ January\ 1,\ 2004} + A_{30,\ January\ 2,\ 2004}) / ((T_{30,\ January\ 1,\ 2004} + T_{30,\ January\ 2,\ 2004})/3600) = (13+3) /$
$((6390sec+4339sec)/3600sec) = 5.37$ per hour

The arrival and service rates are created in SEEStat as a new table and saved in binary format using dbprocedures.

The name of SEEStat table for the daily average Internal ED arrival and service rates over 24 hours per day for all days in period January 2004-October 2007 is "Internal_ED_rates_2004_2007" (source table: *visit_details*, where *entry_group=1 and department=1)*.

Internal ED arrival and service rates, January 2004-October 2007, All days	SEEStat DB Table name
over 24 hours per day	Internal_ED_rates_2004_2007
over 6 hours of day, from 03:00:00 to 08:59:59	Internal_ED_rates_2004_2007_3AM_9AM
over 3 hours of day, from 09:00:00 to 11:59:59	Internal_ED_rates_2004_2007_9AM_12PM
over 10 hours of day, from 12:00:00 to 21:59:59	Internal_ED_rates_2004_2007_12_22PM
over 5 hours of day, from 22:00:00 to 02:59:59	Internal_ED_rates_2004_2007_22PM_3AM

See on how to export these tables from SEEStat

2.2 Calculations over part of day

$$\overline{\mu}_{i,from3to9} = \frac{D_{i,from3to9}}{T_{i,from3to9}}; \quad \overline{\mu}_{i,from9to12} = \frac{D_{i,from9to12}}{T_{i,from9to12}}; \quad \overline{\mu}_{i,from12to22} = \frac{D_{i,from12to22}}{T_{i,from12to22}}; \quad \overline{\mu}_{i,from22to03} = \frac{D_{i,from22to03}}{T_{i,from22to03}}$$

$$\overline{\mu}_{i,over24h} = \frac{D_{i,over24h}}{T_{i,over24h}} = \frac{D_{i,from3to9} + D_{i,from9to12} + D_{i,from12to22} + D_{i,from22to03}}{T_{i,over24h}} =$$

$$\frac{\mu_{i,from3to9} * T_{i,from3to9} + \mu_{i,from9to12} * T_{i,from9to12} + \mu_{i,from12to22} * T_{i,from12to22} + \mu_{i,from22to03} * T_{i,from22to03}}{T_{i,over24h}} =$$

$$\mu_{i,from3to9} * \frac{T_{i,from3to9}}{T_{i,over24h}} + \mu_{i,from9to12} * \frac{T_{i,from9to12}}{T_{i,over24h}} + \mu_{i,from12to22} * \frac{T_{i,from12to22}}{T_{i,over24h}} + \mu_{i,from22to03} * \frac{T_{i,from22to03}}{T_{i,over24h}}$$

$$d_{i,from3to9} = \frac{T_{i,from3to9}}{T_{i,over24h}}$$

HomeHospital, Internal ED state January 2004-October 2007, all days

- ED state duration over 24 hours of day
- ED state duration from 12:00:00 to 21:59:59
- ED state duration from 03:00:00 to 08:59:59
- ED state duration from 09:00:00 to 11:59:59
- ED state duration from 22:00:00 to 02:59:59

HomeHospital, Internal ED state January 2004-October 2007, all days

- state duration 12:00:00-21:59:59 (percent to 24 hours)
- state duration 03:00:00-08:59:59 (percent to 24 hours)
- state duration 09:00:00-11:59:59 (percent to 24 hours)
- state duration 22:00:00-02:59:59 (percent to 24 hours)

$$\overline{\mu}_{i,over24h} = \mu_{i,from3to9} * d_{i,from3to9} + \mu_{i,from9to9}12 * d_{i,from9to12} + \mu_{i,from12to22} * d_{i,from12to22} + \mu_{i,from22to03} * d_{i,from22to03}$$

$$\boxed{\overline{\mu}_{i,over24h} = \sum \mu_{i,partOfDay} * d_{i,partOfDay}}$$

HomeHospital, Internal ED state January 2004-October 2007, all days

Legend:
- Service Rate/L over 24 hours of day
- Service Rate/L from 03:00:00 to 08:59:59
- Service Rate/L from 09:00:00 to 11:59:59
- Service Rate/L from 12:00:00 to 21:59:59
- Service Rate/L from 22:00:00 to 02:59:59
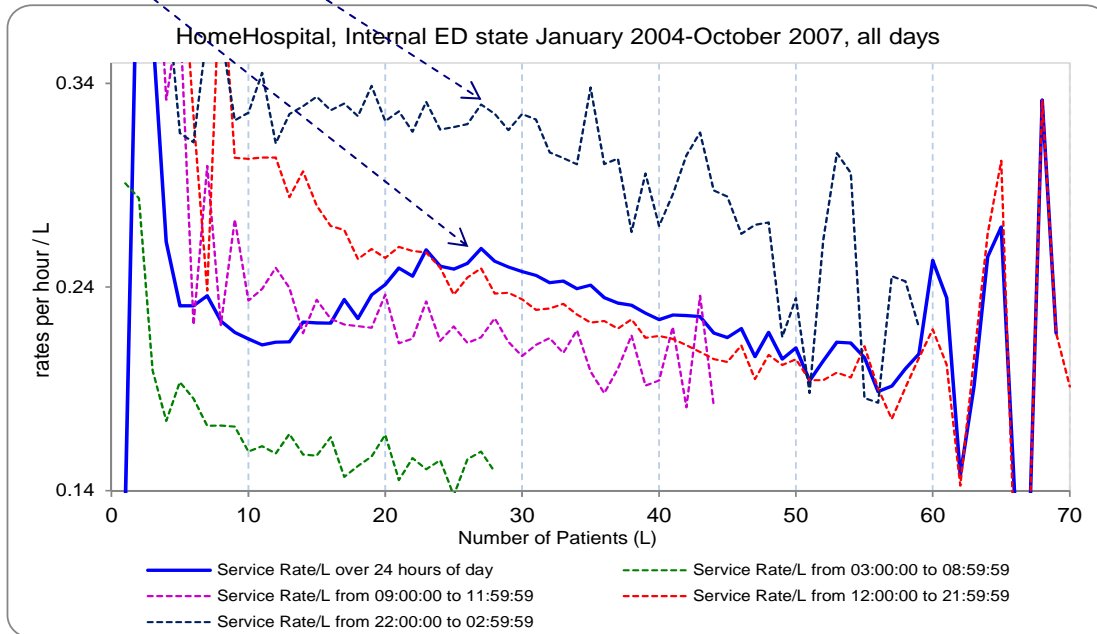
Internal ED, January 2004 - October 2007, all days

number of patients	over 24 hours of day				over 6 hours of day, from 03:00:00 to 08:59:59					over 3 hours of day, from 09:00:00 to 11:59:59					over 10 hours of day, from 12:00:00 to 21:59:59					over 5 hours of day, from 22:00:00 to 02:59:59				
	departures	state duration (hours)	service rate per hour	service rate per hour/L	departures	state duration (hours)	service rate per hour	service rate per hour/L	state duration (hours) percent to 24 hours	departures	state duration (hours)	service rate per hour	service rate per hour/L	state duration (hours) percent to 24 hours	departures	state duration (hours)	service rate per hour	service rate per hour/L	state duration (hours) percent to 24 hours	departures	state duration (hours)	service rate per hour	service rate per hour/L	state duration (hours) percent to 24 hours
0	0	0.48																		0	0.48	0		1
1	2	15.07	0.13	0.133	0	7.89	0	0	0.524	0	1.56	0	0	0.104	0	0.57	0	0	0.038	2	5.05	0.4	0.396	0.335
2	23	25.56	0.9	0.45	10	17.18	0.58	0.291	0.672	2	2.7	0.74	0.371	0.106	3	1.75	1.72	0.859	0.068	8	3.93	2.04	1.018	0.154
3	51	46.41	1.1	0.366	21	24.68	0.85	0.284	0.532	7	5.18	1.35	0.45	0.112	8	3.38	2.37	0.789	0.073	15	13.17	1.14	0.38	0.284
4	91	86.74	1.05	0.262	44	55.25	0.8	0.199	0.637	11	8.28	1.33	0.332	0.095	9	5.86	1.54	0.384	0.068	27	17.35	1.56	0.389	0.200
5	170	147.29	1.15	0.231	86	98.68	0.87	0.174	0.670	18	9.59	1.88	0.375	0.065	18	8.59	2.1	0.419	0.058	48	30.42	1.58	0.316	0.207
6	335	241.86	1.39	0.231	173	149.15	1.16	0.193	0.617	30	22.58	1.33	0.221	0.093	28	14.42	1.94	0.324	0.060	104	55.72	1.87	0.311	0.230
7	585	354.4	1.65	0.236	293	225.92	1.3	0.185	0.637	70	33.4	2.1	0.299	0.094	40	23.98	1.67	0.238	0.068	182	71.1	2.56	0.366	0.201
8	856	479.19	1.79	0.223	436	317	1.38	0.172	0.662	96	54.2	1.77	0.221	0.113	86	26.56	3.24	0.405	0.055	238	81.42	2.92	0.365	0.170
9	1237	631.13	1.96	0.218	634	409.6	1.55	0.172	0.649	182	74.02	2.46	0.273	0.117	103	37.72	2.73	0.303	0.060	318	109.79	2.9	0.322	0.174
10	1717	800.26	2.15	0.215	877	511.2	1.72	0.172	0.639	226	96.82	2.33	0.233	0.121	159	52.48	3.03	0.303	0.066	455	139.76	3.26	0.326	0.175
11	2290	983.48	2.33	0.212	1083	618.36	1.75	0.159	0.629	323	122.82	2.63	0.239	0.125	263	78.74	3.34	0.304	0.080	621	163.56	3.8	0.345	0.166
12	2913	1140.24	2.55	0.213	1331	684.93	1.94	0.162	0.601	435	145.28	2.99	0.25	0.127	365	100.2	3.64	0.304	0.088	782	209.84	3.73	0.311	0.184
13	3434	1239.4	2.77	0.213	1473	716.02	2.06	0.158	0.578	518	166.28	3.12	0.24	0.134	457	123.71	3.69	0.284	0.100	986	233.39	4.22	0.325	0.188
14	3965	1271.26	3.12	0.223	1584	674.03	2.35	0.168	0.530	593	194.87	3.04	0.217	0.153	598	143.9	4.16	0.297	0.113	1190	258.46	4.6	0.329	0.203
15	4336	1299.57	3.34	0.222	1554	656.59	2.37	0.158	0.505	691	197.05	3.51	0.234	0.152	730	173.82	4.2	0.28	0.134	1361	272.11	5	0.333	0.209
16	4666	1311.82	3.56	0.222	1540	612.33	2.51	0.157	0.467	746	207.79	3.59	0.224	0.158	908	210.16	4.32	0.27	0.160	1472	281.54	5.23	0.327	0.215
17	4996	1256.59	3.98	0.234	1407	497.55	2.83	0.166	0.396	845	224.34	3.77	0.222	0.179	1107	242.98	4.56	0.268	0.193	1637	291.72	5.61	0.33	0.232
18	5255	1300.45	4.04	0.224	1267	479.57	2.64	0.147	0.369	929	233.67	3.98	0.221	0.180	1319	288.71	4.57	0.254	0.222	1740	298.51	5.83	0.324	0.230
19	5690	1268.07	4.49	0.236	1164	402.51	2.89	0.152	0.317	1002	239.68	4.18	0.22	0.189	1631	331.77	4.92	0.259	0.262	1893	294.11	6.44	0.339	0.232
20	5756	1193.14	4.82	0.241	978	311.77	3.14	0.157	0.261	1033	218.57	4.73	0.236	0.183	1954	384.29	5.08	0.254	0.322	1791	278.52	6.43	0.322	0.233
21	5895	1125.88	5.24	0.249	780	221.72	3.52	0.168	0.197	939	210.44	4.46	0.212	0.187	2253	413	5.46	0.26	0.367	1923	280.72	6.85	0.326	0.249
22	5929	1098.36	5.4	0.245	598	187.13	3.2	0.145	0.170	954	201.99	4.72	0.215	0.184	2457	433.29	5.67	0.258	0.394	1920	275.95	6.96	0.316	0.251
23	6246	1051.17	5.94	0.258	503	140.13	3.59	0.156	0.133	1010	188.5	5.36	0.233	0.179	2663	450.64	5.91	0.257	0.429	2070	271.9	7.61	0.331	0.259
24	6084	1012.78	6.01	0.25	385	106.55	3.61	0.151	0.105	922	179.8	5.13	0.214	0.178	2784	464.71	5.99	0.25	0.459	1993	261.72	7.62	0.317	0.258
25	6025	968.54	6.22	0.249	279	72.02	3.87	0.155	0.074	880	159.5	5.52	0.221	0.165	2882	487.89	5.91	0.236	0.504	1984	249.12	7.96	0.319	0.257
26	6198	947.36	6.54	0.252	205	57.23	3.58	0.138	0.060	827	149.61	5.53	0.213	0.158	3233	508.23	6.36	0.245	0.536	1933	232.28	8.32	0.32	0.245
27	6342	907.15	6.99	0.259	172	40.98	4.2	0.155	0.045	833	143.27	5.81	0.215	0.158	3397	504.92	6.73	0.249	0.557	1940	217.98	8.9	0.33	0.240
28	6324	893.62	7.08	0.253	140	31.41	4.46	0.159	0.035	746	118.56	6.29	0.225	0.133	3574	538.88	6.63	0.237	0.603	1864	204.77	9.1	0.325	0.229
29	6333	873.99	7.25	0.25	94	21.73	4.33	0.149	0.025	619	100.15	6.18	0.213	0.115	3845	559.07	6.88	0.237	0.640	1775	193.04	9.19	0.317	0.221
30	6119	823.7	7.43	0.248	65	19.95	3.26	0.109	0.024	528	85.38	6.18	0.206	0.104	3803	541.64	7.02	0.234	0.658	1723	176.72	9.75	0.325	0.215
31	6161	808.7	7.62	0.246	60	8.96	6.69	0.216	0.011	487	74.22	6.56	0.212	0.092	4006	564.58	7.1	0.229	0.698	1608	160.93	9.99	0.322	0.199
32	6073	783.64	7.75	0.242	38	8.01	4.74	0.148	0.010	432	62.8	6.88	0.215	0.080	4131	562.56	7.34	0.229	0.718	1472	150.27	9.8	0.306	0.192
33	5996	747.95	8.02	0.243	22	5.54	3.97	0.12	0.007	353	51.51	6.85	0.208	0.069	4188	547.74	7.65	0.232	0.732	1433	143.17	10.01	0.303	0.191
34	5652	695	8.13	0.239	21	4.18	5.03	0.148	0.006	295	39.66	7.44	0.219	0.057	4034	523.63	7.7	0.227	0.753	1302	127.53	10.21	0.3	0.183
35	5470	648.7	8.43	0.241	14	1.95	7.17	0.205	0.003	260	37.41	6.95	0.199	0.058	3879	498.02	7.79	0.223	0.768	1317	111.32	11.83	0.338	0.172
36	5066	599.18	8.45	0.235	10	0.93	10.74	0.298	0.002	200	29.57	6.76	0.188	0.049	3747	466.11	8.04	0.223	0.778	1109	102.56	10.81	0.3	0.171

37	4788	557.43	8.59	0.232	5	0.6	8.34	0.225	0.001	189	25.55	7.4	0.2	0.046	3589	441.67	8.13	0.22	0.792	1005	89.61	11.22	0.303	0.161
38	4588	522.62	8.78	0.231	2	0.57	3.52	0.093	0.001	146	17.76	8.22	0.216	0.034	3538	415.42	8.52	0.224	0.795	902	88.87	10.15	0.267	0.170
39	4166	470.01	8.86	0.227	2	0.11	17.87	0.458	0.0002	116	15.52	7.47	0.192	0.033	3177	378.85	8.39	0.215	0.806	871	75.53	11.53	0.296	0.161
40	3710	413.97	8.96	0.224	2	0.09	23.23	0.581	0.0002	106	13.65	7.77	0.194	0.033	2881	333.49	8.64	0.216	0.806	721	66.75	10.8	0.27	0.161
41	3321	358.01	9.28	0.226						82	9.08	9.03	0.22	0.025	2556	290.57	8.8	0.215	0.812	683	58.36	11.7	0.285	0.163
42	3039	320.07	9.49	0.226						58	7.63	7.6	0.181	0.024	2310	260.01	8.88	0.212	0.812	671	52.43	12.8	0.305	0.164
43	2796	288.37	9.7	0.225						61	6.02	10.13	0.236	0.021	2124	237.36	8.95	0.208	0.823	611	44.99	13.58	0.316	0.156
44	2446	255.55	9.57	0.218						35	4.37	8.01	0.182	0.017	1896	210.47	9.01	0.205	0.824	515	40.71	12.65	0.287	0.159
45	2169	223.9	9.69	0.215						17	2.49	6.83	0.152	0.011	1705	186.48	9.14	0.203	0.833	447	34.93	12.8	0.284	0.156
46	1883	186.44	10.1	0.22						20	1.88	10.64	0.231	0.010	1529	157.28	9.72	0.211	0.844	334	27.28	12.24	0.266	0.146
47	1562	161.37	9.68	0.206						16	1.87	8.55	0.182	0.012	1241	135.51	9.16	0.195	0.840	305	23.99	12.72	0.271	0.149
48	1477	141.28	10.45	0.218						19	1.54	12.35	0.257	0.011	1159	116.82	9.92	0.207	0.827	299	22.92	13.05	0.272	0.162
49	1248	124.41	10.03	0.205						14	1.06	13.17	0.269	0.009	1007	101.85	9.89	0.202	0.819	227	21.5	10.56	0.216	0.173
50	1076	102.37	10.51	0.21						6	0.29	20.85	0.417	0.003	867	84.77	10.23	0.205	0.828	203	17.31	11.73	0.235	0.169
51	860	86.91	9.9	0.194						4	0.08	52.94	1.038	0.001	721	72.75	9.91	0.194	0.837	135	14.08	9.59	0.188	0.162
52	766	72.29	10.6	0.204						0	0.03	0	0	0.0004	629	62.24	10.11	0.194	0.861	137	10.02	13.67	0.263	0.139
53	629	55.73	11.29	0.213						0	0.13	0	0	0.002	500	47.64	10.5	0.198	0.855	129	7.96	16.21	0.306	0.143
54	518	45.14	11.48	0.213											397	37.57	10.57	0.196	0.832	121	7.57	15.99	0.296	0.168
55	406	35.94	11.3	0.205											326	28.1	11.6	0.211	0.782	80	7.84	10.2	0.185	0.218
56	302	28.59	10.56	0.189											240	22.54	10.65	0.19	0.788	62	6.04	10.26	0.183	0.211
57	258	23.65	10.91	0.191											182	18.22	9.99	0.175	0.770	76	5.44	13.98	0.245	0.230
58	171	14.75	11.6	0.2											134	12.12	11.06	0.191	0.822	37	2.63	14.08	0.243	0.178
59	125	10.22	12.23	0.207											107	8.83	12.11	0.205	0.864	18	1.39	12.98	0.22	0.136
60	101	6.65	15.18	0.253											78	5.93	13.15	0.219	0.892	23	0.72	31.83	0.531	0.108
61	71	4.96	14.33	0.235											57	4.63	12.32	0.202	0.933	14	0.33	42.71	0.7	0.067
62	41	4.48	9.14	0.147											39	4.41	8.84	0.143	0.984	2	0.07	27.07	0.437	0.016
63	35	2.9	12.06	0.191											34	2.64	12.9	0.205	0.910	1	0.27	3.76	0.06	0.093
64	29	1.78	16.31	0.255											27	1.59	17.03	0.266	0.893	2	0.19	10.4	0.163	0.107
65	10	0.57	17.52	0.27											8	0.41	19.63	0.302	0.719	2	0.16	12.24	0.188	0.281
66	7	0.79	8.89	0.135											4	0.59	6.83	0.104	0.747	3	0.2	14.84	0.225	0.253
67	4	0.56	7.17	0.107											4	0.56	7.17	0.107	1.0					
68	2	0.09	22.57	0.332											2	0.09	22.57	0.332	1.0					
69	1	0.07	15	0.217											1	0.07	15	0.217	1.0					
70	1	0.07	13.38	0.191											1	0.07	13.38	0.191	1.0					

Appendix 3: Time by ED state (sec.) variable

Appendix 3 consists of two main parts. The first part is an explanation of how to calculate the variable **Time by ED state**, while the second part is a guide to constructing this variable in SEEStat.

The calculation of **Time by ED state** is illustrated by two types of examples. One is a simple calculation for a given dataset. The second type of examples helps one understand the calculation of the variable, given a more complex task, e.g. calculating **Time by ED state** for multiple ED units (Surgery + Internal, all ED without pediatrics and so on), or over multiple days. The last examples are only added to clarify the calculation of the variable, due to many questions that did arise on the subject.

The second part of this Appendix is rather technical and provides of the steps to create the **Time by ED state** variable.

3.1 Definition of the variable

3.1.1 Simple calculation for a given dataset

3.1.1.1 Simple Example

First compute instants (moment of time) counts in time interval from start_time to end_time.

Define:

- **Discrete scale of time**: 24 hours of day divided into 86400 one second length time intervals.

- m_j – moment of time j, or second$_j$; j=1, 2, …, nt;
  nt – length of time interval or number of moments of time;

  nt = end_time – start_time + 1

- x_i – event i (for example call waited in queue or patient gets treatment in ED);
  i=1, 2, … , n;
  n – total number of events

- x_{iopen} – "open" event i at moment of time, so that event start > start_time and event end ≤ end_time

- $N_{at\ moment\ i}$ – number of "open" events at moment of time i
  $$N_{at\ moment\ i} = \sum_i^n x_{iopen}$$

Events A, B, C, D were observed at time interval from t–1 to t+5. Event start time and event end time known.

event	event start	event end
A	t–1	t+1
B	t–1	t
C	t	t+5
D	t+4	t+5
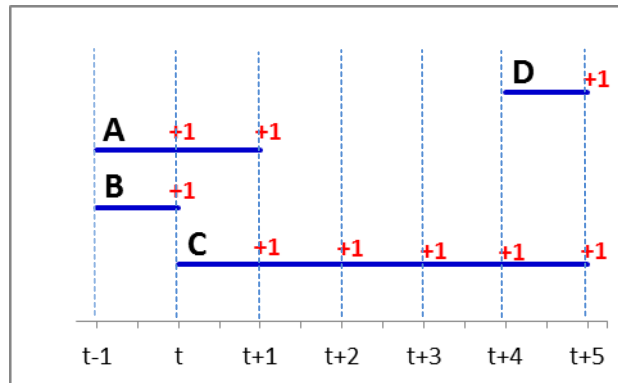
+1 – *add "open" event at moment of time*

Questions: How many "open" events were at every moment of time in defined interval?

Let see the sample:
n = 4
start_time = t–1
end_time = t+5
nt = t+5– (t–1)+1 = 7 moments of time

j	m_j	$N_{at\ moment\ i}$	x_{iopen}
1	t–1	0	
2	t	2	A, B
3	t+1	2	A, C
4	t+2	1	C
5	t+3	1	C
6	t+4	1	C
7	t+5	2	C, D

The creation of $N_{at\ moment\ i}$ via SEEStat can be found in Part 3.2.1 of this appendix.
Second step of variable definition is to compute frequencies of x_{iopen}

$N_{at\ moment\ i}$	Frequencies	Moment of time
1	3	t+2, t+3, t+4
2	3	t, t+1,t+5
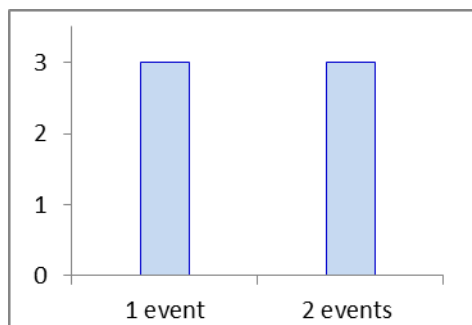
One event was during 3 seconds in time interval from t–1 to t+5.
Two events were during 3 seconds in time interval from t–1 to t+5

The creation of frequencies of $N_{at\ moment\ i}$ via SEEStat can be found in Part 3.2.2 of this appendix.

3.1.1.2 Numerical Example: Surgery ED state

First look at the difference during 1-hour and 24-hour
Surgery ED state on the same day.

HomeHospital Time by ED Surgery state
(sec.),10.05.2006, **(09:00:00 - 10:00:00)**

HomeHospital Time by ED Surgery state (sec.)
10.05.2006, **(00:00:00 - 24:00:00)**
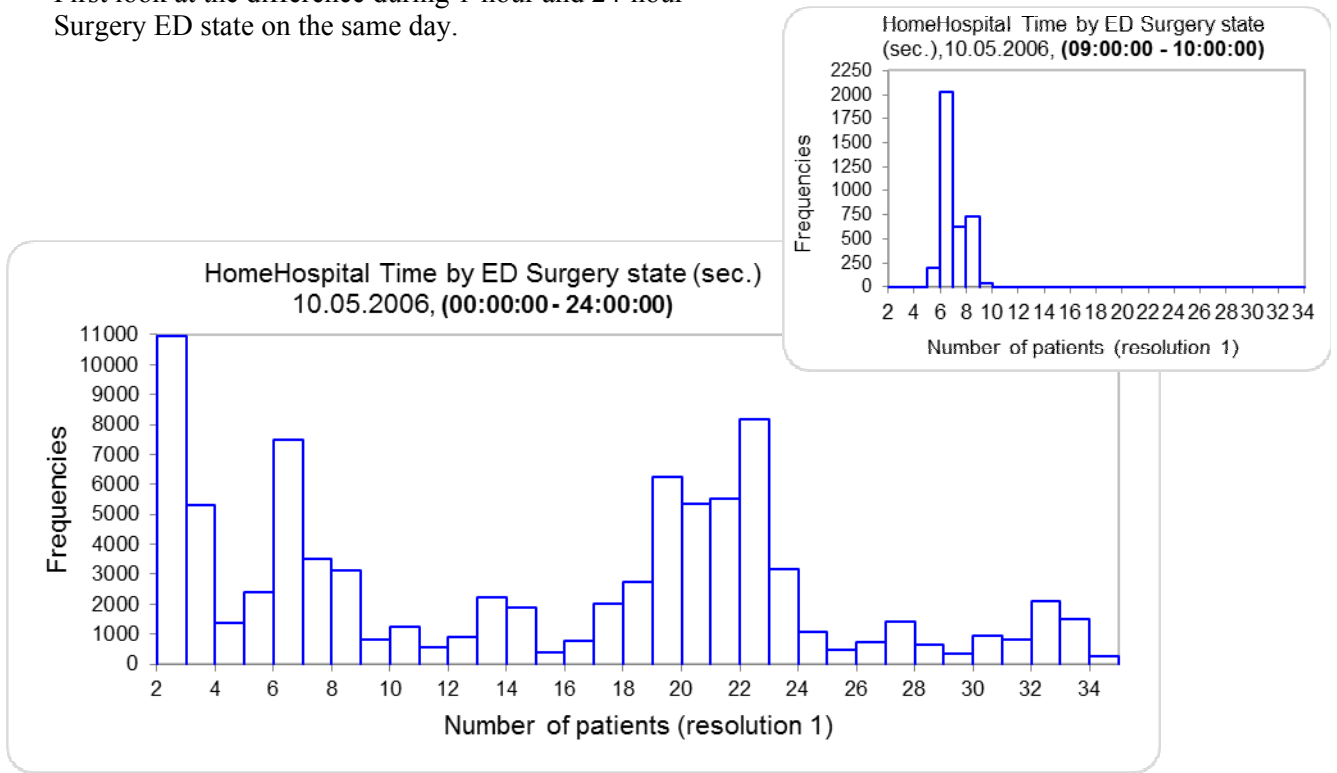
Time by ED Surgery state (sec.), 10.05.2006, **(00:00:00 – 24:00:00)**				
Number of patients	Frequency	Relative frequency %	Cumulative frequency	Relative Cumulative frequency %
2	10964	12.69	10964	12.69
3	5293	6.13	16257	18.82
4	1384	1.60	17641	20.42
5	2406	2.78	20047	23.20
6	7475	8.65	27522	31.85
7	3493	4.04	31015	35.90
8	3111	3.60	34126	39.50
9	819	0.95	34945	40.45
10	1262	1.46	36207	41.91
11	562	0.65	36769	42.56
12	895	1.04	37664	43.59
13	2249	2.60	39913	46.20
14	1877	2.17	41790	48.37
15	396	0.46	42186	48.83
16	753	0.87	42939	49.70
17	2035	2.36	44974	52.05
18	2725	3.15	47699	55.21
19	6233	7.21	53932	62.42
20	5348	6.19	59280	68.61
21	5519	6.39	64799	75.00
22	8185	9.47	72984	84.47
23	3173	3.67	76157	88.14
24	1073	1.24	77230	89.39
25	457	0.53	77687	89.92
26	716	0.83	78403	90.74

27	1412	1.63	79815	92.38
28	628	0.73	80443	93.11
29	337	0.39	80780	93.50
30	961	1.11	81741	94.61
31	803	0.93	82544	95.54
32	2091	2.42	84635	97.96
33	1486	1.72	86121	99.68
34	279	0.32	86400	100.00

Time by ED Surgery state (sec.), 10.05.2006, *(09:00:00 – 10:00:00)*				
Number of patients	Frequency	Relative frequency%	Cumulative frequency	Relative Cumulative frequency %
5	191	5	191	5
6	2022	56	2213	61
7	619	17	2832	79
8	729	20	3561	99
9	39	1	3600	100

Time by ED Surgery state (sec.), 10.05.2006, *(00:00:00 – 24:00:00)* Statistics	
	Time by ED Surgery state (sec.)
N	86400
Mean	14.33
Standard Deviation	9.21
Variance	84.81
Median	17
Minimum	2
Maximum	34

Time by ED Surgery state (sec.), 10.05.2006, *(09:00:00 – 10:00:00)* Statistics	
	Time by ED Surgery state (sec.)
N	3600
Mean	6.556
Standard Deviation	0.907
Variance	0.823
Median	6
Minimum	5
Maximum	9

Data	
Time	Number of Patients in Surgery ED
09:00:00	5
09:00:01	5
09:00:02	5
09:00:03	5
09:00:04	5
09:00:05	5
09:00:06	5
09:00:07	5
09:00:08	5
09:00:09	5
…	…
10:00:00	9

N = 3600

Calculation of ED state during 1 hour from 09:00 to 10:00 a.m..

Data sample: SELECT visit_details.* INTO data_sample FROM visit_details WHERE (entry_group=1 AND department=2 AND entry_date < #5/10/2006 10:00:00# AND exit_date > #5/10/2006 09:00:00#);

#	patient id	medical id	gender	department	entry date	exit date	outcome	age years	age months
1	10209054	20381564	1	2	09/May/2006 15:10:28	11/May/2006 10:17:44	7	30	3
2	10078577	20134193	2	2	09/May/2006 15:33:11	10/May/2006 10:32:50	2	85	4
3	10208982	20381437	1	2	10/May/2006 08:21:58	10/May/2006 09:33:29	7	18	11
4	10190540	20347728	1	2	10/May/2006 08:24:24	10/May/2006 10:41:12	7	52	8
5	10078478	20133991	2	2	10/May/2006 08:26:55	10/May/2006 14:28:35	7	79	4
6	10078437	20133908	2	2	10/May/2006 09:03:10	10/May/2006 12:58:18	7	24	7
7	10101903	20178962	2	2	10/May/2006 09:32:02	10/May/2006 13:21:32	2	68	5
8	10115366	20382950	1	2	10/May/2006 09:38:19	10/May/2006 14:19:28	2	29	10
9	10208011	20381293	1	2	10/May/2006 09:47:11	10/May/2006 10:35:02	7	43	4
10	10180315	20381438	1	2	10/May/2006 09:59:20	10/May/2006 13:26:00	7	49	10

Surgery ED state, 10.05.2006, 09:00:00 – 10:00:00			
Time	number of patients	patient id	duration (seconds)
[09:00:00 – 09:03:10)	5	10209054, 10078577, 10208982, 10190540, 10078478	191
[09:03:10 – 09:32:02)	6	10209054, 10078577, 10208982, 10190540, 10078478, 10078437	1732
[09:32:02 – 09:33:29)	7	10209054, 10078577, 10208982, 10190540, 10078478, 10078437, 10101903	87
[09:33:29 – 09:38:19)	6	10209054, 10078577, 10190540, 10078478, 10078437, 10101903	290
[09:38:19 – 09:47:11)	7	10209054, 10078577, 10190540, 10078478, 10078437, 10101903, 10115366	532
[09:47:11 – 09:59:20)	8	10209054, 10078577, 10190540, 10078478, 10078437, 10101903, 10115366, 10208011	729
[09:59:20 – 10:00:00)	9	10209054, 10078577, 10190540, 10078478, 10078437, 10101903, 10115366, 10208011, 10180315	39

HomeHospital   Surgery ED state, 10.05.2006, 09:00:00 - 10:00:00
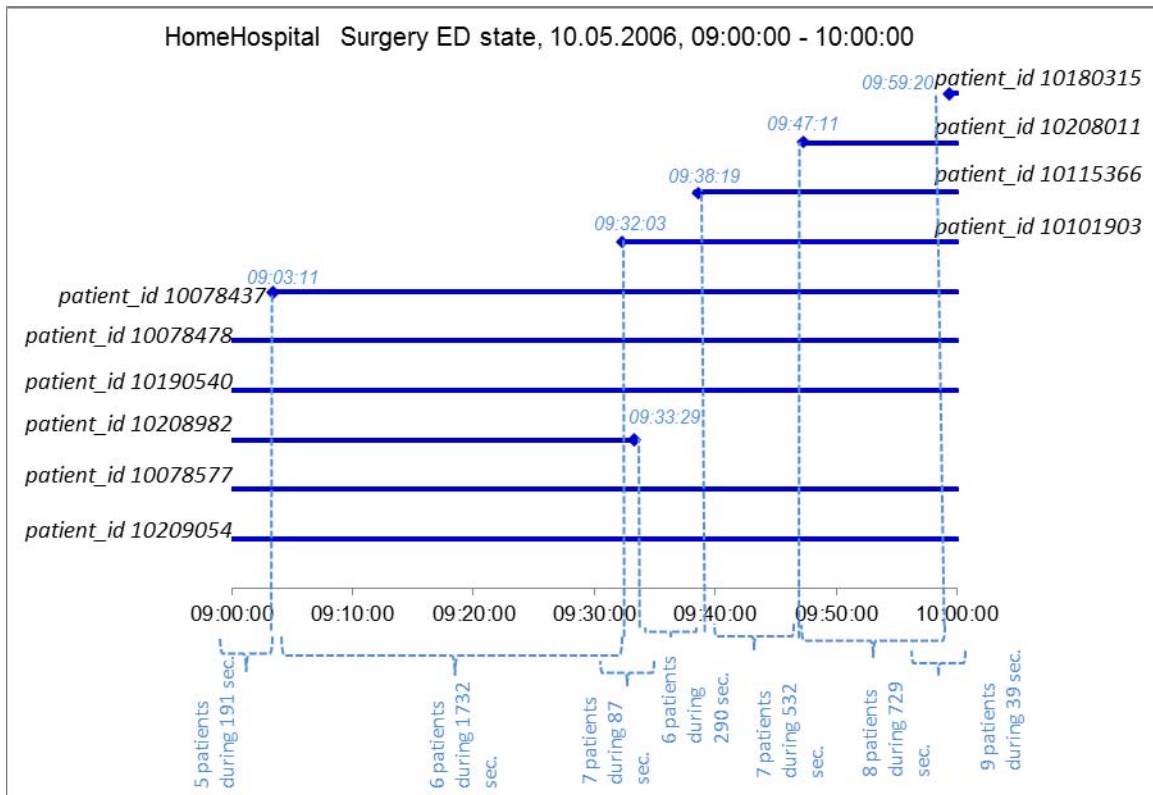
3.1.1.3 Numerical Example: Surgery and Internal ED state

Data sample: SELECT visit_details.* INTO data_sample FROM visit_details WHERE (entry_group=1 AND (department=1 or department=2) AND entry_date < #5/10/2006 10:00:00# AND exit_date > #5/10/2006 09:00:00#);

#	patient id	medical id	gender	department	entry date	exit date	outcome e	age years	age months
1	10050255	20087589	2	1	03/May/2006 22:44:20	12/May/2006 02:29:20	7	26	4
2	10209054	20381564	1	2	09/May/2006 15:10:28	11/May/2006 10:17:44	7	30	3
3	10078577	20134193	2	2	09/May/2006 15:33:11	10/May/2006 10:32:50	2	85	4
4	10032429	20114928	2	1	09/May/2006 18:05:26	10/May/2006 09:19:35	2	49	7
5	10116529	20220470	1	1	09/May/2006 20:10:58	10/May/2006 12:18:29	2	44	11
6	10173335	20316317	1	1	09/May/2006 20:14:53	10/May/2006 10:46:03	7	23	3
7	10055663	20087584	2	1	09/May/2006 21:54:19	10/May/2006 14:57:20	7	22	9
8	10046576	20114954	2	1	09/May/2006 21:58:28	10/May/2006 10:56:20	7	30	7
9	10160307	20318805	1	1	09/May/2006 22:10:34	10/May/2006 10:46:22	7	63	11
10	10000958	20114958	2	1	09/May/2006 22:39:55	10/May/2006 09:50:57	2	53	10
11	10043359	20064973	2	1	09/May/2006 23:15:10	10/May/2006 09:42:43	7	82	2
12	10144618	20329950	1	1	10/May/2006 00:12:55	10/May/2006 12:36:23	2	18	9
13	10027827	20087632	2	1	10/May/2006 03:52:34	10/May/2006 11:09:06	7	34	6
14	10053221	20114968	2	1	10/May/2006 05:02:07	10/May/2006 14:52:14	2	55	0
15	10132704	20295135	1	1	10/May/2006 05:05:19	10/May/2006 09:32:09	7	49	0
16	10020926	20028380	2	1	10/May/2006 05:08:29	10/May/2006 12:08:38	2	63	10
17	10180555	20329953	1	1	10/May/2006 05:32:05	10/May/2006 09:01:37	2	40	3
18	10145499	20295136	1	1	10/May/2006 05:33:09	10/May/2006 09:36:50	7	69	0
19	10164127	20295137	1	1	10/May/2006 05:55:45	10/May/2006 13:40:59	7	22	1
20	10117576	20329954	1	1	10/May/2006 06:15:26	10/May/2006 14:27:05	2	53	0
21	10116665	20329957	1	1	10/May/2006 06:58:57	10/May/2006 16:26:17	2	84	7
22	10034971	20070183	2	1	10/May/2006 07:05:55	10/May/2006 23:50:00	8	59	5
23	10164030	20294954	1	1	10/May/2006 07:57:08	10/May/2006 10:00:44	7	17	0
24	10208982	20381437	1	2	10/May/2006 08:21:58	10/May/2006 09:33:29	7	18	11
25	10190540	20347728	1	2	10/May/2006 08:24:24	10/May/2006 10:41:12	7	52	8
26	10055664	20087586	2	1	10/May/2006 08:24:26	10/May/2006 10:58:42	7	67	8
27	10078478	20133991	2	2	10/May/2006 08:26:55	10/May/2006 14:28:35	7	79	4
28	10116112	20295082	1	1	10/May/2006 08:27:23	10/May/2006 15:11:07	7	64	7
29	10116596	20295138	1	1	10/May/2006 08:33:46	10/May/2006 12:16:42	7	58	4
30	10055630	20087511	2	1	10/May/2006 08:56:18	10/May/2006 14:41:29	7	58	8
31	10078437	20133908	2	2	10/May/2006 09:03:10	10/May/2006 12:58:18	7	24	7
32	10012605	20017254	2	1	10/May/2006 09:08:55	10/May/2006 13:43:59	7	55	10
33	10164086	20295065	1	1	10/May/2006 09:12:39	10/May/2006 11:15:28	7	74	9
34	10116386	20220495	1	1	10/May/2006 09:22:12	10/May/2006 16:16:51	2	73	6
35	10115313	20316325	1	1	10/May/2006 09:24:33	10/May/2006 15:21:25	2	61	0
36	10101903	20178962	2	2	10/May/2006 09:32:02	10/May/2006 13:21:32	2	68	5
37	10118058	20222601	1	1	10/May/2006 09:34:28	10/May/2006 12:56:36	7	77	4
38	10060967	20101007	2	1	10/May/2006 09:37:47	10/May/2006 10:35:59	2	67	8
39	10115366	20382950	1	2	10/May/2006 09:38:19	10/May/2006 14:19:28	2	29	10
40	10208011	20381293	1	2	10/May/2006 09:47:11	10/May/2006 10:35:02	7	43	4
41	10114066	20222624	1	1	10/May/2006 09:50:41	10/May/2006 11:33:37	7	76	4
42	10055656	20087559	2	1	10/May/2006 09:53:42	10/May/2006 17:50:35	7	45	10
43	10180315	20381438	1	2	10/May/2006 09:59:20	10/May/2006 13:26:00	7	49	10

HomeHospital Number of Patients in Surgery and Internal ED
10.05.2006

Time (60 min. resolution)

HomeHospital Number of Patients in Surgery and Internal ED
10.05.2006, 09:00:00 - 10:00:00

Time (1 sec. resolution)
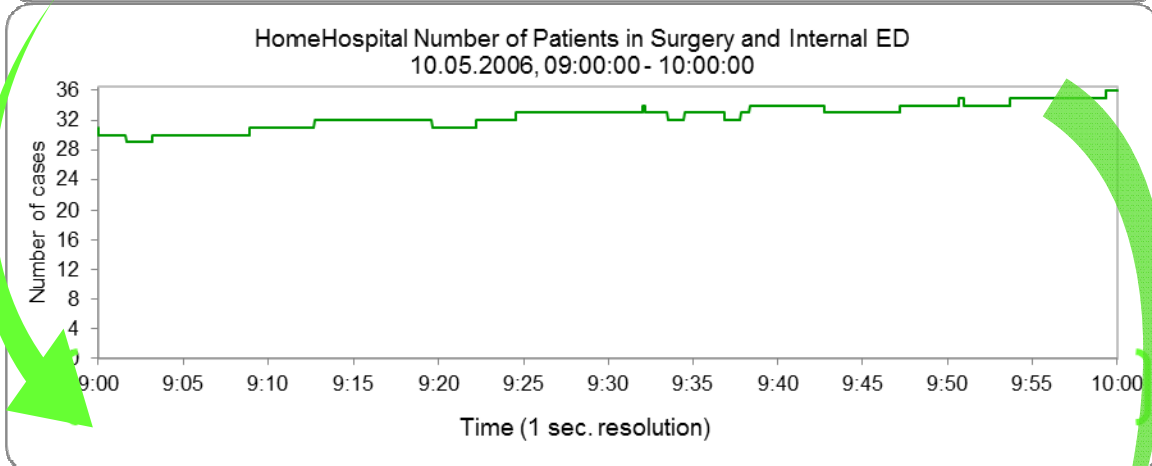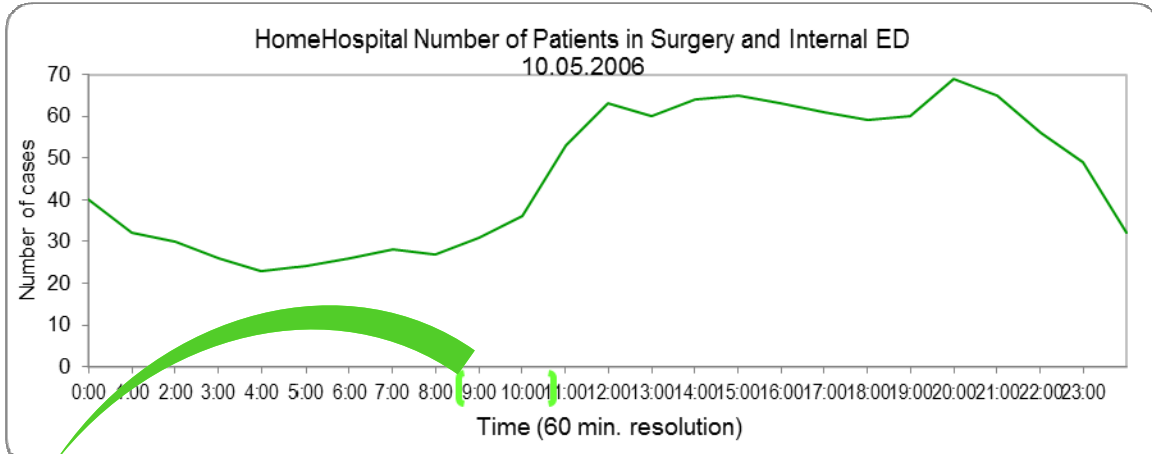
Surgery and Internal ED state, 10.05.2006, 09:00:00 – 10:00:00		
Time	number of patients	duration (seconds)
[09:00:00 – 09:00:01)	31	1
[09:00:01 – 09:01:37)	30	97
[09:01:37 – 09:03:10)	29	93
[09:03:10 – 09:08:55)	30	345
[09:08:55 – 09:12:39)	31	224
[09:12:39 – 09:19:35)	32	416
[09:19:35 – 09:22:12)	31	157
[09:22:12 – 09:24:33)	32	141
[09:24:33 – 09:32:02)	33	449
[09:32:02 – 09:32:09)	34	7
[09:32:09 – 09:33:29)	33	80
[09:33:29 – 09:34:28)	32	59
[09:34:28 – 09:36:50)	33	142
[09:36:50 – 09:37:47)	32	57
[09:37:47 – 09:38:19)	33	32
[09:38:19 – 09:42:43)	34	264
[09:42:43 – 09:47:11)	33	268
[09:47:11 – 09:50:41)	34	210
[09:50:41 – 09:50:57)	35	16
[09:50:57 – 09:53:42)	34	165
[09:53:42 – 09:59:20)	35	338
[09:59:20 – 10:00:00)	36	39

HomeHospital Time by ED Internal and Surgery state (sec.), 09:00:00 - 10:00:00
10.05.2006

HomeHospital Time by ED Internal and Surgery state (sec.), 10.05.2006, 09:00:00 – 10:00:00				
Number of patients	Frequency	Relative frequency %	Cumulative frequency	Relative Cumulative frequency %
29	93	2.58	93	2.58
30	442	12.28	535	14.86
31	382	10.61	917	25.47
32	673	18.69	1590	44.17
33	971	26.97	2561	71.14
34	646	17.94	3207	89.08
35	354	9.83	3561	98.92
36	39	1.08	3600	100.00

For example: 35 patients were in Internal and Surgery ED during 354 seconds in time interval from 09:00 to 10:00.

3.1.2 Calculation for multiple units or one unit over multiple days

3.1.2.1 Simple Example (2 units at same time interval)

Calculate the number of events at moment of time as a sum of the different types of events:

Events A, B, C, D were observed at time interval from t–1 to t+5. Event start time and event end time known. Define events A, B, D belonging to type I and event C belonging to type II.

event		event start	event end
type I	type II		
A		t–1	t+1
B		t–1	t
D		t+4	t+5
	C	t	t+5
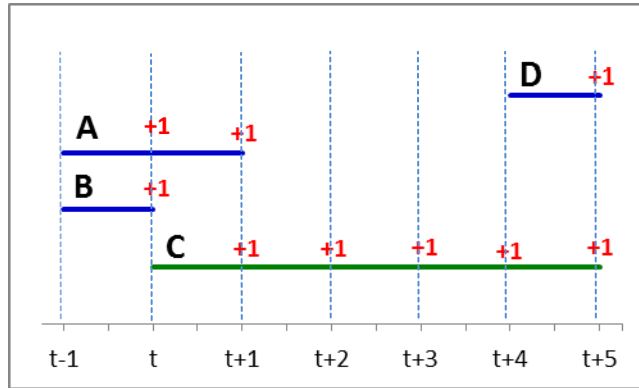
+1 – *add "open" event at moment of time*

Questions: How many "open" events were at every moment of time in the defined interval by event type I and type II?

type I			
j	m_j	$N_{at\ moment\ i}$	x_{iopen}
1	t–1	0	
2	t	2	A, B
3	t+1	1	A
4	t+2	0	
5	t+3	0	
6	t+4	0	
7	t+5	1	D

type I		
$N_{at\ moment\ i}$	Frequencies	Moment of time
1	2	t+1,t+5
2	1	t
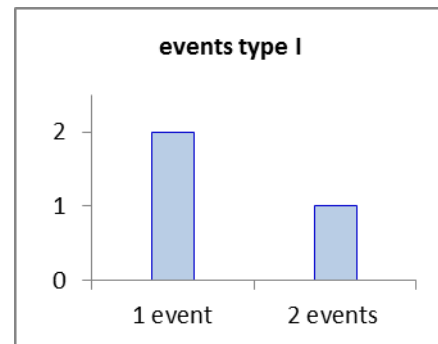
type II			
j	m_j	$N_{at\ moment\ i}$	x_{iopen}
1	t–1	0	
2	t	0	
3	t+1	1	C
4	t+2	1	C
5	t+3	1	C
6	t+4	1	C
7	t+5	1	C

type II		
$N_{at\ moment\ i}$	Frequencies	Moment of time
1	5	t+1,t+2, t+3, t+4, t+5
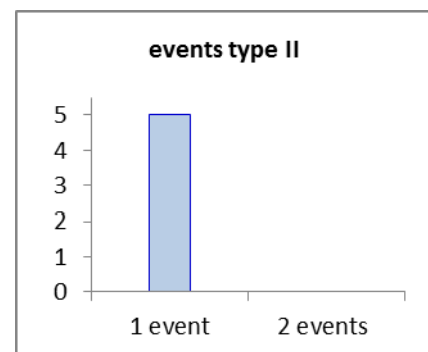
If we want to find the $N_{at\ moment\ i}$ for type I and type II together. We cannot summarize frequencies of type I and type II, but we can summarize $N_{at\ moment\ i}$ at every moment of time.

		$N_{\text{at moment } i}$		x_{iopen}		$N_{\text{at moment } i}$	x_{iopen}
j	m_j	type I	type II	type I	type II	type I and type II	
1	t–1	0	0			0	
2	t	2	0	A, B		2	A, B
3	t+1	1	1	A	C	2	A, C
4	t+2	0	1		C	1	C
5	t+3	0	1		C	1	C
6	t+4	0	1		C	1	C
7	t+5	1	1	D	C	2	D, C

events type I and type II
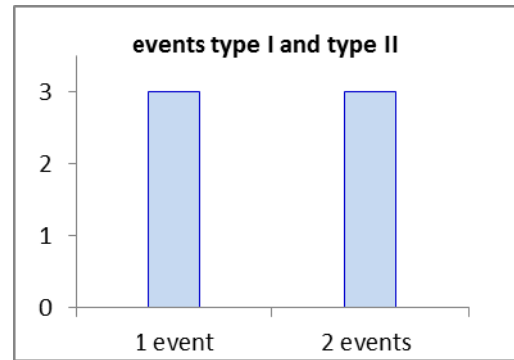
3.1.2.2 Numerical example: Surgery and Internal ED state (2 units over 1 day at same time)
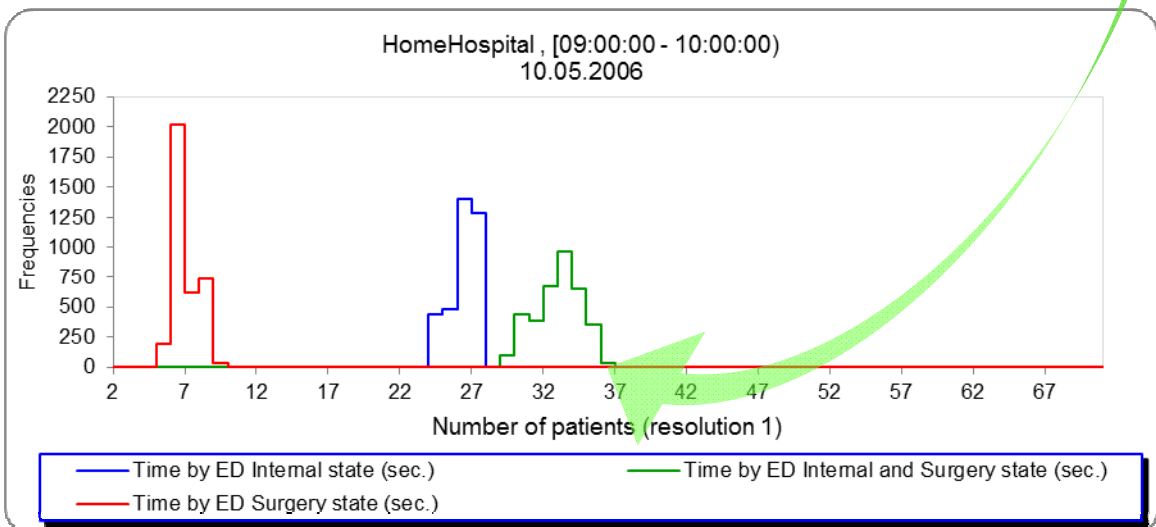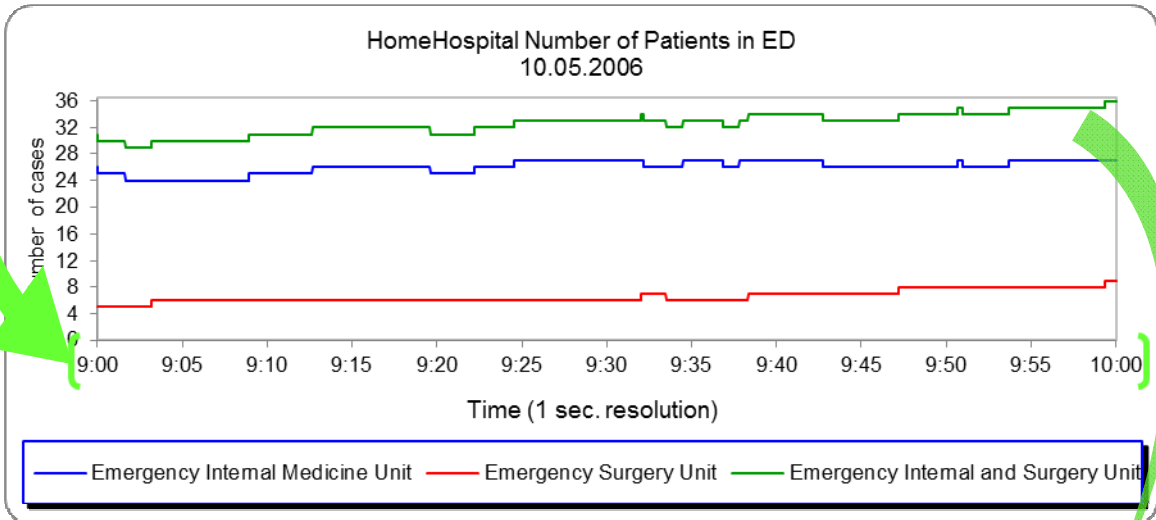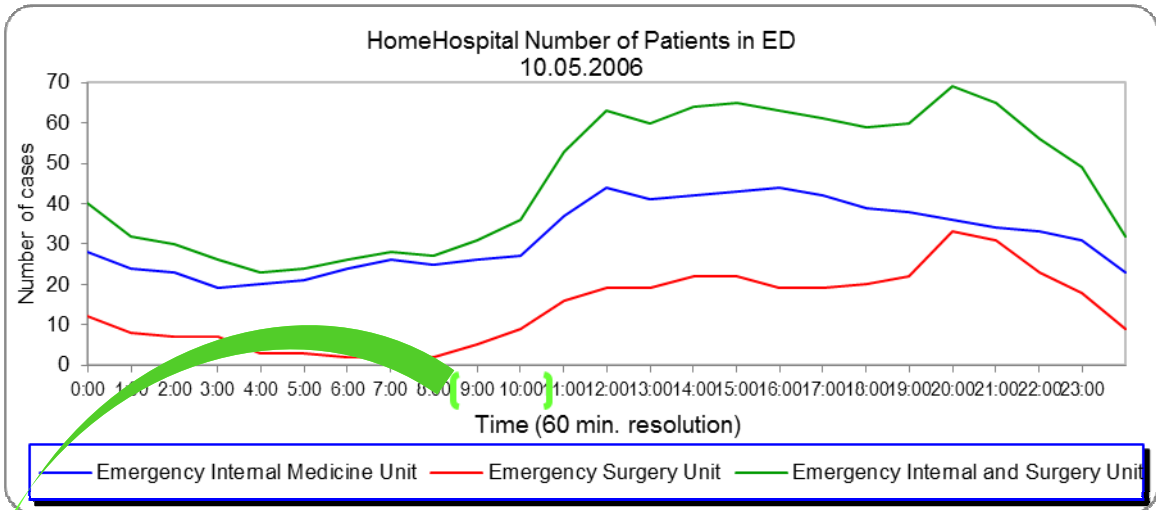
Data sample: SELECT visit_details.* INTO data_sample FROM visit_details WHERE (entry_group=1 AND department=1 AND entry_date < #5/10/2006 10:00:00# AND exit_date > #5/10/2006 09:00:00#);

#	patient id	medical id	gender	department	entry date	exit date	outcome	age years	age months
1	10050255	20087589	2	1	03/May/2006 22:44:20	12/May/2006 02:29:20	7	26	4
2	10032429	20114928	2	1	09/May/2006 18:05:26	10/May/2006 09:19:35	2	49	7
3	10116529	20220470	1	1	09/May/2006 20:10:58	10/May/2006 12:18:29	2	44	11
4	10173335	20316317	1	1	09/May/2006 20:14:53	10/May/2006 10:46:03	7	23	3
5	10055663	20087584	2	1	09/May/2006 21:54:19	10/May/2006 14:57:20	7	22	9
6	10046576	20114954	2	1	09/May/2006 21:58:28	10/May/2006 10:56:20	7	30	7
7	10160307	20318805	1	1	09/May/2006 22:10:34	10/May/2006 10:46:22	7	63	11
8	10000958	20114958	2	1	09/May/2006 22:39:55	10/May/2006 09:50:57	2	53	10
9	10043359	20064973	2	1	09/May/2006 23:15:10	10/May/2006 09:42:43	7	82	2
10	10144618	20329950	1	1	10/May/2006 00:12:55	10/May/2006 12:36:23	2	18	9
11	10027827	20087632	2	1	10/May/2006 03:52:34	10/May/2006 11:09:06	7	34	6
12	10053221	20114968	2	1	10/May/2006 05:02:07	10/May/2006 14:52:14	2	55	0
13	10132704	20295135	1	1	10/May/2006 05:05:19	10/May/2006 09:32:09	7	49	0
14	10020926	20028380	2	1	10/May/2006 05:08:29	10/May/2006 12:08:38	2	63	10
15	10180555	20329953	1	1	10/May/2006 05:32:05	10/May/2006 09:01:37	2	40	3
16	10145499	20295136	1	1	10/May/2006 05:33:09	10/May/2006 09:36:50	7	69	0
17	10164127	20295137	1	1	10/May/2006 05:55:45	10/May/2006 13:40:59	7	22	1
18	10117576	20329954	1	1	10/May/2006 06:15:26	10/May/2006 14:27:05	2	53	0
19	10116665	20329957	1	1	10/May/2006 06:58:57	10/May/2006 16:26:17	2	84	7
20	10034971	20070183	2	1	10/May/2006 07:05:55	10/May/2006 23:50:00	8	59	5
21	10164030	20294954	1	1	10/May/2006 07:57:08	10/May/2006 10:00:44	7	17	0
22	10055664	20087586	2	1	10/May/2006 08:24:26	10/May/2006 10:58:42	7	67	8
23	10116112	20295082	1	1	10/May/2006 08:27:23	10/May/2006 15:11:07	7	64	7
24	10116596	20295138	1	1	10/May/2006 08:33:46	10/May/2006 12:16:42	7	58	4
25	10055630	20087511	2	1	10/May/2006 08:56:18	10/May/2006 14:41:29	7	58	8
26	10012605	20017254	2	1	10/May/2006 09:08:55	10/May/2006 13:43:59	7	55	10
27	10164086	20295065	1	1	10/May/2006 09:12:39	10/May/2006 11:15:28	7	74	9
28	10116386	20220495	1	1	10/May/2006 09:22:12	10/May/2006 16:16:51	2	73	6
29	10115313	20316325	1	1	10/May/2006 09:24:33	10/May/2006 15:21:25	2	61	0
30	10118058	20222601	1	1	10/May/2006 09:34:28	10/May/2006 12:56:36	7	77	4
31	10060967	20101007	2	1	10/May/2006 09:37:47	10/May/2006 10:35:59	2	67	8
32	10114066	20222624	1	1	10/May/2006 09:50:41	10/May/2006 11:33:37	7	76	4
33	10055656	20087559	2	1	10/May/2006 09:53:42	10/May/2006 17:50:35	7	45	10

Data sample: SELECT visit_details.* INTO data_sample FROM visit_details WHERE (entry_group=1 AND department=2 AND entry_date < #5/10/2006 10:00:00# AND exit_date > #5/10/2006 09:00:00#);

#	patient id	medical id	gender	department	entry date	exit date	outcome	age years	age months
1	10209054	20381564	1	2	09/May/2006 15:10:28	11/May/2006 10:17:44	7	30	3
2	10078577	20134193	2	2	09/May/2006 15:33:11	10/May/2006 10:32:50	2	85	4
3	10208982	20381437	1	2	10/May/2006 08:21:58	10/May/2006 09:33:29	7	18	11
4	10190540	20347728	1	2	10/May/2006 08:24:24	10/May/2006 10:41:12	7	52	8
5	10078478	20133991	2	2	10/May/2006 08:26:55	10/May/2006 14:28:35	7	79	4
6	10078437	20133908	2	2	10/May/2006 09:03:10	10/May/2006 12:58:18	7	24	7
7	10101903	20178962	2	2	10/May/2006 09:32:02	10/May/2006 13:21:32	2	68	5
8	10115366	20382950	1	2	10/May/2006 09:38:19	10/May/2006 14:19:28	2	29	10
9	10208011	20381293	1	2	10/May/2006 09:47:11	10/May/2006 10:35:02	7	43	4
10	10180315	20381438	1	2	10/May/2006 09:59:20	10/May/2006 13:26:00	7	49	10

Internal ED state			Surgery ED state			Internal and Surgery ED state		
Time	number of patients	duration (seconds)	Time	number of patients	duration (seconds)	Time	number of patients	duration (seconds)
[09:00:00 – 09:00:01)	26	1	[09:00:00 – 09:03:10)	5	191	[09:00:00 – 09:00:01)	31	1
[09:00:01 – 09:01:37)	25	97	[09:03:10 – 09:32:02)	6	1732	[09:00:01 – 09:01:37)	30	97
[09:01:37 – 09:08:55)	24	438	[09:32:02 – 09:33:29)	7	87	[09:01:37 – 09:03:10)	29	93
[09:08:55 – 09:12:39)	25	224	[09:33:29 – 09:38:19)	6	290	[09:03:10 – 09:08:55)	30	345
[09:12:39 – 09:19:35)	26	416	[09:38:19 – 09:47:11)	7	532	[09:08:55 – 09:12:39)	31	224
[09:19:35 – 09:22:12)	25	157	[09:47:11 – 09:59:20)	8	729	[09:12:39 – 09:19:35)	32	416
[09:22:12 – 09:24:33)	26	141	[09:59:20 – 10:00:00]	9	39	[09:19:35 – 09:22:12)	31	157
[09:24:33 – 09:32:09)	27	456				[09:22:12 – 09:24:33)	32	141
[09:32:09 – 09:34:28)	26	139				[09:24:33 – 09:32:02)	33	449
[09:34:28 – 09:36:50)	27	142				[09:32:02 – 09:32:09)	34	7
[09:36:50 – 09:37:47)	26	57				[09:32:09 – 09:33:29)	33	80
[09:37:47 – 09:42:43)	27	296				[09:33:29 – 09:34:28)	32	59
[09:42:43 – 09:50:41)	26	478				[09:34:28 – 09:36:50)	33	142
[09:50:41 – 09:50:57)	27	16				[09:36:50 – 09:37:47)	32	57
[09:50:57 – 09:53:42)	26	165				[09:37:47 – 09:38:19)	33	32
[09:53:42 – 10:00:00)	27	377				[09:38:19 – 09:42:43)	34	264
						[09:42:43 – 09:47:11)	33	268
						[09:47:11 – 09:50:41)	34	210
						[09:50:41 – 09:50:57)	35	16
						[09:50:57 – 09:53:42)	34	165
						[09:53:42 – 09:59:20)	35	338
						[09:59:20 – 10:00:00)	36	39

Number of patients	Frequency		
	Time by ED Internal state (sec.)	Time by ED Internal and Surgery state (sec.)	Time by ED Surgery state (sec.)
5	0	0	191
6	0	0	2022
7	0	0	619
8	0	0	729
9	0	0	39
10	0	0	0
11	0	0	0
12	0	0	0
13	0	0	0
14	0	0	0
15	0	0	0
16	0	0	0
17	0	0	0
18	0	0	0
19	0	0	0
20	0	0	0
21	0	0	0
22	0	0	0
23	0	0	0
24	438	0	0
25	478	0	0
26	1397	0	0
27	1287	0	0
28	0	0	0
29	0	93	0

30	0	442	0
31	0	382	0
32	0	673	0
33	0	971	0
34	0	646	0
35	0	354	0
36	0	39	0

If we want to obtain $N_{at\ moment\ i}$ for both Surgery ED and Internal ED, we can summarize $N_{at\ moment\ i}$ for every moment in time or, if we want to summarize in some interval of time we may only <u>do so until the first "jump" in</u> $N_{at\ moment\ i}$ (either for Surgery or for Internal). See the following table.

Internal ED state			Surgery ED state			Internal and Surgery ED state		
Time	number of patients	duration (seconds)	Time	number of patients	duration (seconds)	Time	number of patients	duration (seconds)
[09:00:00 – 09:00:01)	26	1	[09:00:00 – 09:00:01)	5	1	[09:00:00 – 09:00:01)	31	1
[09:00:01 – 09:01:37)	25	97	[09:00:01 – 09:01:37)	5	97	[09:00:01 – 09:01:37)	30	97
[09:01:37 – 09:03:10)	24	93	[09:01:37 – 09:03:10)	5	93	[09:01:37 – 09:03:10)	29	93
[09:03:10 – 09:08:55)	24	345	[09:03:10 – 09:08:55)	6	345	[09:03:10 – 09:08:55)	30	345
[09:08:55 – 09:12:39)	25	224	[09:08:55 – 09:12:39)	6	224	[09:08:55 – 09:12:39)	31	224
[09:12:39 – 09:19:35)	26	416	[09:12:39 – 09:19:35)	6	416	[09:12:39 – 09:19:35)	32	416
[09:19:35 – 09:22:12)	25	157	[09:19:35 – 09:22:12)	6	157	[09:19:35 – 09:22:12)	31	157
[09:22:12 – 09:24:33)	26	141	[09:22:12 – 09:24:33)	6	141	[09:22:12 – 09:24:33)	32	141
[09:24:33 – 09:32:02)	27	449	[09:24:33 – 09:32:02)	6	449	[09:24:33 – 09:32:02)	33	449
[09:32:02 – 09:32:09)	27	7	[09:32:02 – 09:32:09)	7	7	[09:32:02 – 09:32:09)	34	7
[09:32:09 – 09:33:29)	26	80	[09:32:09 – 09:33:29)	7	80	[09:32:09 – 09:33:29)	33	80
[09:33:29 – 09:34:28)	26	59	[09:33:29 – 09:34:28)	6	59	[09:33:29 – 09:34:28)	32	59
[09:34:28 – 09:36:50)	27	142	[09:34:28 – 09:36:50)	6	142	[09:34:28 – 09:36:50)	33	142
[09:36:50 – 09:37:47)	26	57	[09:36:50 – 09:37:47)	6	57	[09:36:50 – 09:37:47)	32	57
[09:37:47 – 09:38:19)	27	32	[09:37:47 – 09:38:19)	6	32	[09:37:47 – 09:38:19)	33	32
[09:38:19 – 09:42:43)	27	264	[09:38:19 – 09:42:43)	7	264	[09:38:19 – 09:42:43)	34	264
[09:42:43 – 09:47:11)	26	268	[09:42:43 – 09:47:11)	7	268	[09:42:43 – 09:47:11)	33	268
[09:47:11 – 09:50:41)	26	210	[09:47:11 – 09:50:41)	8	210	[09:47:11 – 09:50:41)	34	210
[09:50:41 – 09:50:57)	27	16	[09:50:41 – 09:50:57)	8	16	[09:50:41 – 09:50:57)	35	16
[09:50:57 – 09:53:42)	26	165	[09:50:57 – 09:53:42)	8	165	[09:50:57 – 09:53:42)	34	165
[09:53:42 – 09:59:20)	27	338	[09:53:42 – 09:59:20)	8	338	[09:53:42 – 09:59:20)	35	338
[09:59:20 – 10:00:00)	27	39	[09:59:20 – 10:00:00)	9	39	[09:59:20 – 10:00:00)	36	39

HomeHospital Number of Patients in ED
10.05.2006

Number of cases

9:00 — 10:00
Time (1 sec. resolution)

Emergency Internal Medicine Unit
Emergency Surgery Unit
Emergency Internal and Surgery Unit

HomeHospital , [09:00:00 - 10:00:00)
10.05.2006

Frequencies

35 patients
during
354sec.

5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37
Number of patients (resolution 1)

Time by ED Internal state (sec.)
Time by ED Internal and Surgery state (sec.)
Time by ED Surgery state (sec.)

27 patients in Internal ED in
[09:50:41 - 09:50:57) and
[09:53:42 - 09:59:20)

8 patients in Surgery ED in
[09:50:41 - 09:59:20)

35 patients in Internal and Surgery ED,
during 354 sec:
16 sec **[09:50:41 - 09:50:57)** and
338 sec **[09:53:42 - 09:59:20)**

59

3.1.2.3 Numerical example: Internal ED state (1 unit over 2 days (Mondays) at same time)
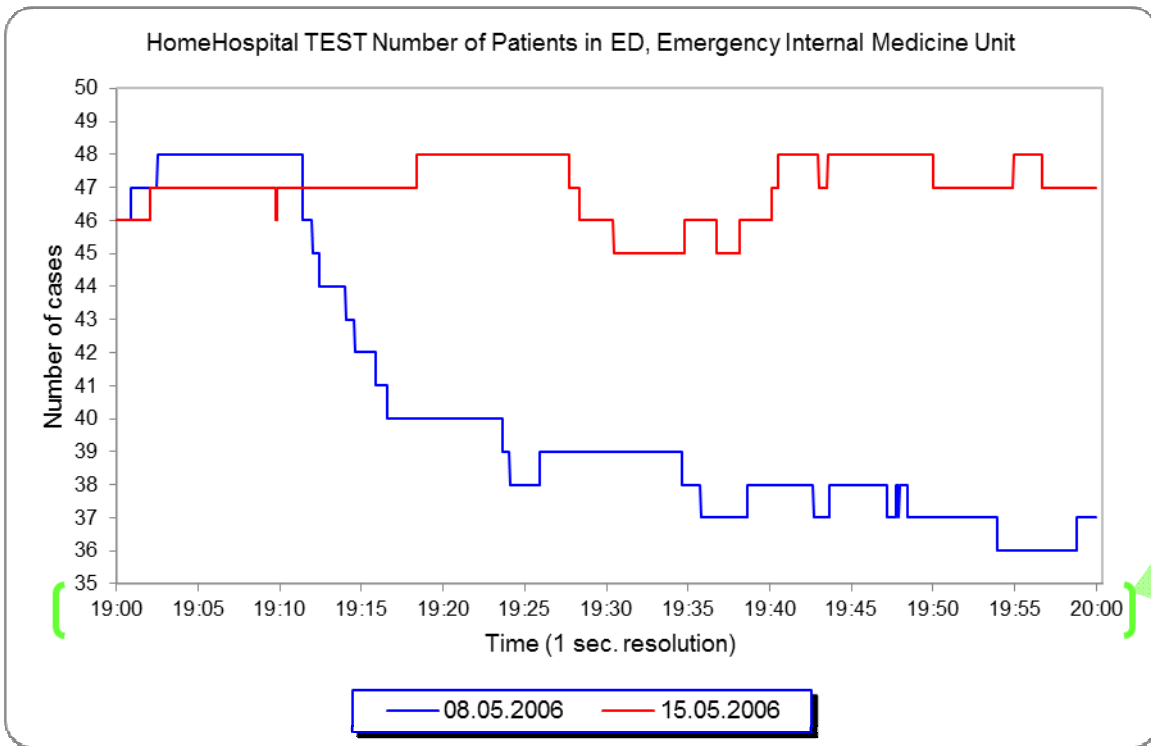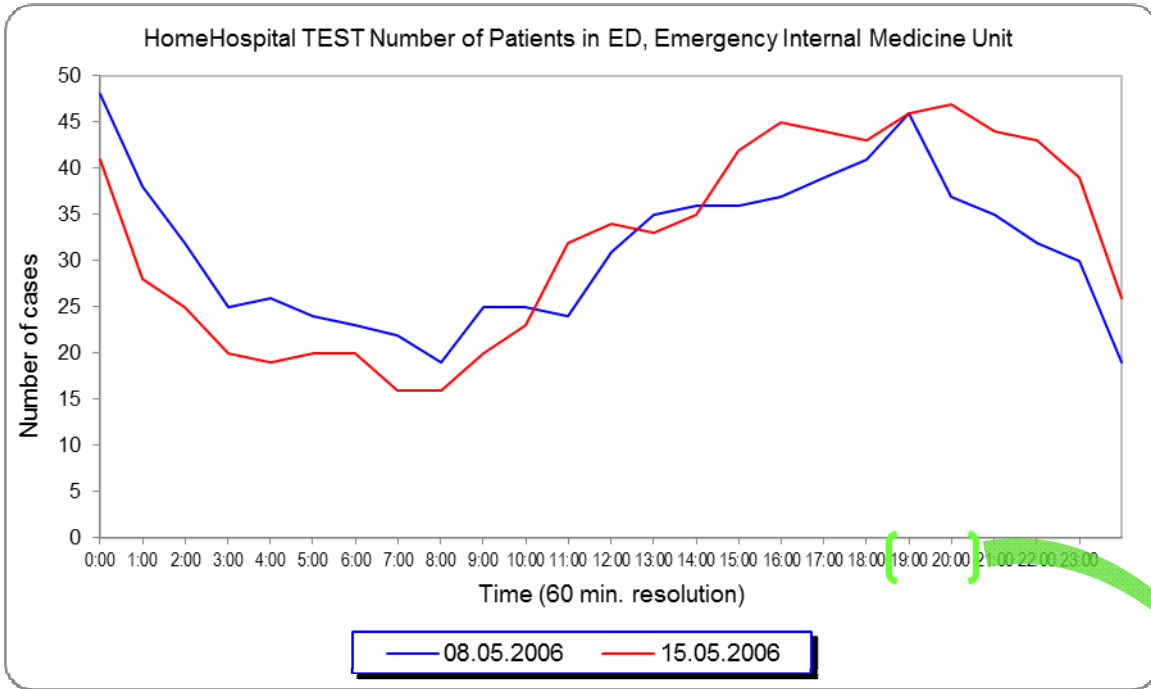
Data sample: SELECT visit_details.* INTO data_sample FROM visit_details WHERE (entry_group=1 AND department=1 AND entry_date < #5/08/2006 20:00:00# AND exit_date > #5/08/2006 19:00:00#);

#	patient id	medical id	gender	department	entry date	exit date	outcome	age years	age months
1	10050255	20087589	2	1	03/May/2006 22:44:20	12/May/2006 02:29:20	7	26	4
2	10117940	20222451	1	1	08/May/2006 08:27:25	08/May/2006 23:50:00	9	76	6
3	10011308	20015032	2	1	08/May/2006 09:57:31	08/May/2006 20:48:51	7	43	1
4	10068408	20114960	2	1	08/May/2006 10:50:55	08/May/2006 20:08:54	2	56	7
5	10163430	20293859	1	1	08/May/2006 10:51:39	08/May/2006 23:50:00	9	19	2
6	10117142	20295194	1	1	08/May/2006 11:14:24	08/May/2006 22:34:50	7	45	4
7	10011299	20015012	2	1	08/May/2006 11:20:21	08/May/2006 19:11:23	2	74	4
8	10137516	20277589	1	1	08/May/2006 12:56:42	08/May/2006 22:01:21	2	72	10
9	10146544	20295099	1	1	08/May/2006 13:14:24	08/May/2006 19:14:01	7	61	4
10	10151823	20272033	1	1	08/May/2006 14:15:42	08/May/2006 19:11:23	2	81	9
11	10164029	20294953	1	1	08/May/2006 14:15:49	08/May/2006 20:45:43	7	31	5
12	10012598	20017244	2	1	08/May/2006 14:33:47	08/May/2006 19:23:39	7	33	8
13	10174062	20318799	1	1	08/May/2006 15:13:18	08/May/2006 21:33:46	2	53	10
14	10051406	20102555	2	1	08/May/2006 15:22:48	08/May/2006 21:51:23	2	18	11
15	10034953	20114952	2	1	08/May/2006 15:25:47	08/May/2006 19:11:59	2	58	10
16	10009410	20015040	2	1	08/May/2006 15:26:42	08/May/2006 19:34:36	2	54	2
17	10131548	20329939	1	1	08/May/2006 15:27:11	09/May/2006 04:01:53	2	50	9
18	10012614	20017264	2	1	08/May/2006 15:37:57	08/May/2006 20:57:17	7	89	6
19	10154092	20276933	1	1	08/May/2006 15:45:43	08/May/2006 19:24:04	2	40	0
20	10003715	20004460	2	1	08/May/2006 15:50:26	08/May/2006 19:16:33	2	64	3
21	10116543	20220487	1	1	08/May/2006 15:51:54	08/May/2006 19:15:51	2	78	6
22	10116547	20220491	1	1	08/May/2006 16:05:56	09/May/2006 02:05:33	2	39	4
23	10020941	20087631	2	1	08/May/2006 16:20:56	08/May/2006 23:06:09	7	87	10
24	10116105	20295131	1	1	08/May/2006 16:27:32	08/May/2006 23:48:16	7	73	4
25	10164125	20295132	1	1	08/May/2006 16:28:24	08/May/2006 19:12:24	7	71	5
26	10173593	20317070	1	1	08/May/2006 16:30:26	08/May/2006 20:44:00	2	70	4
27	10055567	20087636	2	1	08/May/2006 16:37:53	08/May/2006 19:35:45	7	73	10
28	10030148	20114973	2	1	08/May/2006 16:48:21	08/May/2006 19:42:40	2	43	7
29	10147177	20263000	1	1	08/May/2006 17:09:46	08/May/2006 21:07:19	2	43	3
30	10011355	20066017	2	1	08/May/2006 17:19:46	08/May/2006 22:18:39	7	72	4
31	10164144	20295170	1	1	08/May/2006 17:21:42	08/May/2006 22:04:36	7	39	7
32	10172127	20313629	1	1	08/May/2006 17:29:26	08/May/2006 19:47:09	2	82	4
33	10006371	20087649	2	1	08/May/2006 17:30:17	08/May/2006 19:47:53	7	46	10
34	10113697	20220512	1	1	08/May/2006 17:50:52	08/May/2006 20:18:34	2	82	1
35	10171693	20312423	1	1	08/May/2006 17:53:25	08/May/2006 20:45:42	2	20	4
36	10112674	20222599	1	1	08/May/2006 18:07:51	09/May/2006 00:01:02	7	77	7
37	10058532	20099193	2	1	08/May/2006 18:08:43	09/May/2006 03:37:23	2	21	2
38	10140598	20293855	1	1	08/May/2006 18:17:27	08/May/2006 23:50:00	9	20	7
39	10140049	20294908	1	1	08/May/2006 18:23:49	08/May/2006 21:16:04	7	26	7
40	10002649	20015010	2	1	08/May/2006 18:24:59	08/May/2006 23:46:35	2	66	4
41	10022644	20087476	2	1	08/May/2006 18:34:18	08/May/2006 19:14:34	7	84	4
42	10000144	20015013	2	1	08/May/2006 18:35:27	08/May/2006 23:45:00	2	60	2
43	10038052	20087492	2	1	08/May/2006 18:35:29	08/May/2006 21:48:39	7	33	1
44	10055622	20087493	2	1	08/May/2006 18:37:42	08/May/2006 19:53:55	7	18	8
45	10164016	20294933	1	1	08/May/2006 18:44:27	09/May/2006 00:51:59	7	20	4
46	10007344	20017232	2	1	08/May/2006 18:44:39	09/May/2006 01:34:10	7	92	1
47	10180549	20329919	1	1	08/May/2006 19:00:51	08/May/2006 22:27:49	2	65	1
48	10000489	20015017	2	1	08/May/2006 19:02:29	09/May/2006 01:26:02	2	74	4
49	10118066	20222611	1	1	08/May/2006 19:25:54	09/May/2006 00:42:28	7	73	6
50	10022011	20030386	2	1	08/May/2006 19:38:38	08/May/2006 22:04:47	2	67	2
51	10011302	20015020	2	1	08/May/2006 19:43:39	09/May/2006 02:29:25	2	68	8
52	10129199	20264582	1	1	08/May/2006 19:47:44	08/May/2006 19:48:26	2	51	0
53	10003211	20015021	2	1	08/May/2006 19:47:55	09/May/2006 08:01:21	7	75	0
54	10130693	20329923	1	1	08/May/2006 19:58:49	09/May/2006 01:16:34	2	82	8

Data sample: SELECT visit_details.* INTO data_sample FROM visit_details WHERE (entry_group=1 AND department=1 AND entry_date < #5/15/2006 20:00:00# AND exit_date > #5/15/2006 19:00:00#);

#	patient id	medical id	gender	department	entry date	exit date	outcome	age years	age months
1	10043846	20066002	2	1	15/May/2006 00:49:01	16/May/2006 09:25:00	7	28	3
2	10008600	20017042	2	1	15/May/2006 04:25:10	15/May/2006 23:50:00	9	31	10
3	10118068	20222613	1	1	15/May/2006 08:14:53	15/May/2006 23:50:00	7	51	11
4	10116527	20220468	1	1	15/May/2006 09:55:10	15/May/2006 23:25:57	2	56	4
5	10116532	20220473	1	1	15/May/2006 10:44:26	16/May/2006 09:04:27	2	68	4
6	10156924	20313626	1	1	15/May/2006 10:59:42	15/May/2006 19:09:45	2	38	9
7	10117941	20222452	1	1	15/May/2006 11:04:39	15/May/2006 23:50:00	9	80	5
8	10055255	20086726	2	1	15/May/2006 11:44:02	15/May/2006 23:50:00	9	54	4
9	10055661	20087577	2	1	15/May/2006 13:06:37	15/May/2006 21:30:10	7	29	11
10	10055684	20087644	2	1	15/May/2006 13:49:45	16/May/2006 07:39:48	7	20	2
11	10001574	20017233	2	1	15/May/2006 14:30:27	15/May/2006 20:52:55	7	80	5
12	10164034	20294961	1	1	15/May/2006 14:34:20	15/May/2006 23:21:48	7	40	1
13	10116513	20220453	1	1	15/May/2006 14:40:53	15/May/2006 20:37:44	2	54	11
14	10011247	20114934	2	1	15/May/2006 14:44:16	15/May/2006 20:36:43	2	83	4
15	10011305	20015026	2	1	15/May/2006 14:48:20	15/May/2006 20:27:49	2	85	0
16	10030067	20087552	2	1	15/May/2006 14:59:07	15/May/2006 19:28:22	7	85	1
17	10164064	20295023	1	1	15/May/2006 15:01:20	15/May/2006 21:31:08	7	50	6
18	10116538	20220480	1	1	15/May/2006 15:20:54	15/May/2006 23:43:47	2	80	11
19	10170133	20313619	1	1	15/May/2006 15:22:00	15/May/2006 21:14:55	2	76	7
20	10045549	20086727	2	1	15/May/2006 15:29:04	15/May/2006 23:50:00	9	90	2
21	10164103	20295093	1	1	15/May/2006 15:53:11	15/May/2006 22:22:57	7	70	4
22	10113227	20295114	1	1	15/May/2006 16:00:25	15/May/2006 20:13:52	7	62	8
23	10116549	20220494	1	1	15/May/2006 16:30:53	15/May/2006 21:24:35	2	77	3
24	10164140	20295164	1	1	15/May/2006 16:53:31	15/May/2006 20:04:21	7	72	9
25	10164141	20295165	1	1	15/May/2006 16:56:10	15/May/2006 19:36:46	7	19	9
26	10114337	20353722	1	1	15/May/2006 17:05:32	16/May/2006 11:39:29	14	69	4
27	10164142	20295166	1	1	15/May/2006 17:12:40	15/May/2006 19:42:59	7	68	4
28	10116554	20220501	1	1	15/May/2006 17:21:34	15/May/2006 23:46:51	2	50	3
29	10055685	20087645	2	1	15/May/2006 17:32:54	15/May/2006 20:33:47	7	25	10
30	10026565	20037179	2	1	15/May/2006 17:34:11	15/May/2006 19:30:25	7	64	8
31	10138837	20329963	1	1	15/May/2006 17:34:45	15/May/2006 20:02:22	2	58	5
32	10180556	20329964	1	1	15/May/2006 17:36:16	15/May/2006 22:01:33	2	91	4
33	10123504	20295188	1	1	15/May/2006 17:37:00	15/May/2006 23:34:17	7	53	7
34	10039992	20087657	2	1	15/May/2006 17:39:40	15/May/2006 22:21:46	7	31	1
35	10001570	20017043	2	1	15/May/2006 17:49:22	15/May/2006 23:50:00	9	58	7
36	10152497	20295190	1	1	15/May/2006 18:09:16	15/May/2006 23:39:30	7	72	4
37	10055692	20087658	2	1	15/May/2006 18:16:14	15/May/2006 21:04:43	7	52	0
38	10131948	20240412	1	1	15/May/2006 18:21:52	15/May/2006 19:56:39	2	68	4
39	10131949	20240413	1	1	15/May/2006 18:23:14	15/May/2006 20:40:02	2	45	11
40	10172386	20314440	1	1	15/May/2006 18:32:47	16/May/2006 01:21:58	2	66	4
41	10131406	20313612	1	1	15/May/2006 18:41:56	16/May/2006 04:35:01	2	77	3
42	10005939	20017223	2	1	15/May/2006 18:47:59	16/May/2006 00:00:32	7	29	10
43	10055610	20087468	2	1	15/May/2006 18:48:23	16/May/2006 00:17:38	7	50	9
44	10114471	20220435	1	1	15/May/2006 18:50:04	16/May/2006 06:49:20	2	81	11
45	10114250	20294899	1	1	15/May/2006 18:50:53	15/May/2006 22:49:02	7	59	4
46	10163993	20294900	1	1	15/May/2006 18:57:45	15/May/2006 22:52:10	7	58	6
47	10114532	20220436	1	1	15/May/2006 19:02:03	15/May/2006 19:27:41	2	57	3
48	10173330	20316309	1	1	15/May/2006 19:09:51	16/May/2006 12:30:00	2	71	0
49	10138831	20294919	1	1	15/May/2006 19:18:23	15/May/2006 22:20:20	7	70	0
50	10008364	20028365	2	1	15/May/2006 19:34:45	15/May/2006 21:44:40	2	76	4
51	10138750	20294920	1	1	15/May/2006 19:38:10	15/May/2006 21:40:26	7	22	4
52	10055618	20087482	2	1	15/May/2006 19:40:08	15/May/2006 19:50:00	7	52	1
53	10164010	20294921	1	1	15/May/2006 19:40:29	15/May/2006 23:16:26	7	19	8
54	10020212	20087483	2	1	15/May/2006 19:43:32	16/May/2006 06:09:35	7	62	4
55	10162796	20294943	1	1	15/May/2006 19:54:54	15/May/2006 20:04:00	7	36	4

First find the $N_{at\ moment\ i}$ for 08.05.2006 and 15.05.2006 at time interval [19:00:00 - 20:00:00).

Emergency Internal Medicine Unit					
08.05.2006			15.05.2006		
Time	number of patients	duration (seconds)	Time	number of patients	duration (seconds)
[19:00:00 - 19:00:51)	46	52	[19:00:00 - 19:02:03)	46	124
[19:00:51 - 19:02:29)	47	98	[19:02:03 - 19:09:45)	47	462
[19:02:29 - 19:11:23)	48	534	[19:09:45 - 19:09:51)	46	6
[19:11:23 - 19:11:59)	46	36	[19:09:51 - 19:18:23)	47	512
[19:11:59 - 19:12:24)	45	25	[19:18:23 - 19:27:41)	48	558
[19:12:24 - 19:14:01)	44	97	[19:27:41 - 19:28:22)	47	41
[19:14:01 - 19:14:34)	43	33	[19:28:22 - 19:30:25)	46	123
[19:14:34 - 19:15:51)	42	77	[19:30:25 - 19:34:45)	45	260
[19:15:51 - 19:16:33)	41	42	[19:34:45 - 19:36:46)	46	121
[19:16:33 - 19:23:39)	40	426	[19:36:46 - 19:38:10)	45	84
[19:23:39 - 19:24:04)	39	25	[19:38:10 - 19:40:08)	46	118
[19:24:04 - 19:25:54)	38	110	[19:40:08 - 19:40:29)	47	21
[19:25:54 - 19:34:36)	39	522	[19:40:29 - 19:42:59)	48	150
[19:34:36 - 19:35:45)	38	69	[19:42:59 - 19:43:32)	47	33
[19:35:45 - 19:38:38)	37	173	[19:43:32 - 19:50:00)	48	388
[19:38:38 - 19:42:40)	38	242	[19:50:00 - 19:54:54)	47	294
[19:42:40 - 19:43:39)	37	59	[19:54:54 - 19:56:39)	48	105
[19:43:39 - 19:47:09)	38	210	[19:56:39 - 20:00:00)	47	200
[19:47:09 - 19:47:44)	37	35			
[19:47:44 - 19:48:26)	38	42			
[19:48:26 - 19:53:55)	37	329			
[19:53:55 - 19:58:49)	36	294			
[19:58:49 - 20:00:00)	37	70			

Second compute frequencies of the time-interval for 08.05.2006 and 15.05.2006.
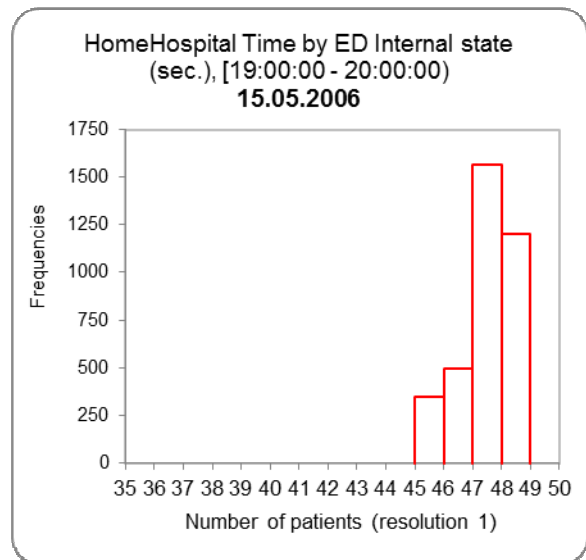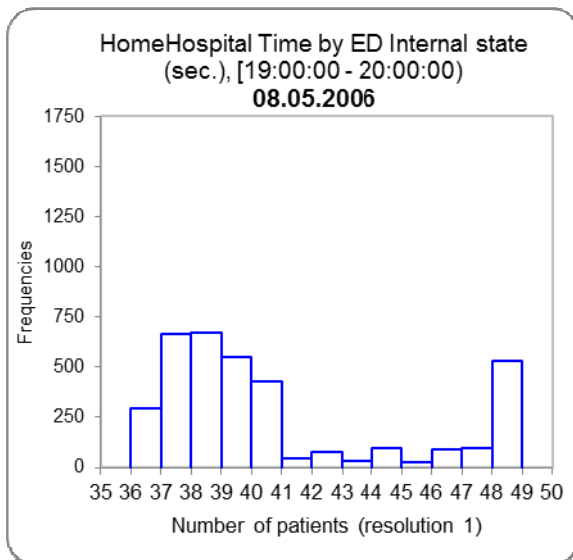
And last step find daily average by average out of frequencies of 08.05.2006 and 15.08.2006.
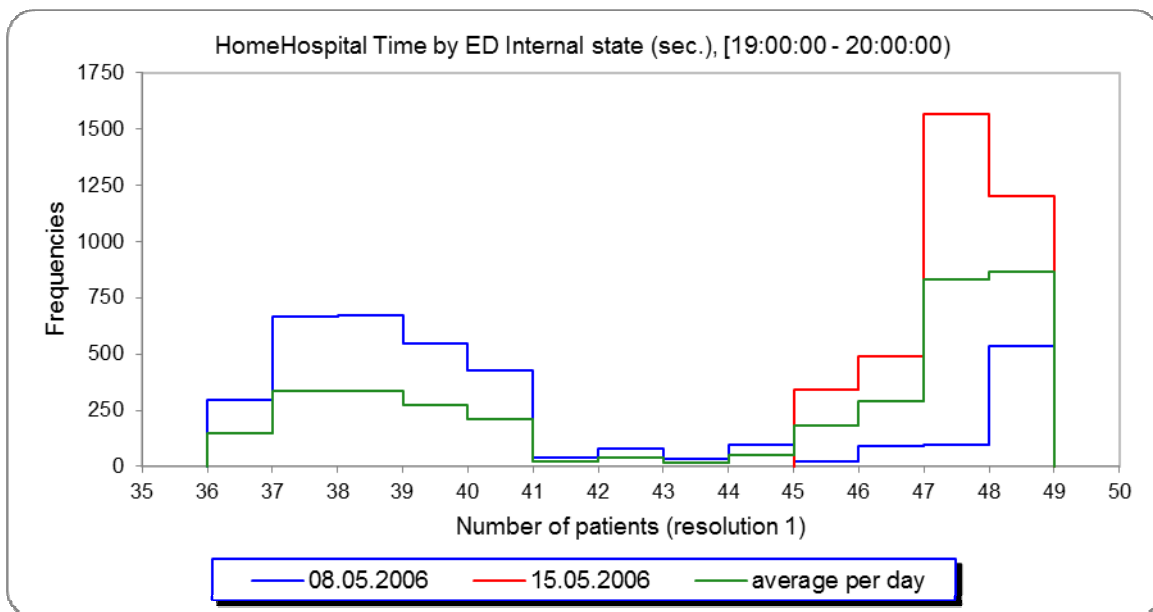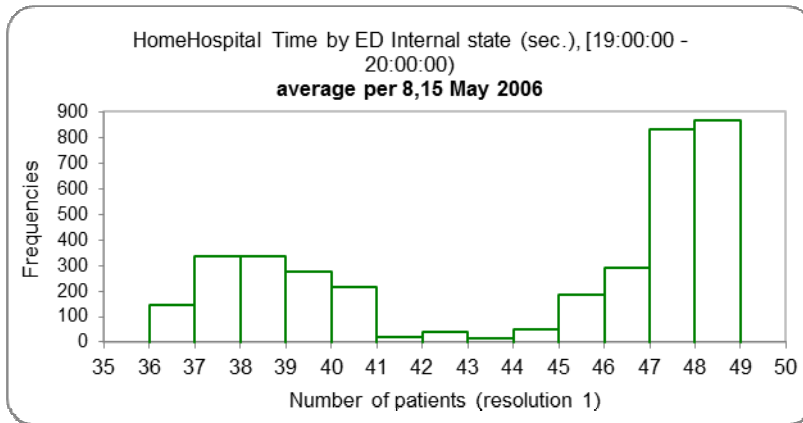
Time by ED Internal state (sec.), [19:00:00 - 20:00:00]			
number of patients	Frequency		
	08.05.2006	15.05.2006	average per day 08.05.2006 and 15.05.2006
36	294	0	147
37	668	0	334
38	671	0	336
39	547	0	274
40	426	0	213
41	42	0	21
42	77	0	39
43	33	0	17
44	97	0	49
45	25	344	185
46	88	492	290
47	98	1563	831
48	534	1201	868

3.1.2.4 Exercise (find out number of patients in 2 units over 1 day)

Consider the following scenario: 15 patients were treated during 6 hours in medical department A on a particular day, 15 patients were treated during 6 hours in medical B department on the same day.
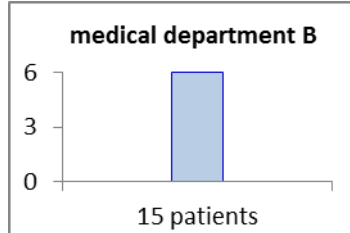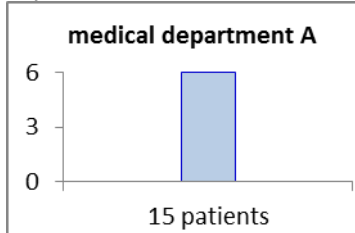
Which of the following is correct when looking at A and B together?

A) 30 patients were treated during 6 hours
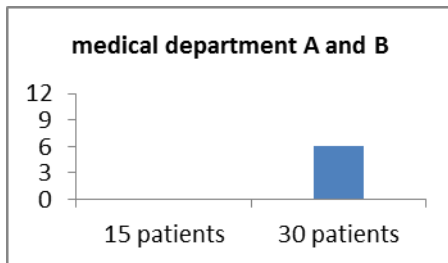
B) 15 patients were treated during 12 hours
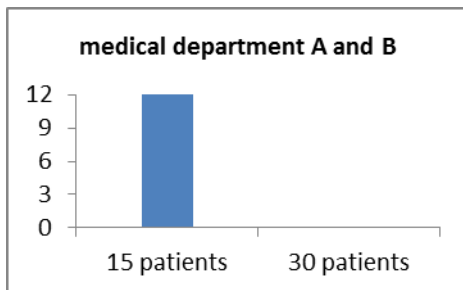
C) 30 patients were treated during 3 hours and 15 patients were treated during 4 hours
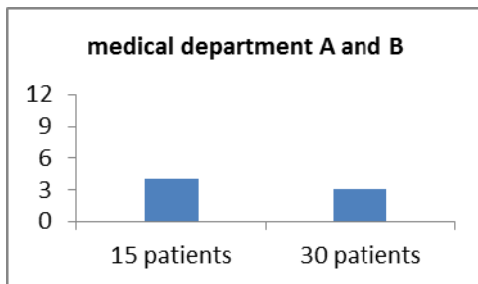
All of the above may be correct. See below graphs of each medical department state.

A) 30 patients were treated during 6 hours

time	number of patients		
	A	B	A and
0:00			
1:00			
2:00			
3:00			
4:00			
5:00			
6:00			
7:00			
8:00			
9:00	15	15	30
10:00	15	15	30
11:00	15	15	30
12:00	15	15	30
13:00	15	15	30
14:00	15	15	30
15:00	15	15	30
16:00			
17:00			
18:00			
19:00			
20:00			
21:00			
22:00			
23:00			

number of patients — medical department A / medical department B

number of patients — medical department A and B
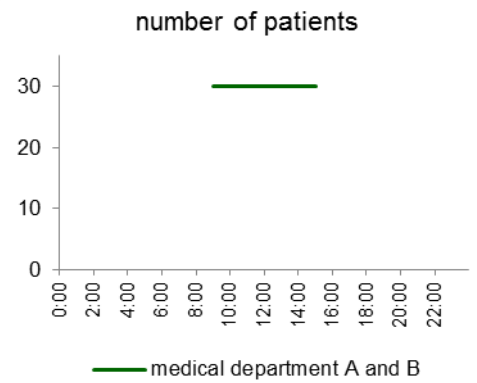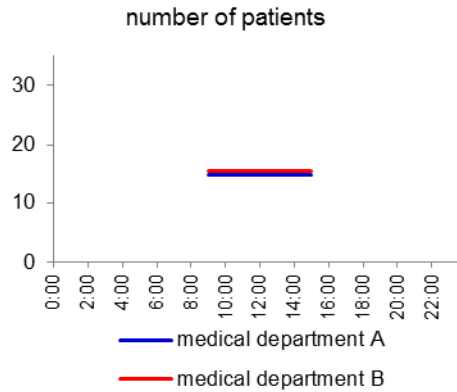
B) 15 patients were treated during 12 hours

time	number of patients		
	A	B	A and B
0:00			
1:00			
2:00			
3:00			
4:00			
5:00			
6:00			
7:00	15		15
8:00	15		15
9:00	15		15
10:00	15		15
11:00	15		15
12:00	15		15
13:00	15		15
14:00			
15:00		15	15
16:00		15	15
17:00		15	15
18:00		15	15
19:00		15	15
20:00		15	15
21:00		15	15
22:00			
23:00			

number of patients — medical department A / medical department B

number of patients — medical department A and B
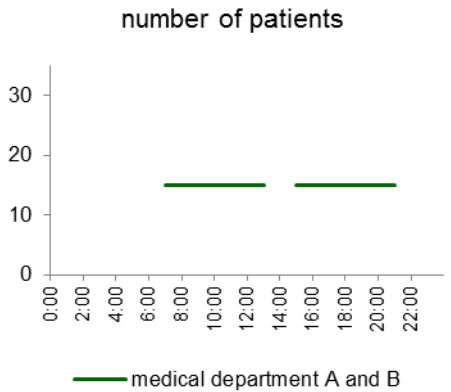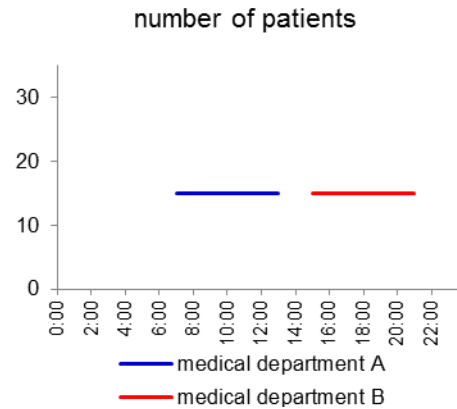
C) 30 patients were treated during 3 hours and 15 patients were treated during 4 hours

time	number of patients		
	A	B	A and B
0:00			
1:00			
2:00			
3:00			
4:00			
5:00			
6:00			
7:00			
8:00			
9:00			
10:00			
11:00			
12:00	15		15
13:00	15		15
14:00	15		15
15:00	15	15	30
16:00	15	15	30
17:00	15	15	30
18:00	15	15	30
19:00		15	15
20:00		15	15
21:00		15	15
22:00			
23:00			

number of patients — medical department A / medical department B

number of patients — medical department A and B
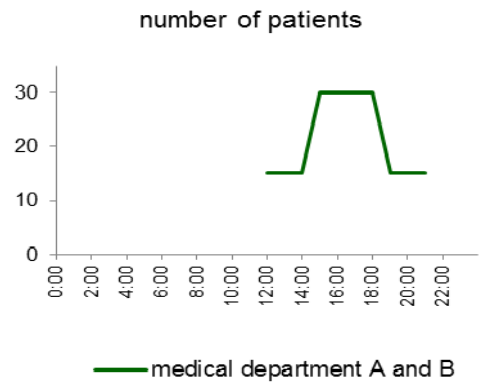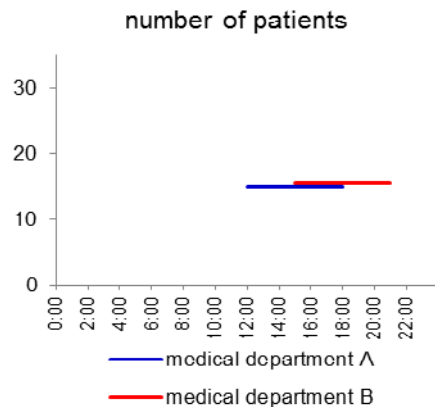
3.2 Creation of the variable by SEEStat

3.2.1 Calculating the number of patients during the day by "instants count" procedure

If user extension was not configured first, it is necessary to define it and only then start building procedure (see Appendix 6 Creation SEEStat user extension).

Click Main-> Data Management
Click DB Procedures -> Design DB Procedures
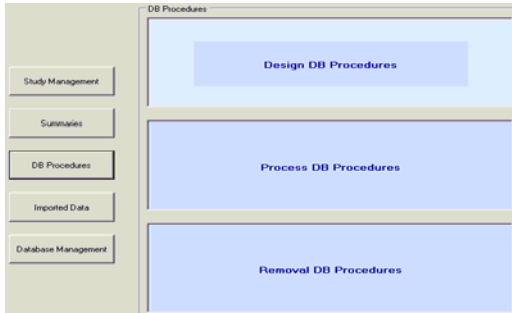
Select study HomeHospital (if needed).

Select radio-button DB Macro
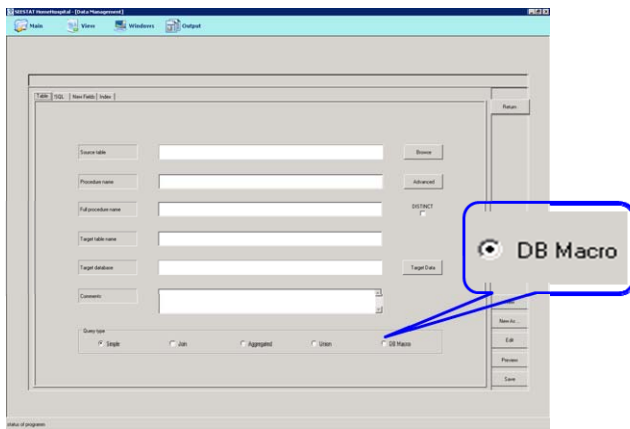
Select *add previous* type of macro and click OK. This type of macro procedure adds previous table data to current table data. For example: this procedure combines prev_visits_detail table and visits_detail table. Prev_visits_details table includes records of hospital visits for previous months. Procedure combines all records: records that started in current month and records that started in previous months and end after current month (detailed description of visit_detail table can be found in http://ie.technion.ac.il/Labs/Serveng/files/HHD/database.pdf).
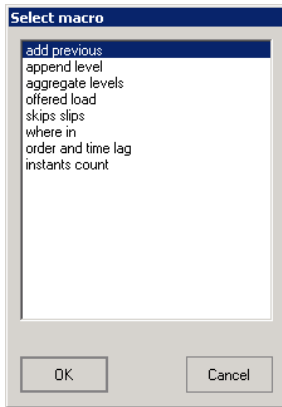
Click Browse.
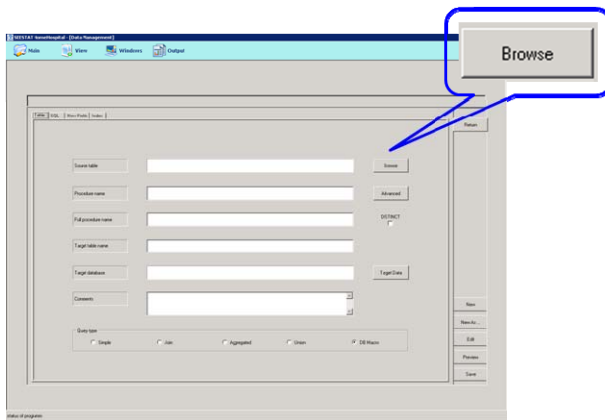
Select visit_detail table, click OK
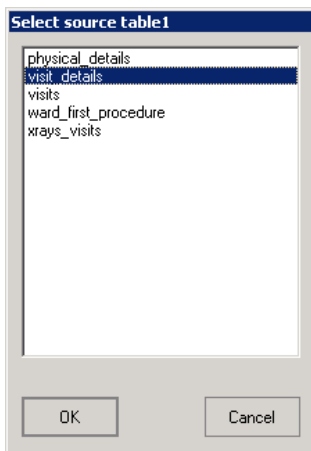
Fill in procedure name, full procedure name and target table name
add_prev_Surgery_and_Internal_ED. Click button Target Data and select target database
user_db, click OK.
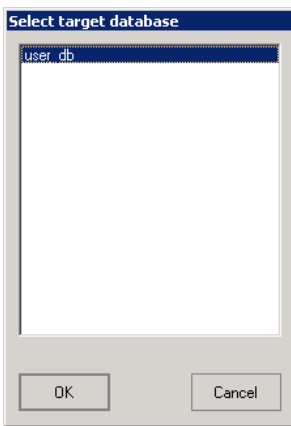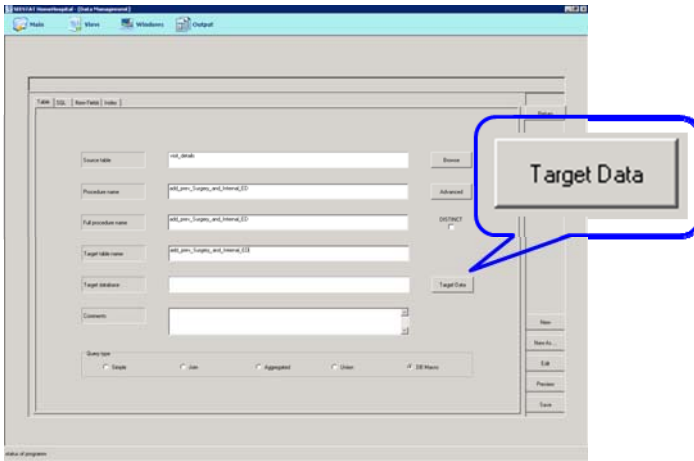
Click tab SQL. Select *entry_time* and *exit_time* fields, click button Add.
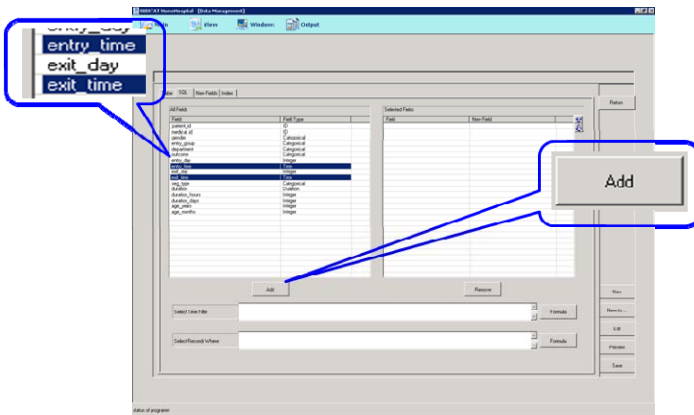
Right click on *entry_time* and rename to *event_start*, click OK
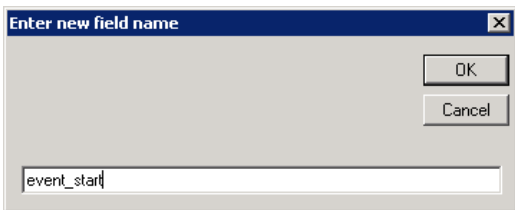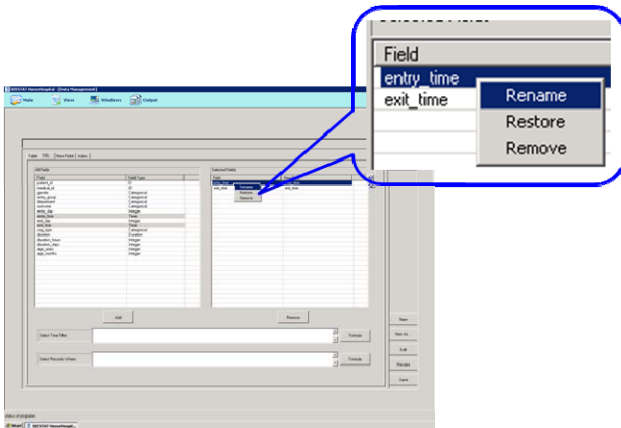
Right click on *exit_time* and rename to *event_end,* click OK

Click Formula button in *Select Records Where* frame.
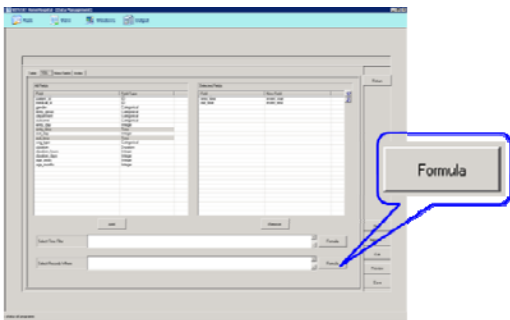
Fill in formula: *entry_group = 1 and duration_days < 30 and (department = 1 or department = 2)*

 (see Appendix 7 How to type formula in SEEStat).
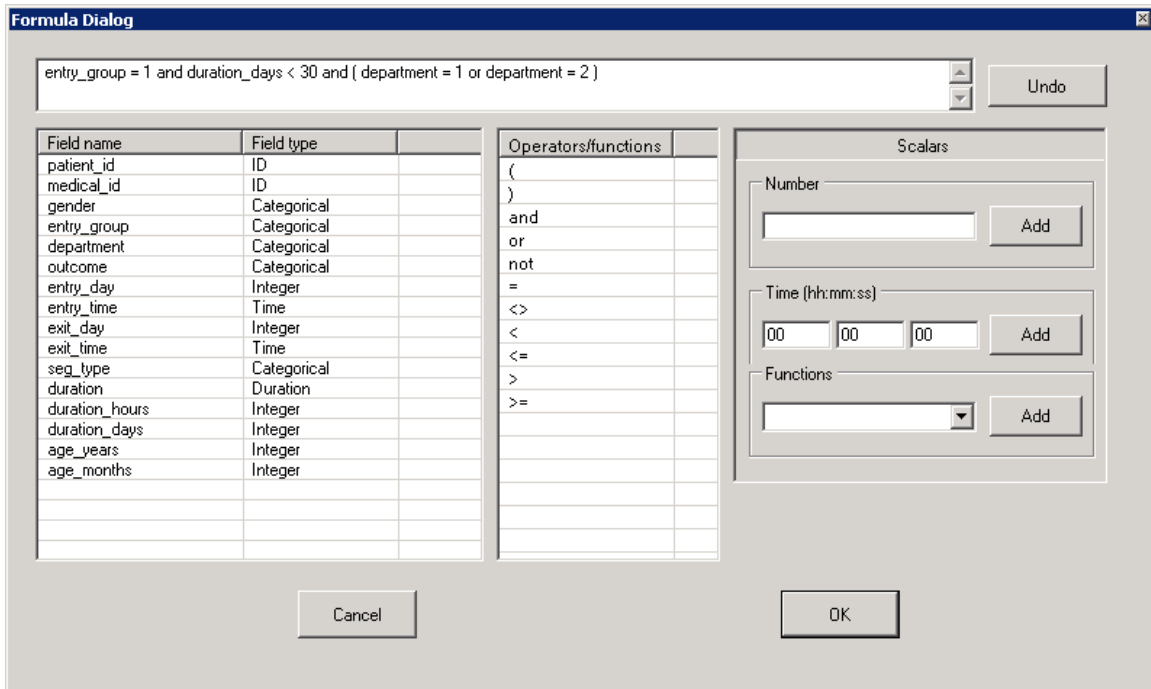
Click OK and Save.

Notes:
- codes for entry_group, department and other categorical fields can be found in SEEStat interface: View –> Dictionary or in http://ie.technion.ac.il/Labs/Serveng/files/HHD/database.pdf;

- For creation *Time by ED (without Pediatric Units) state (sec.)* use filter where: *entry_group = 1 and duration_days < 30 and (department <> 9 and department <> 10)* (For finding necessary codes: click View –> Dictionary–> hospital_unit: 9-Pediatric Emergency Unit, 10-Pediatric Emergency Surgery Unit)
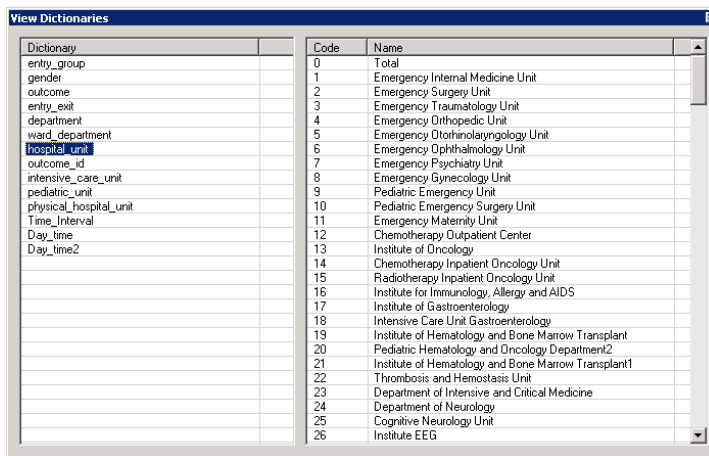
- duration_days < 30 - there are a few records with possibly incorrect times, see example below

patient_id	medical_id	entry_group	department	entry_date	exit_date	outcome	duration_days
10086416	20208896	1	8	14/11/2004 18:39	20/03/2006 18:24	7	491
10109070	20203816	1	7	19/01/2004 11:11	18/01/2005 16:00	7	365
10112397	20215749	1	5	29/12/2004 18:10	09/02/2005 18:11	7	42
10066764	20111655	1	2	07/03/2006 15:10	07/04/2006 17:00	7	31
10145911	20314046	1	1	17/06/2005 10:42	17/07/2005 13:11	7	30

Click Return and Design DB Procedures.
Select button DB Macro and select macro type *instants count*, click OK.
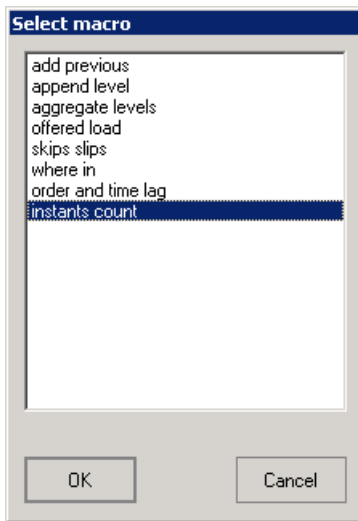
Click button Browse and select *add_prev_Surgery_and_Internal_ED procedure*, click OK.
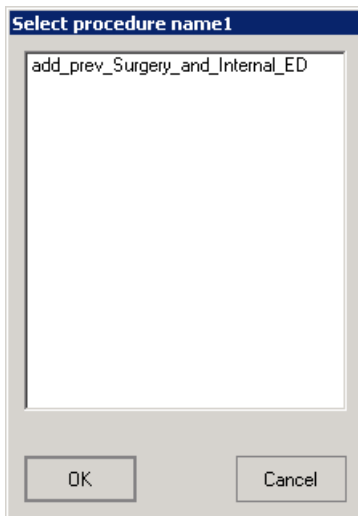
Fill in procedure name, full procedure name and target table name
Surgery_and_Internal_ED_count. Click button Target Data and select target database *user_db,*
click OK.

In SQL tab select event_start and click button Add, select event_end and click button Add.
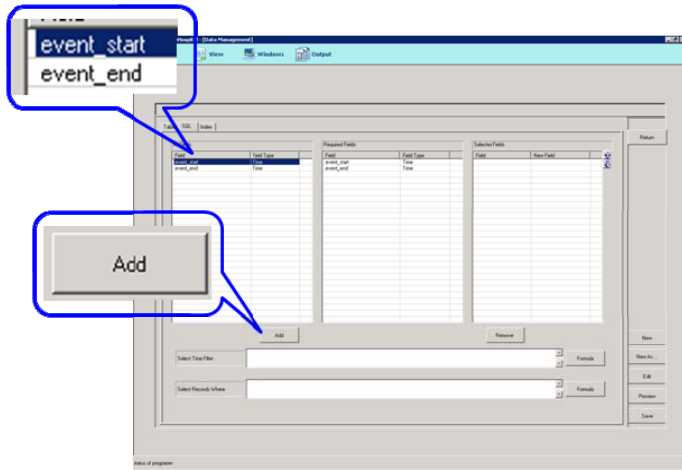
Click Save.
Click Return.
Select Process DB Procedures.
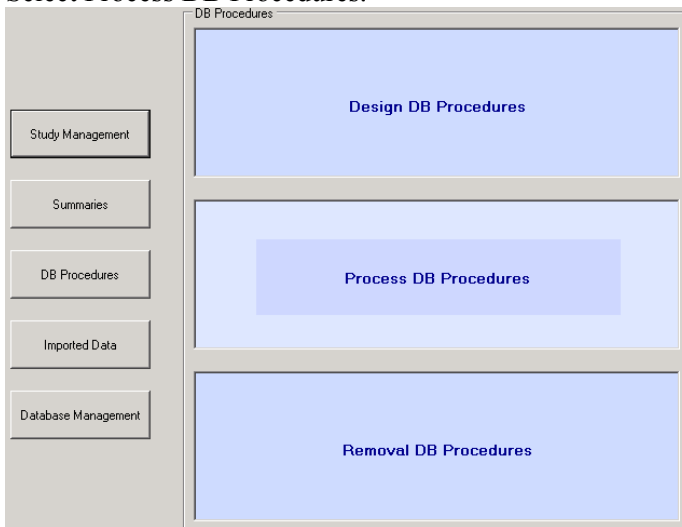
Select Surgery_and_Internal_ED_count and May 2006. Click Process. Wait a few seconds.
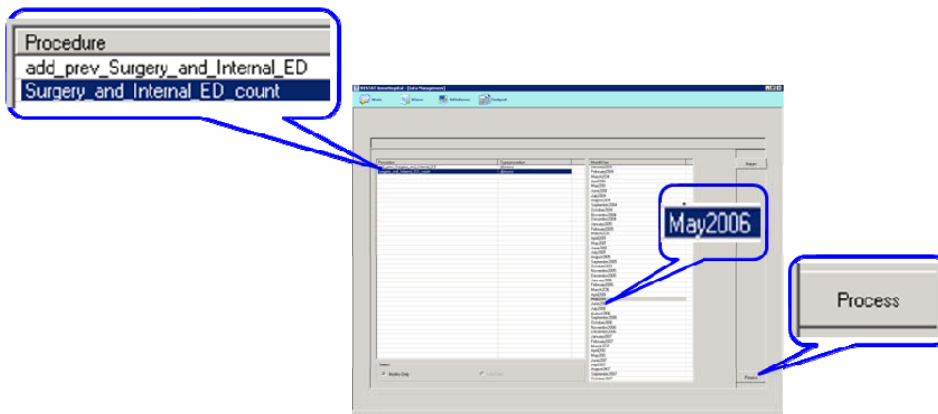
3.2.2 Creating ED state during the day on the basis of "instants count" procedure

Click Return.
Select Summaries –>Design Summaries
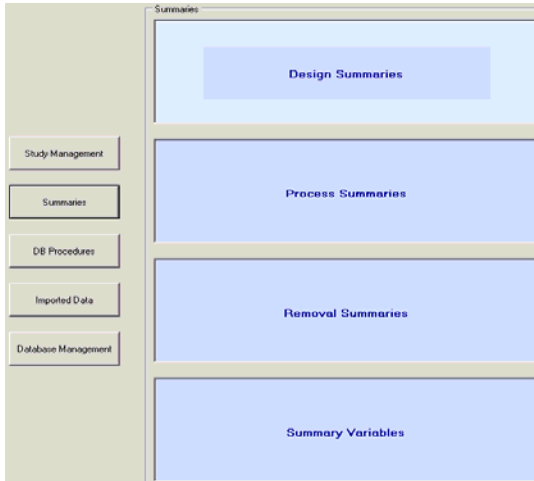
Fill in name of summaries *Surgery_Internal_ED_count.* Click on button Select in *X (first dimension)* frame.
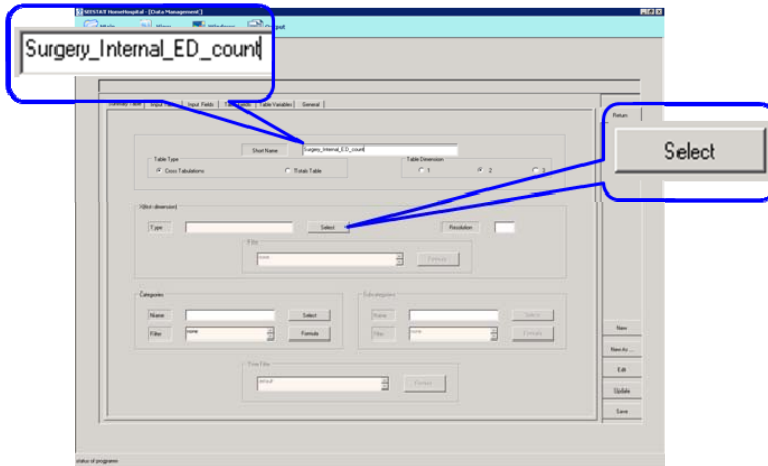
Select X type Integer and OK.
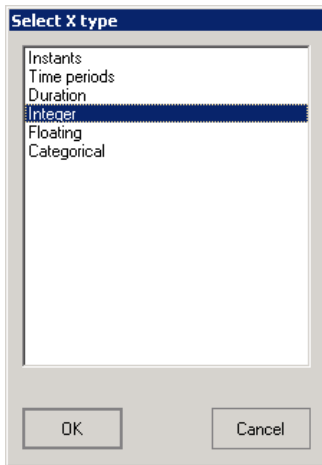
Click on button Select in *Categories* frame and select *Time_Interval* dictionary and OK.
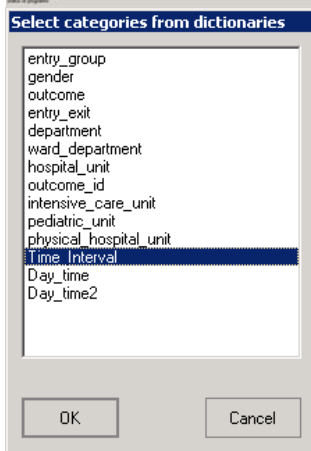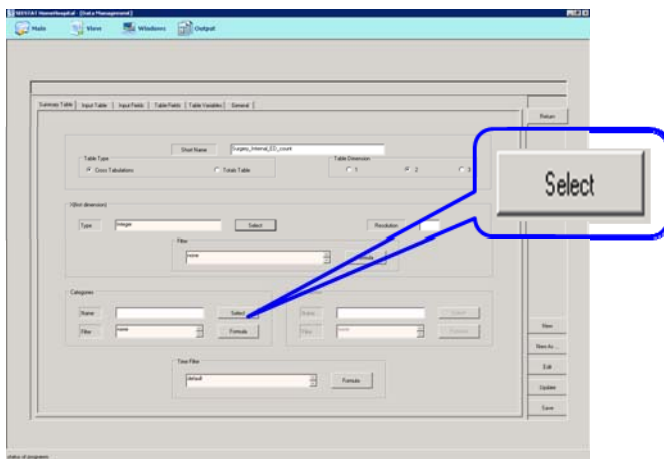
Fill in resolution 1 in *X (first dimension)* frame.
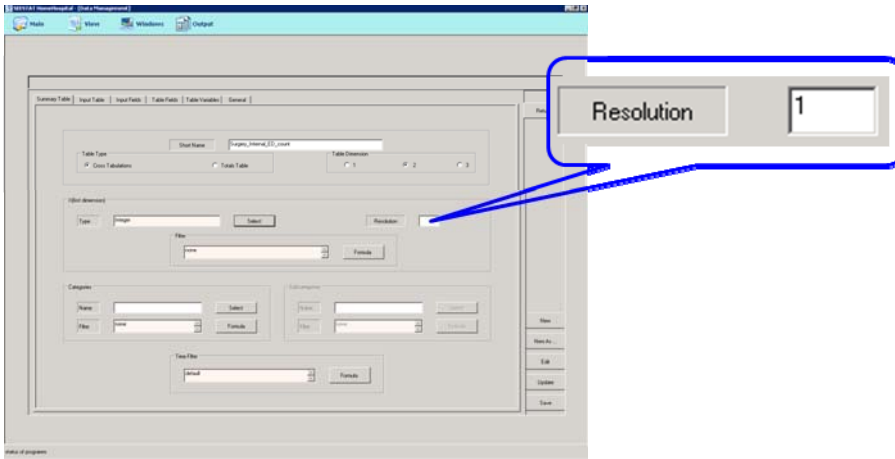
In Input Table Tab, click on button Select, select user_db database, OK and
Surgery_and_Internal_ED_count, OK
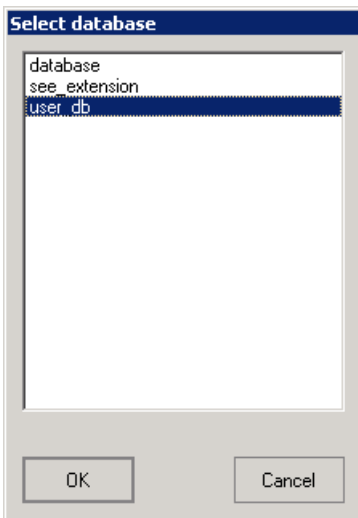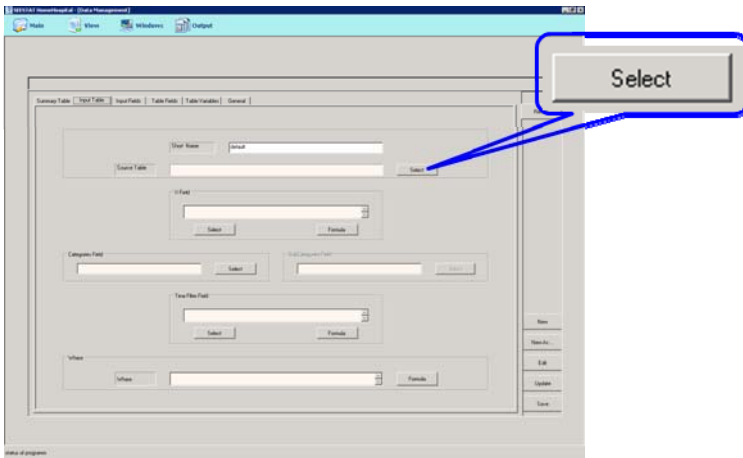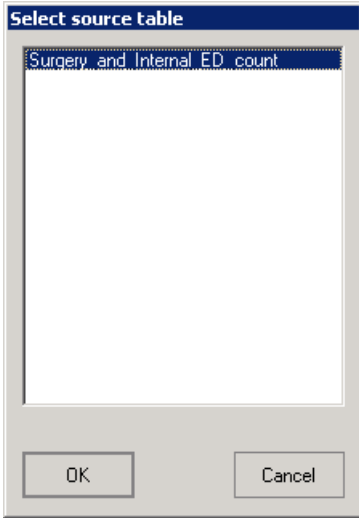
Click on Select button in *X field* frame.
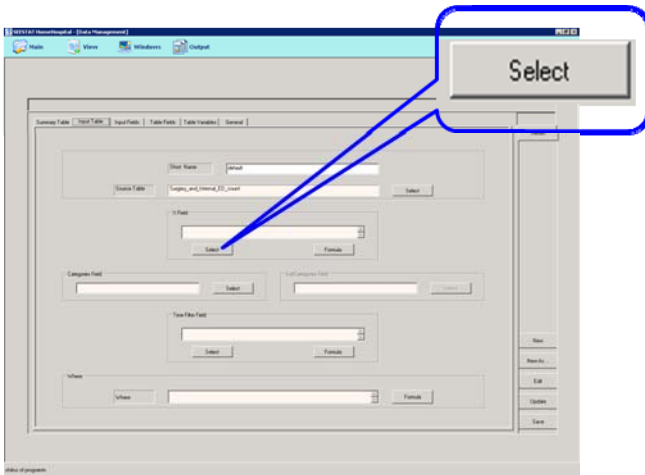
Select state_count field.
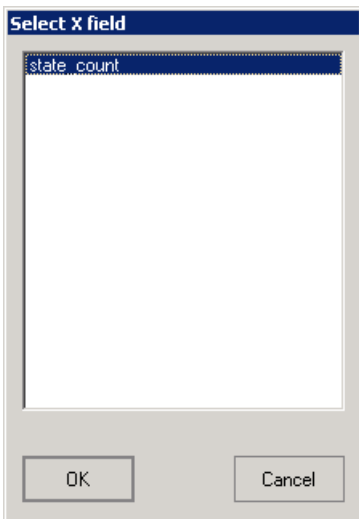
Select categories field state_time.
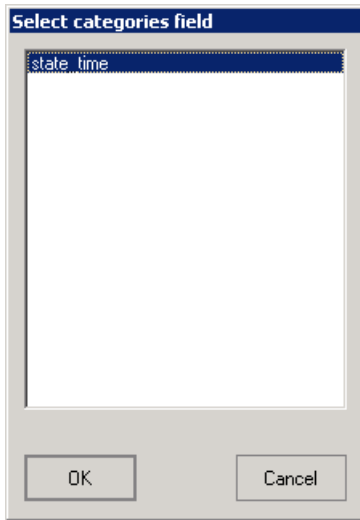
Select time filter field state_time.
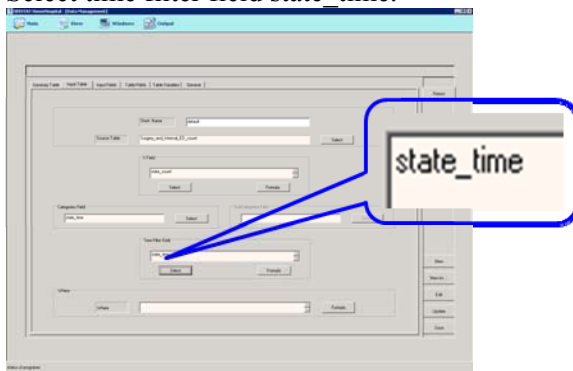
In Input Fields tab select state_count field.
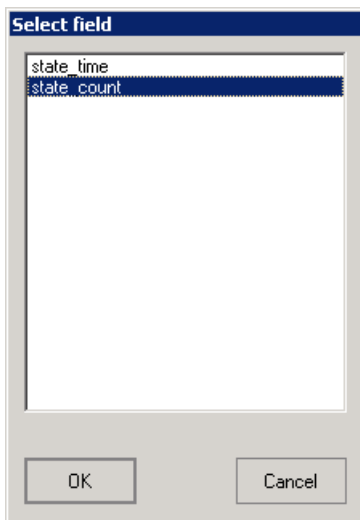
In Table Fields click Define button and fill in number 1 in formula, click OK
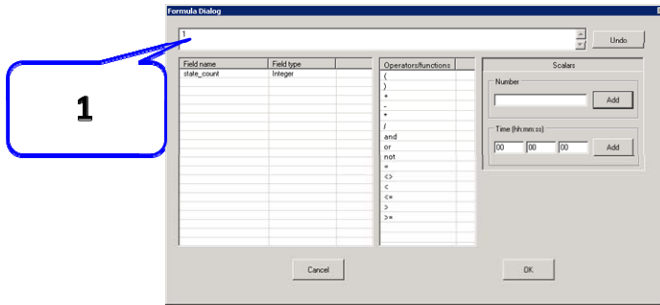
Fill in *freq_ED* name , click Add button.
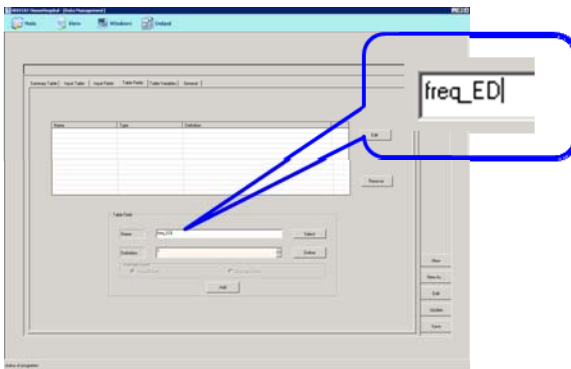
In Table Variables tab select freq_ED and fill in name *Time by ED Surgery and Internal state (sec.) USER*, click Add button. Click Save.
Click Return and Process Summaries.
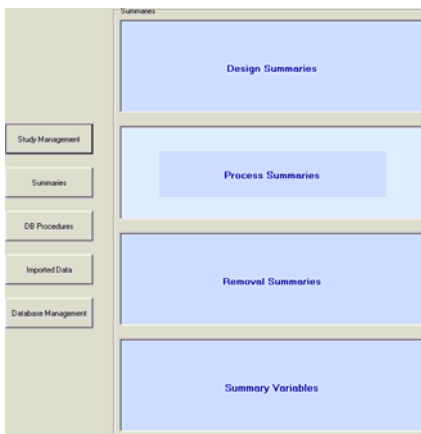
Select Surgery_Internal_Ed_count, May 2006 and click Process button.
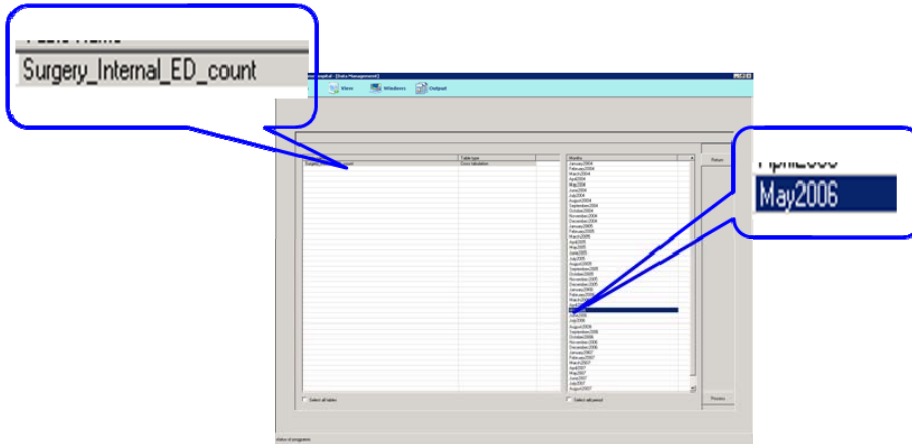
After end of process summary, reopen SEEStat.
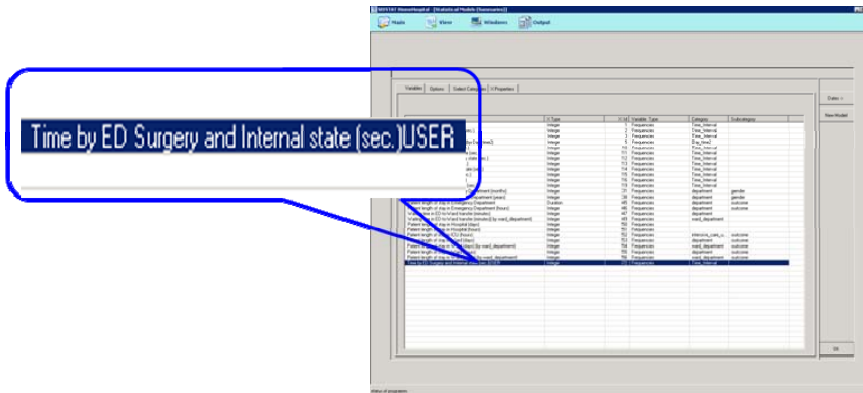
Appendix 4: How export data table from SEEStat

Click Main->Data Management
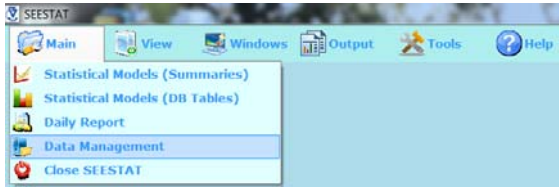
Select Database Management->Database Conversion
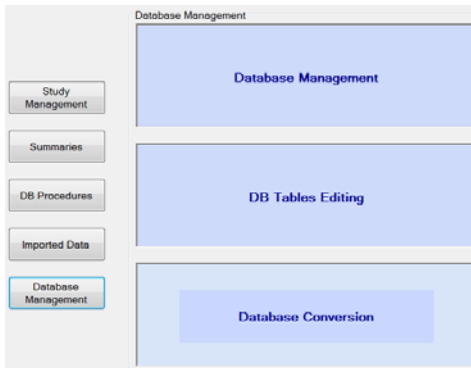
Select type of tables **Database** and select **table Int_ED_rates_avg_2004_2007_12_21PM**
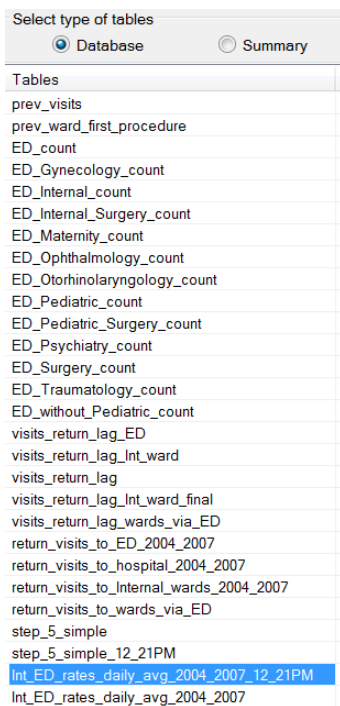
Click **Convert** button
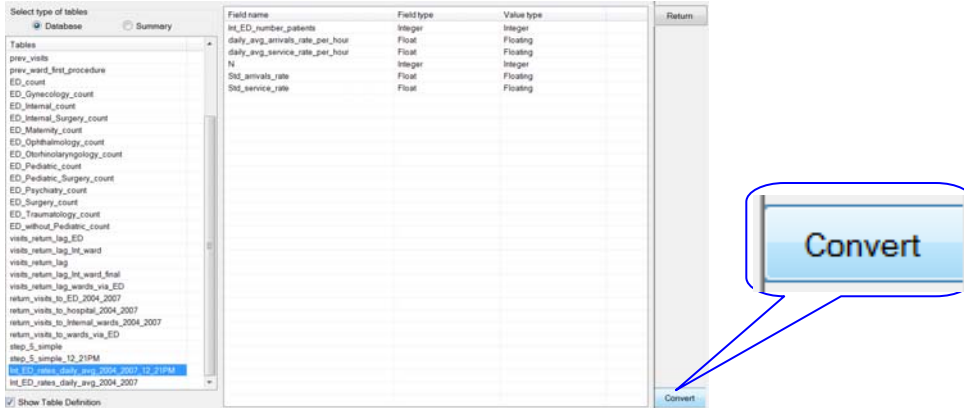
Save file
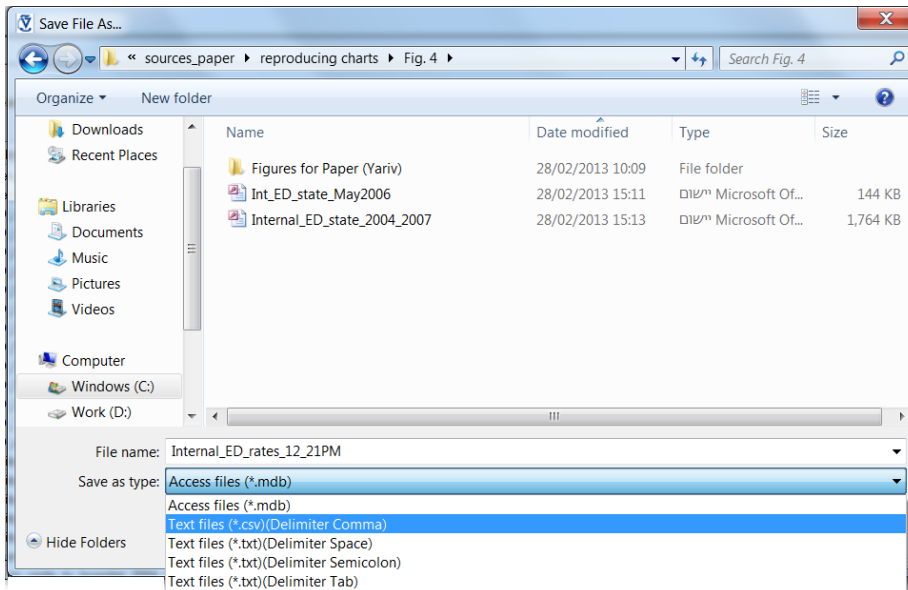
Appendix 5: How to add a secondary vertical axis in Excel

1. Add a secondary vertical axis in the chart: right click on data series "Number of Patients in Ward (average) (by ward_department)" (green line)
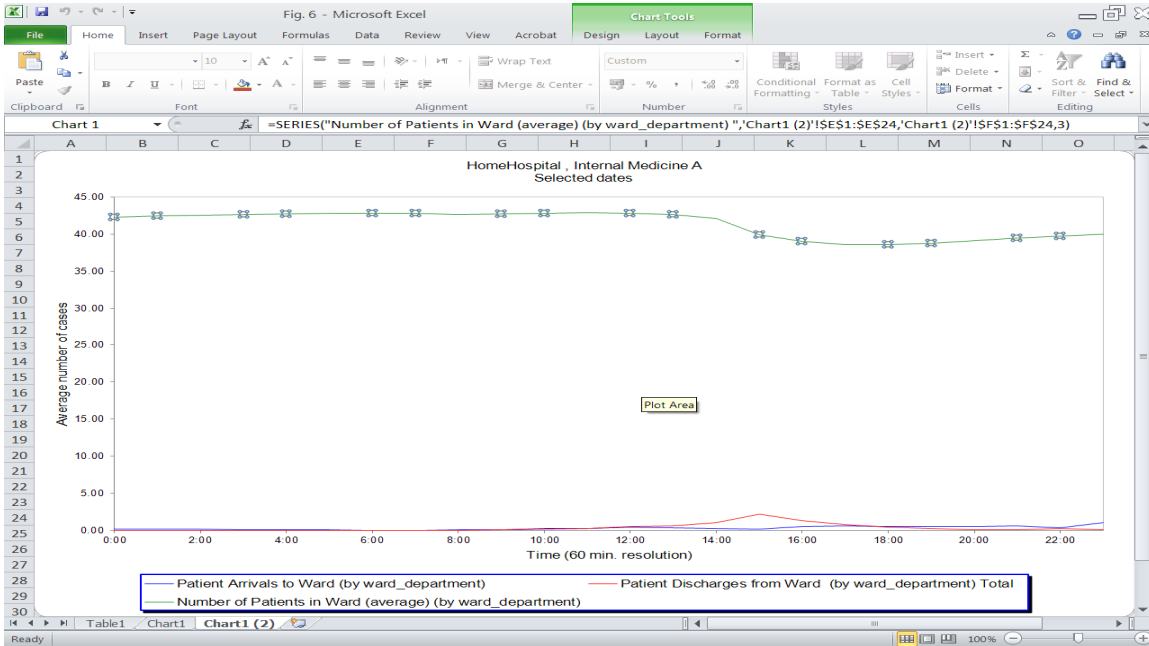
2. Select Format Data Series…
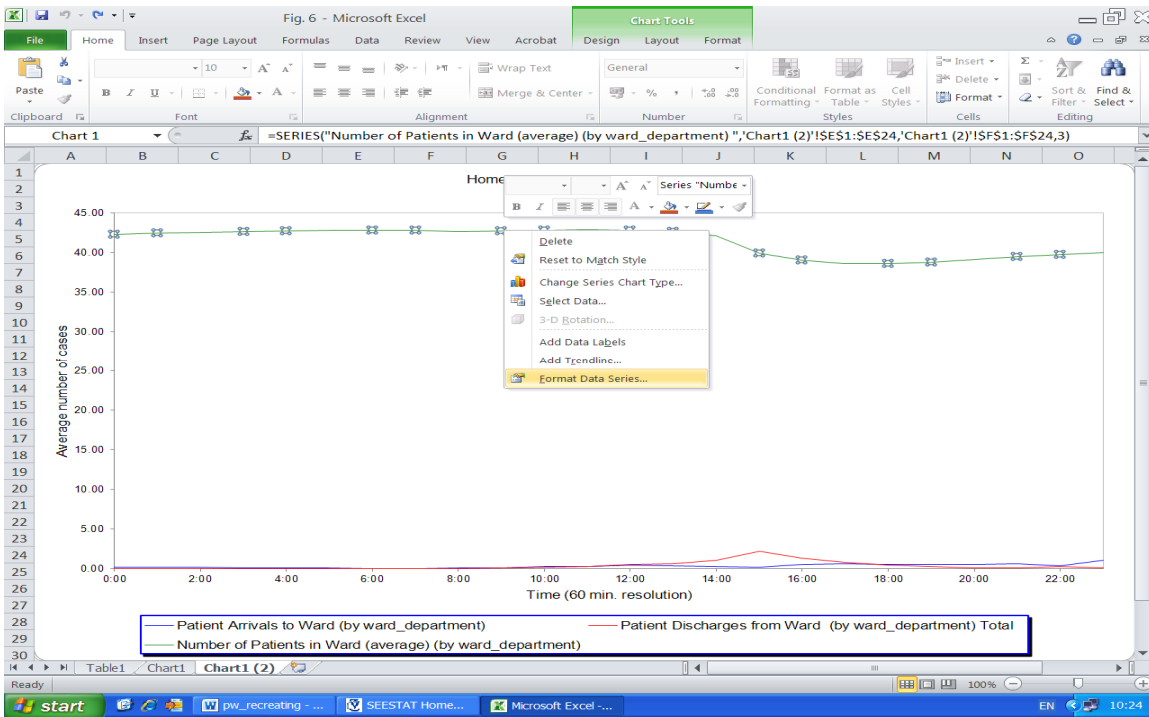
3. Select Secondary Axis

Excel 2003: Click on Axis tab and select plot series on Secondary axis.
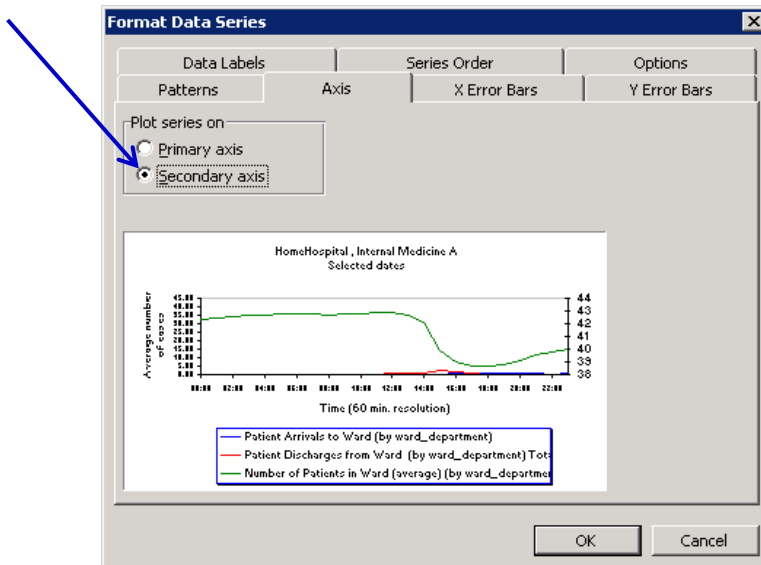
Excel 2010: in Series Options select Secondary Axis.
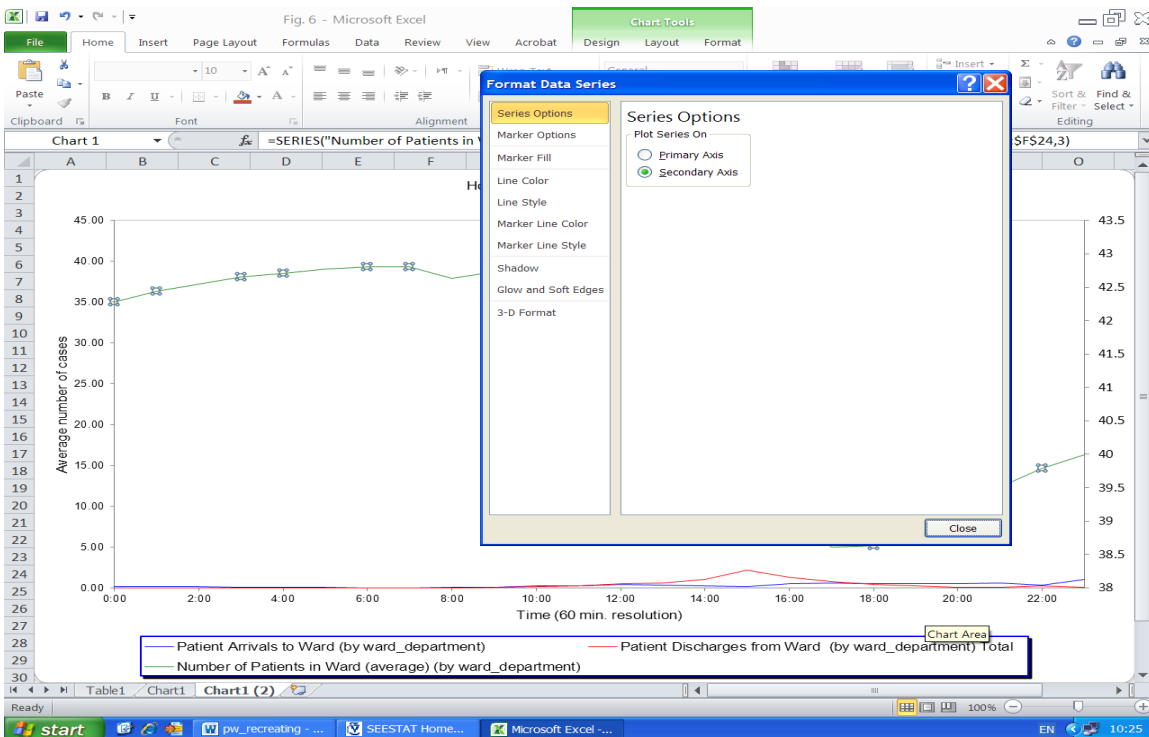
4. Right click on secondary axis and select Format Axis …
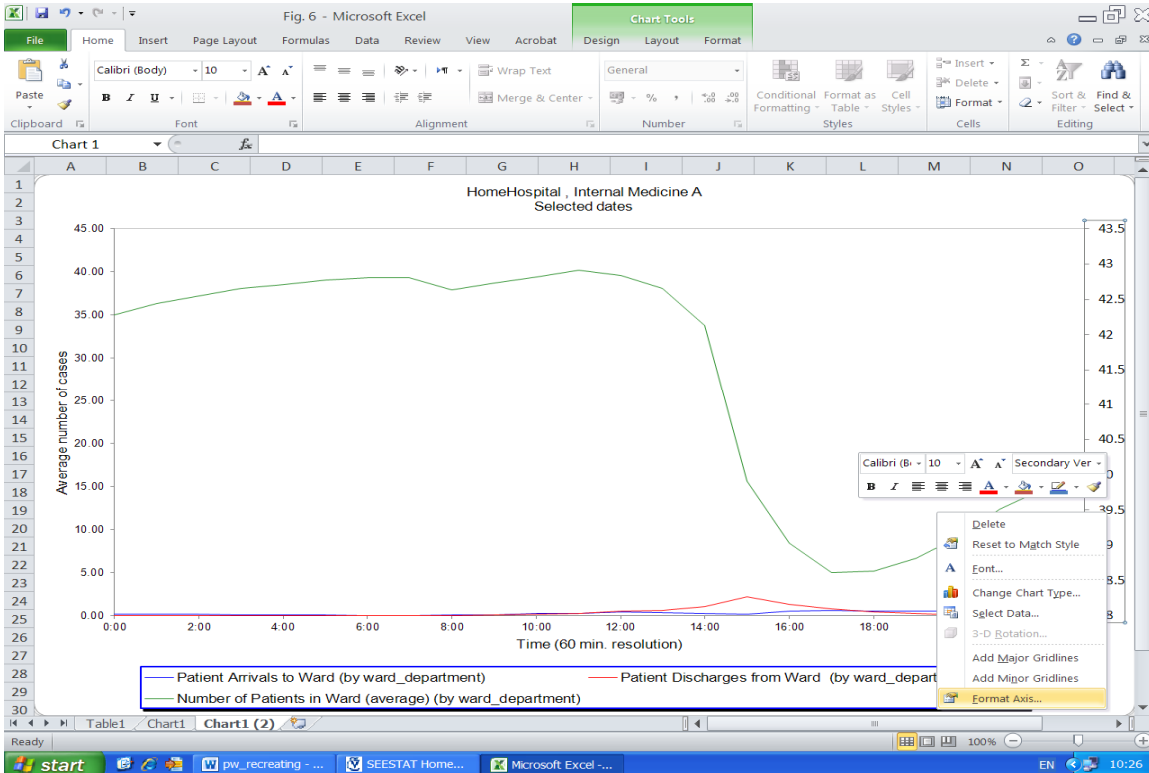
5. Fill in axis options minimum 36, maximum 43.5 major unit 1
Excel 2003: click on tab Scale and fill in parameters.

Excel 2010: select Axis Options and fill in parameters.
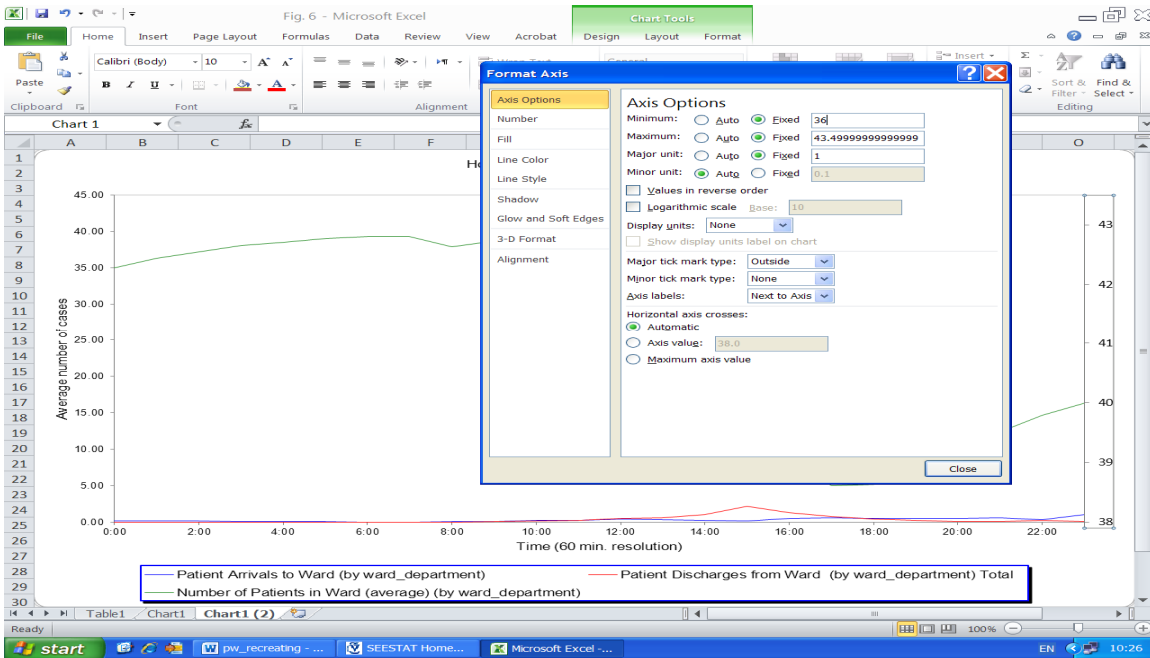
6.   Right click on primary axis (left side) and select Format Axis …
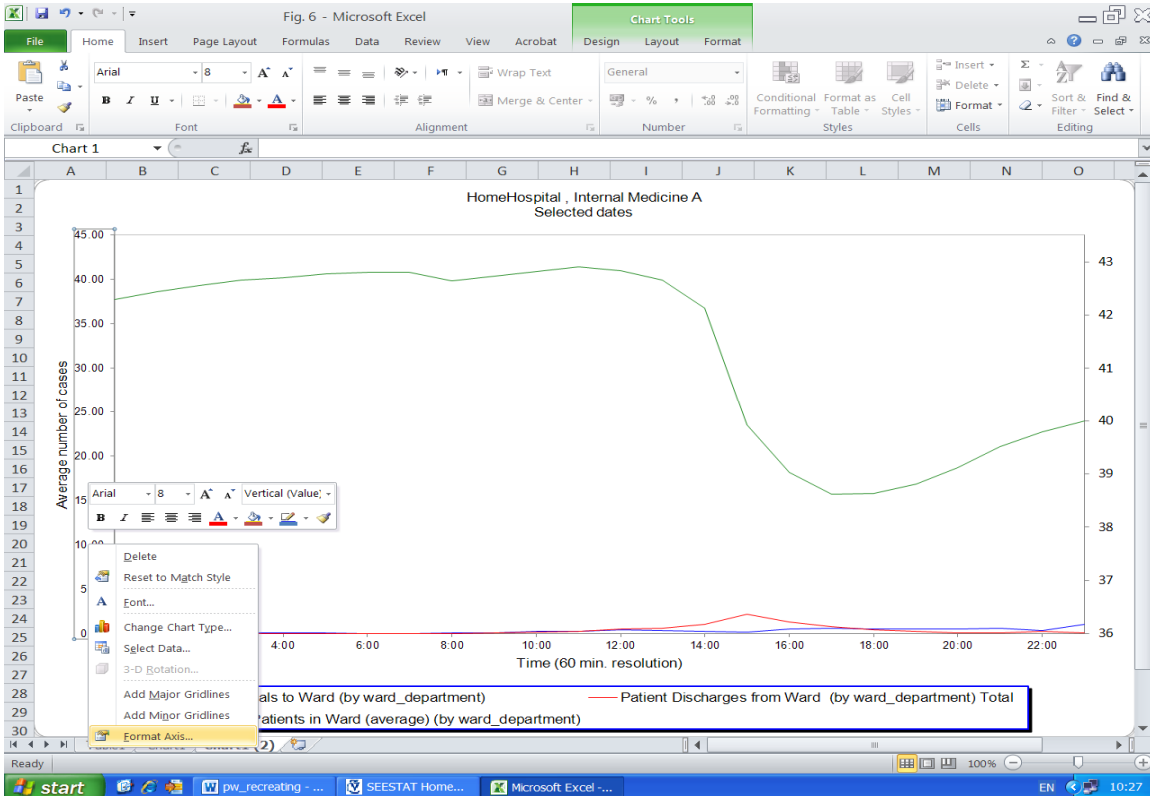
7.   Fill in axis options minimum 0, maximum 2.3 major unit 0.2

Excel 2003: click on tab Scale and fill in parameters.
Excel 2010: select Axis Options and fill in parameters.
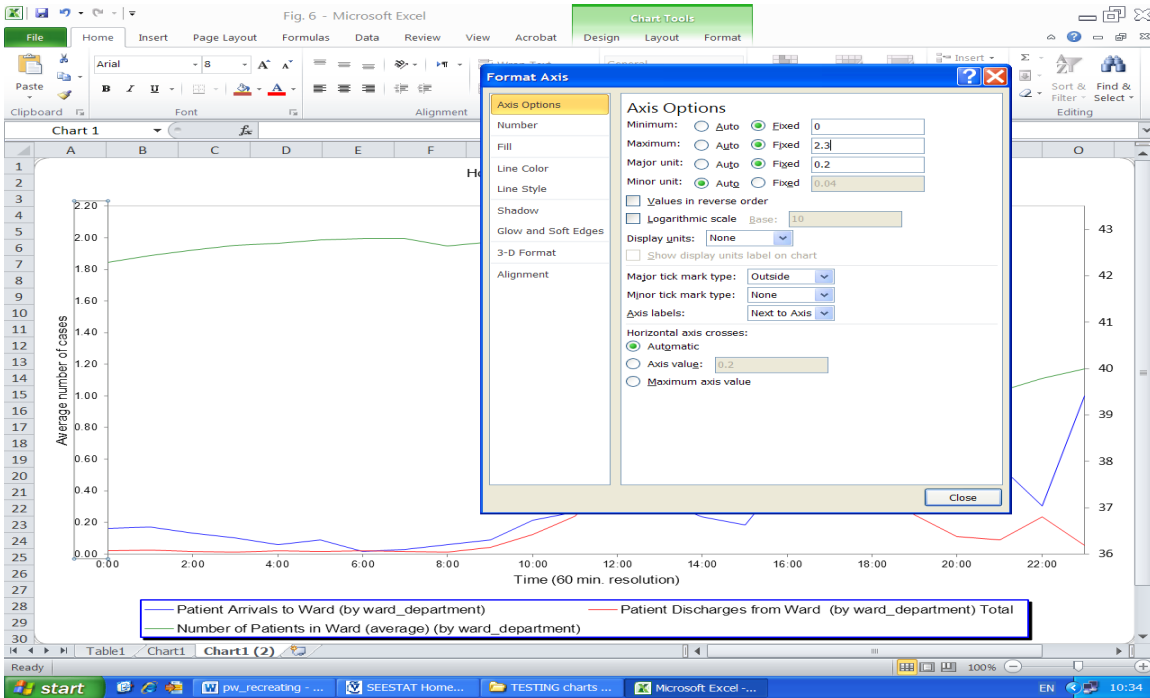
Appendix 6: Creation of SEEStat user extension

Do it only one time and then it is not needed to repeat. Note: user space in SEE Server is limited to 150MB.

6.1 Register user folder

Click Main –> Data Management
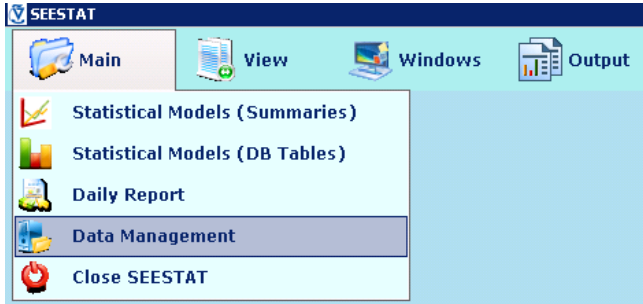
Click Study Management –> User Extension
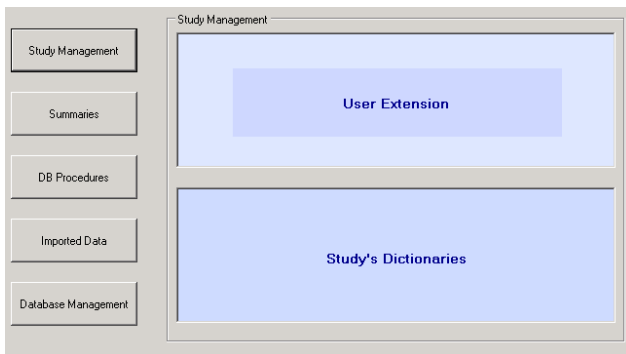
Click Register Folder
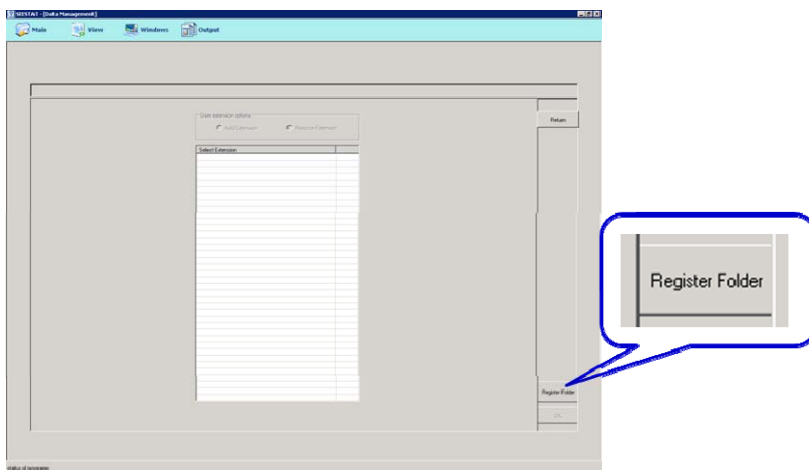
Click Yes
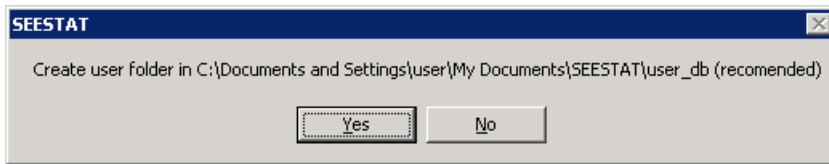
6.2 Add user extension

Select Add Extension –> select HomeHospital –>click OK
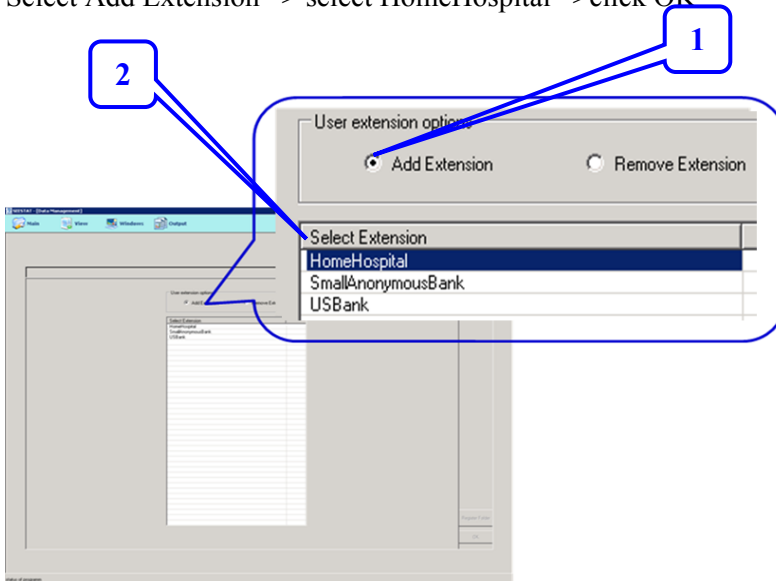
If the message: "*Unable to add or rename extension of the open study HomeHospital*" appeared, reopen SEEStat. Click Main –> Data Management –> Study Management –> User Extension. Select Add Extension –> select HomeHospital –>click OK

If the above message did not appear, continue with next step:
Click Return
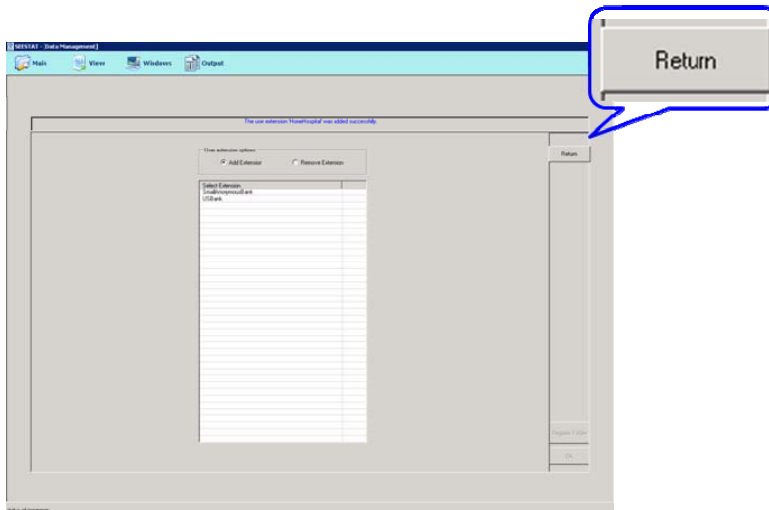
6.3 Create user database

Select Database Management –> Database Management
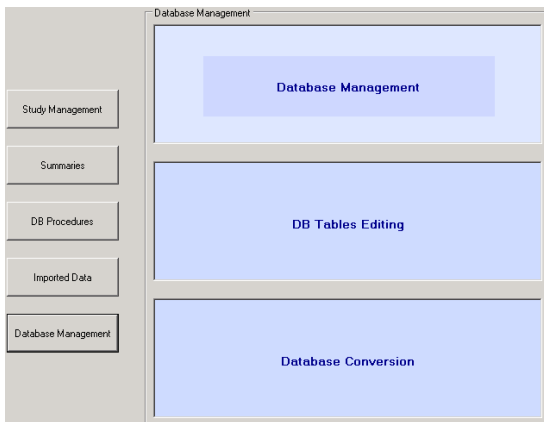
Select HomeHospital study and OK.

From database options select Create DB (radio-button), select database type SEE extension
(radio-button),
Fill in database name user_db, click OK
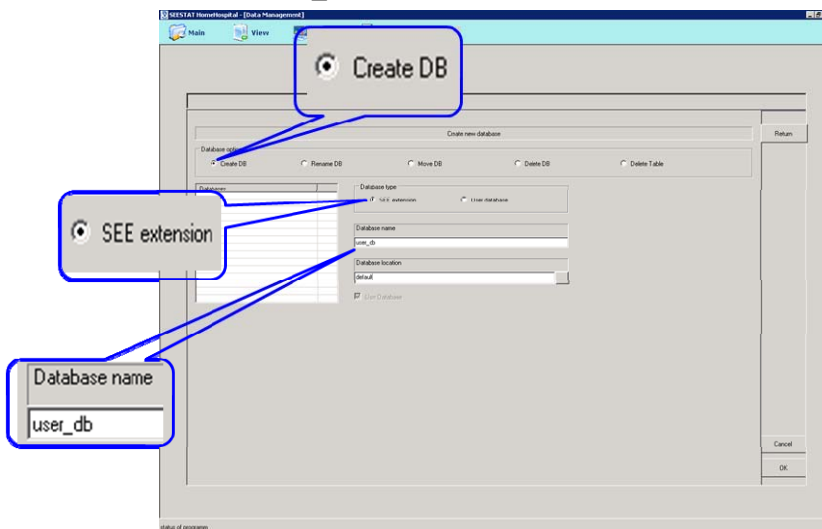
Appendix 7: How to type formula in SEEStat
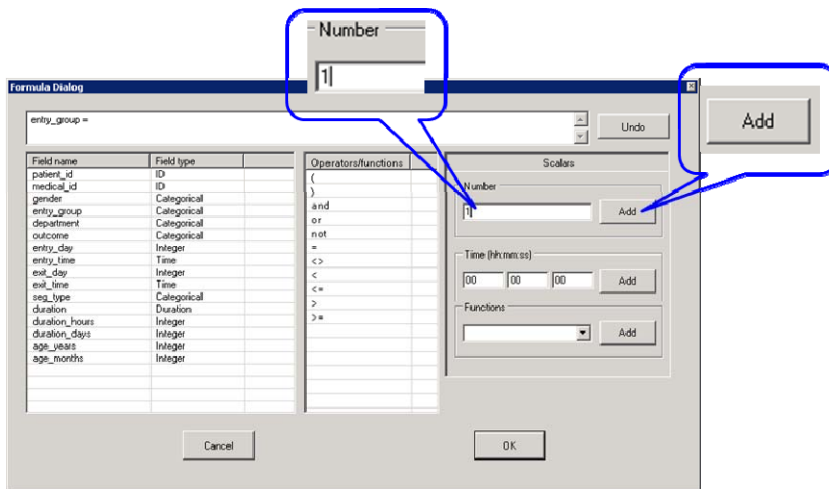
7.1 Fill in formula: *entry_group = 1*

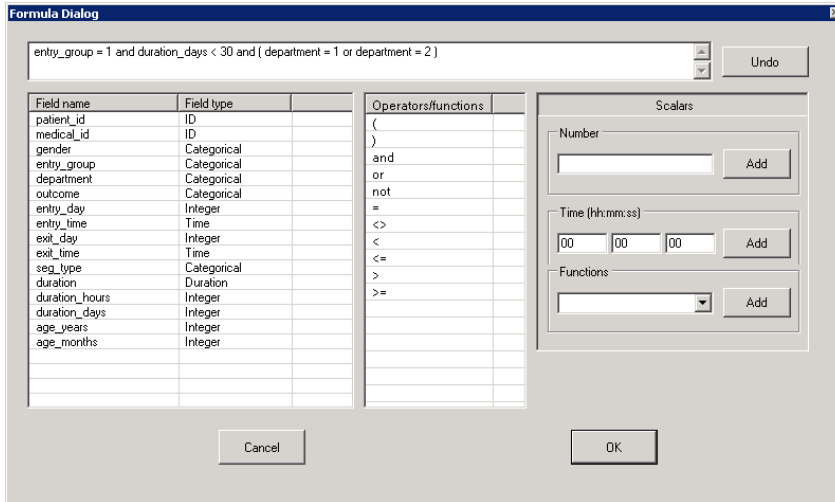Select entry_group field in Field name list box.
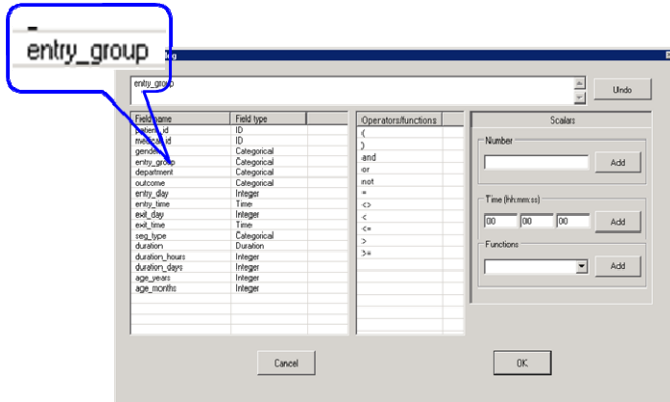
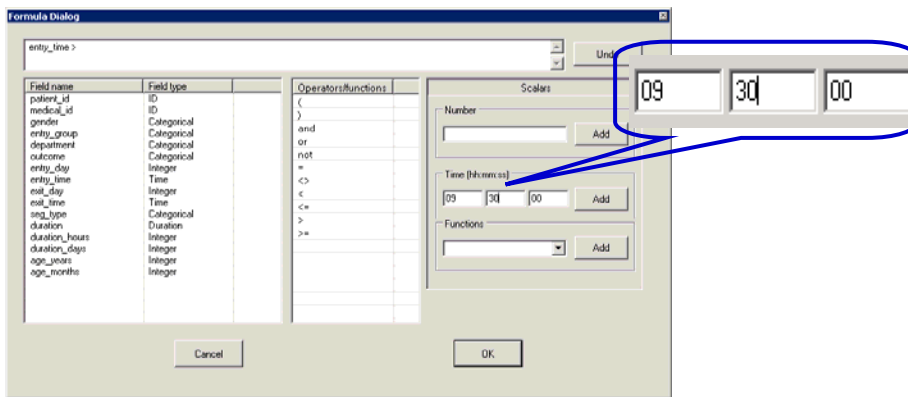Click on operator *equal* (=) in Operators/functions list box.
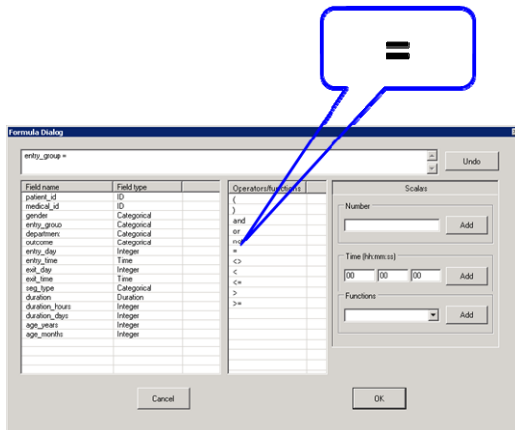
Write number 1 in text box in frame *Scalars* and click button Add.

7.2 Fill in formula: *entry_time > 09:30:00*

Select *entry_time* field in Field name list box. Click on operator *more* (**>**) in Operators/functions list box. Fill in time *09:30:00* in text box in frame *Time (hh:mm:ss)* and click button Add.

7.3 Fill in formula: *log (duration)*

Select *log* in combo box in frame *Functions* and click button Add.
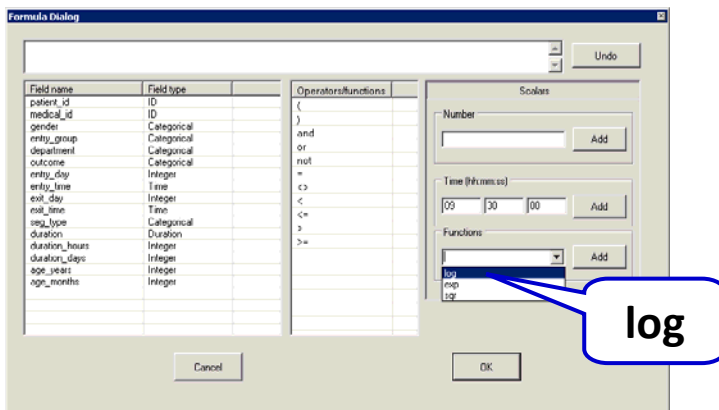
Click on operator *left bracket* (**(**) in Operators/functions list box. Select *duration* field in Field name list box and click on operator *right bracket* (**)**)