Time Series Analysis on Numbers of Patients Visiting ED

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0.1 Introduction

The Centre for Addiction and Mental Health (CAMH) is Canada's largest mental health and addiction teaching hospital, as well as one of the world's leading research centres in the area of addiction and mental health. CAMH's 24/7 Psychiatric Emergency Department is located at 250 College Street. It serves 40% of the Toronto Central LHIN emergency presentations for mental health and addictions and is the largest teaching site for the Department of Psychiatry at the University of Toronto.

According to CAMH, visits to the ED have increased dramatically, with 76 percent more visits in 2014 than in 2006 (2). Therefore, it is very important if we can obtain information which will help the ED to make effective staffing decisions and effective allocate other resources. This paper anlayzed daily visiting patients for last five years and

0.2 Data Description

The data set is dail records of paitents visited to the Emergency Department, starting from April 1st, 2010 to August 31st, 2015. It includes 38, 112 observations and 13 variables.

0.3 Statistical Summaries and Exploratory Data Analysis

Usually statistical analysis should start with prelimilary exploratory analysis so that we could have any ideas how to conduct the analysis.

0.3.1 Read the Data to R

First, we create a data set for numbers of patients visiting ED per day and then analyze the data, and the first few lines of the new data set is as follow.

Table 1: First 8 rows in the data set

Date	Patients	Year	Month	Weekday	Weekends	holidays	WeekendHolidays
2010-04-01	17	2010	04	Thursday	0	0	0
2010-04-02	8	2010	04	Friday	0	1	1
2010-04-03	12	2010	04	Saturday	1	0	1
2010-04-04	12	2010	04	Sunday	1	0	1
2010-04-05	18	2010	04	Monday	0	0	0
2010-04-06	22	2010	04	Tuesday	0	0	0

Table 2: Number of Patients by Year

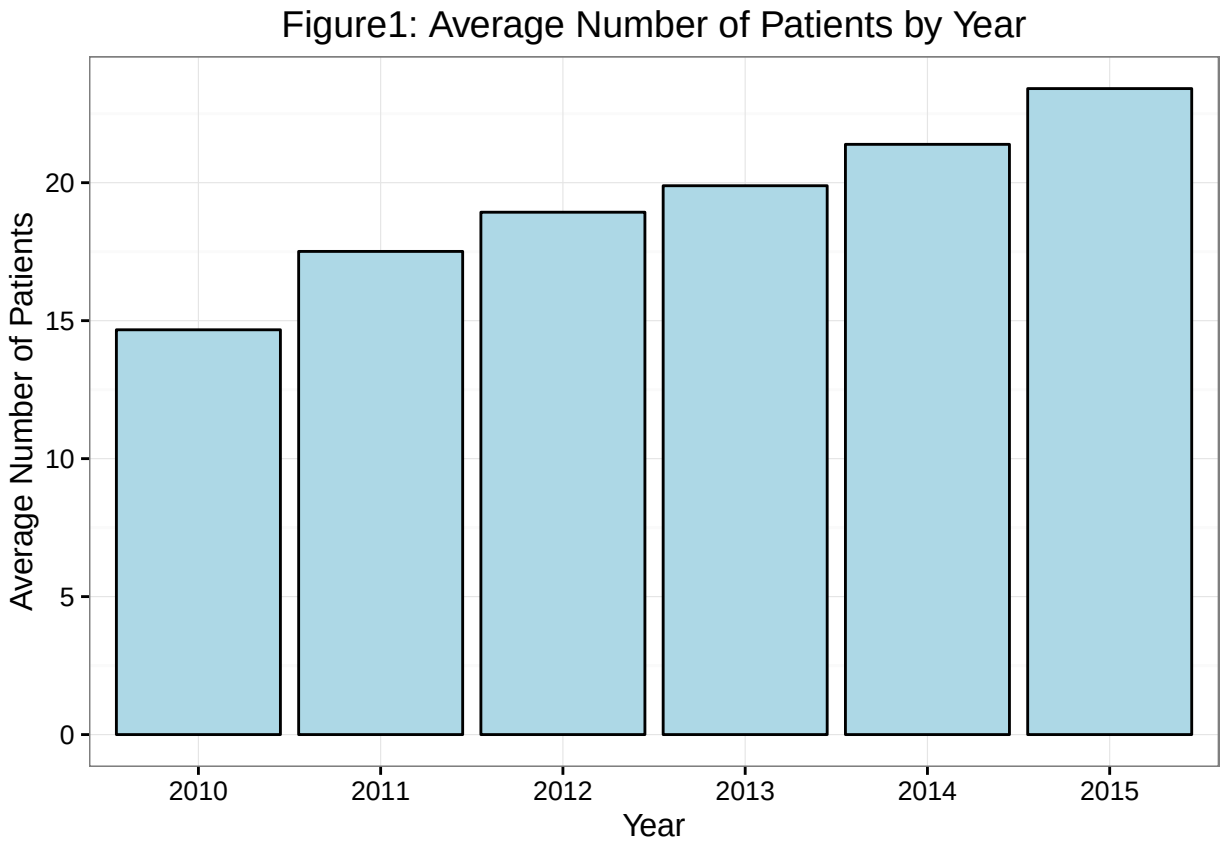
year	Average Number of Patients/day	Total Numbers of Patients
2010	14.67	4035
2011	17.51	6391
2012	18.93	6929
2013	19.89	7261
2014	21.39	7807
2015	23.41	5689

0.3.2 Yearly Trend

The data set shows an increasing trend of numbers of patients by year, so we would expect more patients come to the ED in the future years.

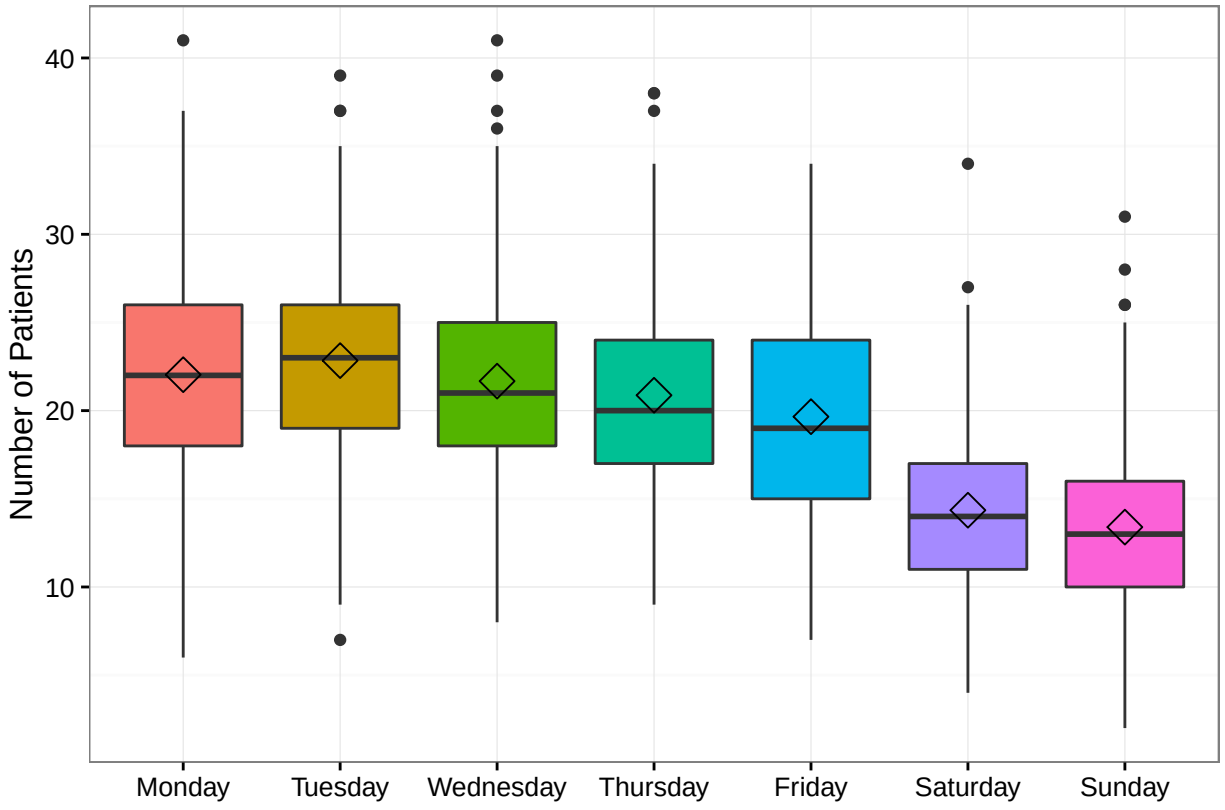
Table 3: Summary of Number of Patients by Weekdays

Weekday	Average	Total	Percent
Monday	22.04	6237	0.16
Tuesday	22.84	6440	0.17
Wednesday	21.67	6112	0.16
Thursday	20.87	5907	0.15
Friday	19.66	5563	0.15
Saturday	14.35	4062	0.11
Sunday	13.40	3791	0.10



Weekday Effects

If we summary number of patients by weekday, we can easily see that a decreasing trend starting from Monday. So the most of the patients come to the ED during weekdays and they less likely to come on weekends.


Number of Patients
40
30
20
10
Monday
Tuesday
Wednesday
Thursday
Friday
Saturday
Sunday

Hourly Data

Table 4: Number of Patients by Hours

hours	Total	Avg	Percent
0	1072	0.54	2.81
1	819	0.41	2.15
2	643	0.32	1.69
3	543	0.27	1.42
4	450	0.23	1.18
5	401	0.20	1.05
6	372	0.19	0.98
7	421	0.21	1.10
8	659	0.33	1.73
9	973	0.49	2.55
10	1725	0.87	4.53
11	2391	1.21	6.27
12	2737	1.38	7.18
13	2798	1.41	7.34
14	3077	1.55	8.07
15	2969	1.50	7.79
16	2964	1.50	7.78
17	2507	1.27	6.58
18	2272	1.15	5.96
19	2031	1.03	5.33
20	2042	1.03	5.36
21	1712	0.87	4.49
22	1437	0.73	3.77
23	1097	0.55	2.88

Table 5: Number of Patients by Hours During Weekdays

hours	Total	Avg	Percent
0	762	0.56	2.58
1	585	0.43	1.98
2	441	0.32	1.49
3	375	0.27	1.27
4	314	0.23	1.06
5	277	0.20	0.94
6	262	0.19	0.89
7	316	0.23	1.07
8	476	0.35	1.61
9	718	0.53	2.43
10	1407	1.03	4.76
11	1955	1.43	6.61
12	2238	1.64	7.57
13	2278	1.67	7.71
14	2464	1.81	8.34
15	2395	1.75	8.10
16	2357	1.73	7.97
17	1950	1.43	6.60
18	1759	1.29	5.95
19	1555	1.14	5.26
20	1531	1.12	5.18
21	1257	0.92	4.25
22	1082	0.79	3.66
23	803	0.59	2.72

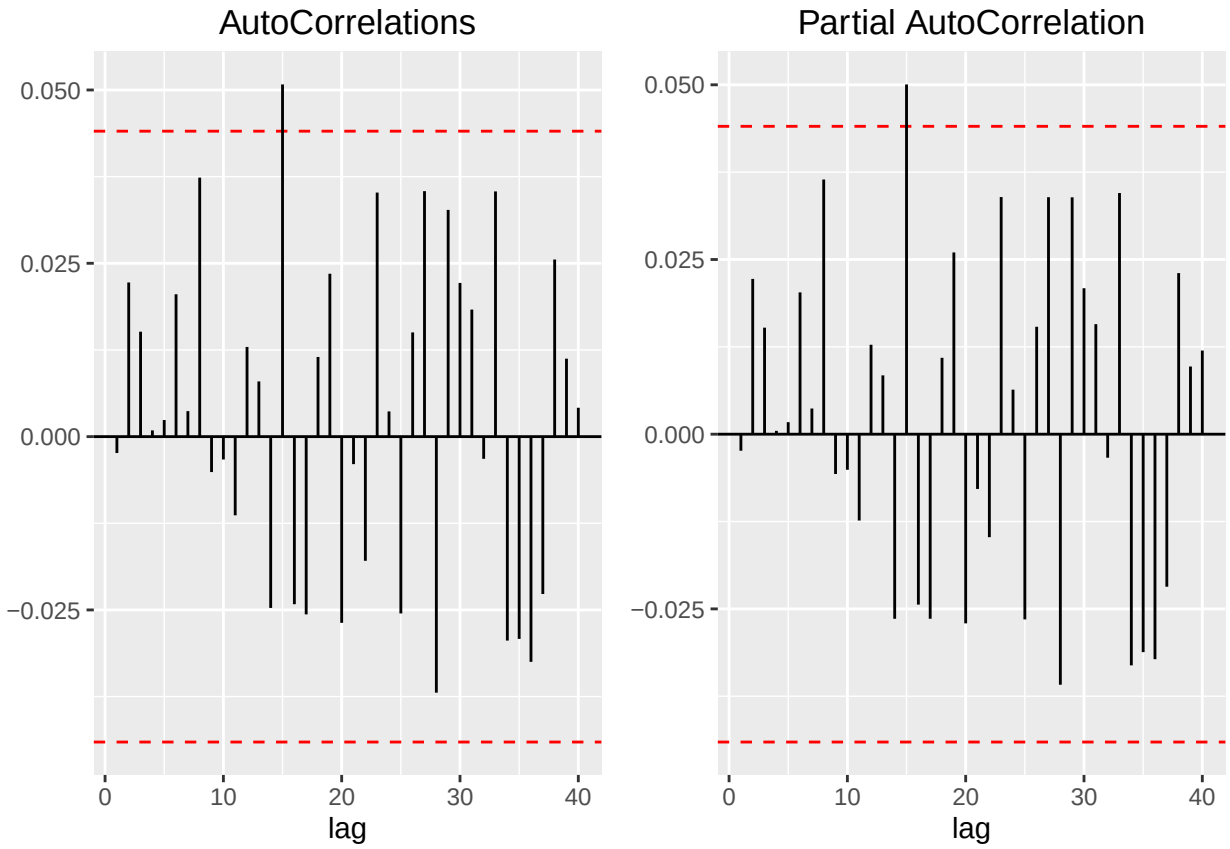
Table 6: Number of Patients by Hours During Weekends and Holidays

hours	Total	Avg	Percent
0	310	0.50	3.62
1	234	0.38	2.74
2	202	0.33	2.36
3	168	0.27	1.96
4	136	0.22	1.59
5	124	0.20	1.45
6	110	0.18	1.29
7	105	0.17	1.23
8	183	0.30	2.14
9	255	0.42	2.98
10	318	0.52	3.72
11	436	0.71	5.10
12	499	0.81	5.83
13	520	0.85	6.08
14	613	1.00	7.17
15	574	0.93	6.71
16	607	0.99	7.10
17	557	0.91	6.51
18	513	0.84	6.00
19	476	0.78	5.56
20	511	0.83	5.97
21	455	0.74	5.32
22	355	0.58	4.15
23	294	0.48	3.44

Table 7: Summary of Time Series Model

	Coef	Sterr	t	p-value
ar1	0.0873070	0.0253948	3.437988	0.0005982
ma1	-0.9728285	0.0110930	-87.697818	0.0000000
Monday	8.6432456	0.3717208	23.251985	0.0000000
Tuesday	9.4551807	0.3880162	24.368006	0.0000000
Wednesday	8.2836030	0.3893921	21.273168	0.0000000
Thursday	7.4932572	0.3890494	19.260424	0.0000000
Friday	6.2778594	0.3876794	16.193430	0.0000000
Saturday	0.9660063	0.3717392	2.598613	0.0094296
Year2011	2.3774396	1.1883244	2.000666	0.0455648
Year2012	4.7886187	1.7946778	2.668233	0.0076874
Year2013	5.6996965	2.1965357	2.594857	0.0095329
Year2014	8.2197634	2.6934411	3.051770	0.0023052
Year2015	9.3575411	2.9033555	3.223009	0.0012891

0.4 Time Series Analysis



References: (1) http://www.camh.ca/en/hospital/about_camh/who_we_are/Pages/who_we_are.aspx