

Developing an Emergency Physician Productivity Index Using Descriptive Health Analytics

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Abstract. Emergency department (ED) crowding became a major barrier to receiving timely emergency care. At King Faisal Specialist Hospital and Research Center, Saudi Arabia, we identified variables and factors affecting crowding and performance to develop indicators to help evaluation and improvement. Measuring efficiency of work and activity of throughput processes; it was important to develop an ED physician productivity index. Data on all ED patients' encounters over the last six months of 2014 were retrieved and descriptive health analytics methods were used. Three variables were identified for their influence on productivity and performance; Number of Treated Patients per Physician, Patient Acuity Level and Treatment Time. The study suggested a formula to calculate the productivity index of each physician through dividing the Number of Treated Patients by Patient Acuity Level squared and Treatment Time to identify physicians with low productivity index and investigate causes and factors.

Keywords. Reducing Emergency Crowding, Productivity, Analytics, Hospitals.

Introduction

ED crowding became a major barrier to receiving timely emergency care all over the world. Patients who present to EDs often face long waiting times to be treated and those under treatment face even longer treatment time till they are admitted to the hospital or discharged home [1]. The effects of ED crowding can be classified into four main categories; adverse outcomes, reduced quality, impaired timely access to care, and provider losses [2]. Patient mortality is a commonly studied adverse outcome of crowding. Significant increase in mortality rates is associated with increased ED crowding [3]. Patient transport from ED to investigation areas, such as radiology, and patient treatment inside the ED usually are delayed due to ED crowding. Patients who arrive at the ED during crowded periods will wait longer for an ED bed to be treated. Crowding is also associated with increased door to doctor (patient arrival to doctor examination) and door-to-needle (patient arrival to doctor intervention) time for patients with suspected myocardial infarction. High ED occupancy levels can also be associated with delayed pain assessment and deficient pain documentation [4]. Ambulance diversion and patient leave are also effects of crowding related to impaired access. Patients are more likely to leave without being seen when ED occupancy approaches 100%. The rate of patients leaving without being seen is closely correlated

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with waiting times. Patients frequently cite long waiting times as a reason for leaving without being seen and many of them will seek other medical care. Patients who leave the ED without being seen are twice as likely to report worsened health problems [5]. The negative financial effect on hospitals due to ED crowding is documented. Patients who boarded in the ED longer than a day also stayed in the hospital longer [6].

A conceptual model of ED crowding classified crowding factors into three interdependent categories: input, throughput, and output; where the input factors are related to the number and severity of patients conditions arriving at the ED, throughput factors are related to the waiting time and the efficiency of processes, such as triage by nurses and treatment by physicians, and output factors which are related to patient discharge, transfer to other facilities and boarding time for patients who are to be admitted, which is affected by the occupancy rates of the inpatient departments and the availability of inpatient beds [7]. Inadequate staffing, low ED physicians' productivity and shortages of treatment areas are commonly studied throughput factors that may cause ED crowding [8]. Lower staffing levels or productivity of physicians and triage nurses predisposed patients to wait longer for care [9]. Efficiency of attending physicians in ED has been associated with patients leaving without being seen after long waiting time. The use and/or delays of the ancillary services, including lab, radiology and other procedures, usually prolong the ED length of stay [10].

1. Methods

As a part of an ED performance improvement project at King Faisal Specialist Hospital and Research Center, Saudi Arabia, we worked on identifying variables affecting crowding and performance in order to develop indicators to help the hospital to evaluate and improve performance. Among the suggested performance indicators measuring the efficiency of work and reflecting the throughput process activity is the physicians' productivity. It was important to develop a productivity index. Data on all ED patients' encounters over the last six months of 2014 were retrieved, retrospectively in January 2015, from the hospital data warehouse system. Descriptive health analytics methods were used in categorizing, aggregating and classifying data, where descriptive analytics is typically utilized in converting data into useful information for understanding and analyzing healthcare decisions, outcomes and quality [11].

2. Results

Over 12,600 emergency encounters were conducted during the studies period. Retrieved data were cleaned and validated; 9,665 encounters were included in the analysis. 42 physicians participated in managing these cases; 90% of cases i.e. 8,605 were managed by 26 physicians, which were selected as the target of this study. These top 26 physicians were emergency physicians with a few supportive, but highly productive, physicians from other specialties. Among different variables, three were identified for their influence on productivity and performance; Patient Acuity Level, using the Canadian Triage and Acuity Scale with a score from 1 to 5, where level 1 is the most sever and 5 is the least, Treatment Time (calculated in hours, excluding waiting time and boarding time for admission; waiting for an inpatient bed), and Number of Treated Patients. Productivity is a measure of the efficiency of performance,

or a relationship of outputs to inputs, and should always include time element [12]. The author designed a formula (Figure 1) to calculate productivity index of each emergency physician (Table 1) through dividing the Number of Treated Patients by the Acuity Level squared; since its range and variance are small (using the mean for each physician) and Treatment Time (Using the median to avoid outliers' effect).

$$\text{Productivity Index} = \frac{\text{Number of Emergency Patients Treated}}{(\text{Mean Acuity Level})^2 \times (\text{Median Treatment Time in Hours})}$$

Figure 1. The Suggested Emergency Physician Productivity Index Calculation Formula.

Table 1. Numbers of ED Patients Treated, Patients' Mean Acuity Levels, Patients' Median Treatment Time in Hours and the Calculated Productivity Index for the top 26 ED Physicians with their Status.

S/N	ER Physician Name	Patients Treated in Six Months	Mean Acuity Level	Median Treat Time (Hours)	Productivity Index	Status
1	Physician 1	514	2.9	7.7	7.9	+3.0%
2	Physician 2	473	4.1	1.7	17.0	+120.5%
3	Physician 3	438	2.9	7.2	7.0	-8.9%
4	Physician 4	426	3.0	5.8	8.3	+7.9%
5	Physician 5	418	2.9	4.8	10.1	+31.7%
6	Physician 6	380	4.1	1.1	20.3	+163.5%
7	Physician 7	379	2.9	6.0	7.4	-3.8%
8	Physician 8	376	3.0	6.6	6.2	-19.5%
9	Physician 9	374	3.1	3.6	11.0	+42.4%
10	Physician 10	367	2.9	4.8	8.8	+14.1%
11	Physician 11	363	2.9	5.0	8.5	+9.8%
12	Physician 12	356	3.0	9.7	4.1	-46.4%
13	Physician 13	350	3.0	6.2	6.3	-17.8%
14	Physician 14	348	3.0	4.7	8.1	+5.0%
15	Physician 15	343	3.3	3.9	8.2	+6.7%
16	Physician 16	321	3.0	5.4	6.6	-14.4%
17	Physician 17	280	2.9	4.6	7.1	-7.7%
18	Physician 18	278	2.9	5.9	5.6	-27.8%
19	Physician 19	277	4.1	1.3	12.8	+66.5%
20	Physician 20	275	2.9	5.9	5.4	-29.7%
21	Physician 21	273	4.1	1.9	8.6	+11.9%
22	Physician 22	240	3.0	6.4	4.1	-46.4%
23	Physician 23	227	4.1	1.9	7.2	-6.5%
24	Physician 24	190	4.2	1.2	9.4	+22.1%
25	Physician 25	172	3.1	2.8	6.3	-17.7%
26	Physician 26	167	3.3	3.3	4.6	-40.8%
Average		331	3.2	4.2	7.7	0%

3. Discussion

Productivity in our case means comparing the number of produced units (treated patients as a numerator) to the time needed to treat those patients (Treatment Time as a denominator), taking into consideration that acuity levels are closely related to treatment time i.e. sever conditions take longer time to be treated, this is why the acuity level was added to the denominator and was squared to maximize its effect on the productivity index. The waiting time (from patient arrival to doctor examination) ratio was around 20% of the total ED Length of Stay on average. Table 1 shows the top 26

ED physicians sorted descending by number of treated patients, mean acuity level and median treatment time of patients in hours calculated for each physician. The productivity index is calculated for each physician using the formula in figure 1, and an average productivity index for all the 8,605 patients is calculated for comparison. The last column shows the status of each physician compared to the average productivity index; being above or below this average in a percentage result. 13 physicians were below the average productivity index and 5 of them were significantly, more than 25%, below the average. It is expected logically that physicians with more severe acuity level patients will have longer treatment time for their patients and consequently might have a lower productivity index as a general concept, but this does not explain why some physicians with equal acuity level scores and nearly equal numbers of treated patients have significantly longer treatment time and consequently lower productivity index than their colleagues; compare physician 11 to physician 12. Other physicians might have the same acuity level scores and the same treatment time yet they have completely different productivity index due to huge differences in the number of patients treated; compare physician 2 to physician 23, if both are full time emergency physicians who have the same job type, duties and working hours; the significantly lower performance should be investigated. We should not forget to recognize and reward physicians with high productivity. This suggested productivity index can reflect the efficiency or quantity of treatment in the ED but it cannot reflect the effectiveness or quality of this treatment. It is important to find a way of evaluating quality such as calculating patients' emergency re-visits frequencies for each physician; this indicator is currently out of the scope of this study. Before using this index to evaluate physicians' productivity it should be validated first, through examining individual physician's performance compared to what the index says about their productivity.

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