

## Original Article

# Emergency Department Crowding of a General Hospital in Alexandria, Egypt

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## Abstract

**Background:** Emergency Department (ED) overcrowding has been described as a major public health problem regarding its impact on the outcome of healthcare process.

**Objective(s):** To measure the level of ED crowding using the National Emergency Department Overcrowding Scale (NEDOCS) and ED occupancy.

**Methods:** An Analytical cross-sectional study was conducted in the ED of a 144 bed general hospital in Alexandria, Egypt among 168 sampling instances of ED visits. NEDOCS score (developed by Weiss et al.) was calculated using a web-based calculator and the occupancy rate was calculated as the total number of ED patients divided by the number of licensed ED beds.

**Results:** The mean NEDOCS score ranged from 19 to 200 indicating an overcrowded status in 59.3% of occasions. The ED occupancy ranged from 18.18 % to 272.73 % and exceeded 100 % in 66 % of measurements. The average NEDOCS score, ED occupancy and number of Left without being Seen (LWBS) differed significantly per hour being highest from 10 A.M. till 14 P.M. ( $p=0.000$ ) while only the average NEDOCS score number and LWBS patients differed by weekday ( $p=0.004$  and  $0.005$  respectively). The daily number of LWBS patients showed a moderate positive correlation with NEDOCS score (Spearman's  $\rho = 0.648$ ,  $p = .0000$ ) and the ED occupancy (Spearman's  $\rho = 0.650$ ,  $p < .001$ ).

**Conclusion:** There is a high level of ED overcrowding and ED occupancy which is affected by time of the day and the weekday. Overcrowding is associated with more LWBS patients.

**Keywords:** Emergency department crowding, NEDOCS, LWBS, ED occupancy.

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## INTRODUCTION

The growing role of Emergency Department (ED) for patients seeking health care has always been placed it in the focus of health care research. Policy makers can not overlook the alarming statistics and trends of ED visits, admissions, length of stay, and crowding in order to plan effectively for health services reform. ED overcrowding has been becoming a global concern. Among the many attempts to define ED crowding, it has been defined as the condition where the number of patients waiting to be seen, undergoing assessment and treatment, or waiting for departure exceeds either the physical bed and/or staffing capacity of the ED.<sup>(1)</sup> In other words if care of urgent problems is delayed due to congestion, then overcrowding exists.<sup>(2)</sup>

Overcrowded ED could be brought by multiple factors. The number of ED visits may rise as it is available

after the working hours of primary care centers,<sup>(3-7)</sup> a place to seek medical care without scheduled appointment or if non-insured,<sup>(5, 8)</sup> a facility with rapid diagnostic modalities and early initiation of therapy and patients can expect a higher possibility to be admitted to the hospital by the ED attendant.<sup>(7, 9, 10)</sup> Other factors for crowding are shortage of resources including staff, beds, diagnostic resources and boarding of admitted patients.<sup>(2, 11-13)</sup> ED crowding has negative consequences on the process and outcomes of patient care. ED crowding research showed delay of pain management,<sup>(14)</sup> inadequate mechanical ventilation practice of patients waiting for admission to the medical intensive care unit,<sup>(15)</sup> low compliance to hand hygiene,<sup>(16)</sup> lower compliance to the resuscitation bundle during management of severe sepsis and septic shock,<sup>(17)</sup> longer waiting time for triage and preventable medical errors.<sup>(18, 19)</sup> A recent study showed that ED crowding prolonged decision making time by physicians.<sup>(20)</sup> Mortality rates were shown

to be higher among patients admitted during peaks of crowding which was suggested to be due to either deteriorated treatment processes or longer boarding time.<sup>(21-24)</sup> Higher rates of hospital admission and longer length of stay are other consequences of ED crowding with a subsequent higher health care cost.<sup>(22, 25)</sup> Leaving the ED without being seen, which is a priority concern of healthcare due to the possible adverse health outcomes, has been associated with ED crowding.<sup>(26)</sup> Moreover, the average daily ED occupancy rate has shown a positive correlation with the number of left without being seen (LWBS) patients.<sup>(27)</sup> “Fed up with waiting” was found to be the most common major reason for 44.8% for LWBS among 498 cases in Canada.<sup>(28)</sup>

Several methodologies have been attempted to analyze and measure crowding. Clinician opinion or impression of being rushed, as rated by the ED nurse and the ED physician has been used to assess crowding subjectively. Surrogate quantitative markers of crowding, which use individual variables as their sole measure of crowding, have been used. They include occupancy rate, patients who leave without being seen (LWBS), and ambulance diversion.<sup>(29-32)</sup> Four quantitative crowding scales have been proposed in the emergency medicine literature: the Real-time Emergency Analysis of Demand Indicators (READI), the Emergency Department Work Index (EDWIN), the National Emergency Department Overcrowding Study (NEDOCS) scale, and the Emergency Department Crowding Scale (EDCS).<sup>(29)</sup> Egypt is not far from this problem with all the prementioned burden on the health care system.

The present study aimed to measure ED crowding using NENOCs Score, developed by Weiss et al.,<sup>(31)</sup> and assess the relation of ED crowding measures and patients LWBS and ED crowding in a Ministry of Health general hospital.

## METHODS

The study is an analytical cross-sectional study which was conducted at the ED of an 144- bed Ministry of Health general hospital serving noninsured patients in Alexandria; the second largest town in Egypt. The hospital was selected because it is the largest general hospital in Alexandria and the only Ministry of Health hospital that receives accidents patients. In the year 2017, the average occupancy rate was 69%, the total ED visits were 66497. The hospital was responsible for receiving accidents on Saturdays, Mondays, Wednesdays and two Fridays per month determined by a monthly schedule as well as receiving patients requiring dialysis on Tuesdays. The working hours of the outpatient clinics are from 8 am till 2 pm. The ED team consists of one emergency resident and three nurses in the morning shift, two emergency residents and two nurses in the evening and night shifts.

Data was collected by trained nurses over a 14-day period starting from the first of March, 2018 at 2 hours intervals. In total, 168 sessions were observed. Observation

using a data collection sheet was used to record data for calculating NEDOCS scale (developed by Weiss et al.), total patients in the ED (including waiting area, hallways, etc.), number of ED patients on ventilators, number of ED inpatient admissions, and waiting time of longest waiting ED patient (Times from registration / triage until patient was called from the waiting room to be seen by the physician), waiting time of longest admitted patient (The longest time that an admitted patient was being held in the ED).<sup>(29)</sup> In addition, the following data was collected; day of the week, hour of the day, and number of LWBS patients in the previous 2 hours.

Data was entered into the web-based calculator created by Weiss et al to calculate NEDOCS score 33 that range between 1 and 200 categorized as follow; 0–20 not busy; 21–60 busy; 61–100 very busy; 101–140 overcrowded ;141–180 dangerous; >181 disaster. The following formula is used calculate NEDOCS.  $NEDOCS = 85.8(C/A) + 600(F/B) + 13.4(D) + 0.93(E) + 5.64(G) - 20$ .<sup>(31,33)</sup> (where A = number of beds, B = Number of inpatient beds, C = Number of ED beds, D = Number of Critical Care Patients (in the ED), E = Longest ED Admit (in hours), G = Last Door-to-bed Time (in hours))

The occupancy rate was defined as the total number of patients in the ED during 2 hour period divided by the number of licensed ED beds.

### Statistical Analysis

Raw data was coded and entered using the SPSS (Statistical Package for Social Sciences) version 21. Mean values and SDs were calculated for twelve 2-hour periods for LWBS, NEDOCS and ED occupancy. Normality of data was tested using Shapiro-Wilk test. Data did not follow the normal distribution. Accordingly, non-parametric tests were used for comparison of means (Kruskal Wallis Test). Spearman correlation coefficients were used to test association mean scores of NEDOCS and ED occupancy with LWBS. The 0.05 level was used as the cut off value for statistical significance.

### Ethical Considerations

The researchers sought the approval of the Ethics Committee of the Faculty of Medicine, Alexandria University for conduction of the study. The researchers complied with the International Guidelines for Research Ethics. Anonymity and confidentiality of data were assured and maintained.

## RESULTS

For the 168 sampling sessions, the distribution of NEDOCS score and ED occupancy revealed that in 59% of cases the NEDOCS score exceeded 100 (very busy) and in about two thirds of the observations (66.0%) the ED occupancy exceeded 100 %. (Table 1). The median number of LWBS patients was 2 and ranged from 0 to 5.

Table 2 shows the distribution of NEDOCS score, ED occupancy and LWBS. It revealed that the highest median score of crowding was recorded at 10, 12 and 14 hours

(166.0, 153.0 and 174.0 respectively) while the lowest score was at 6 A.M. (54.0). The highest ED median occupancy was at hour 10, 12 and 14 (181.8%, 181.8% and 209.0%, respectively) and the lowest ED occupancy was at hour 4 (54.5%). The highest means for LWBS patients were at 12 and 14 am (3 for both) while the lowest mean number of LWBS patients was at 4 and 6 (zero for both). The statistical difference between the NEDOCS scores, ED occupancy and LWBS by hour of the day was significant. ( $p=0.000$ ). Table 3 shows the mean NEDOCS score, ED occupancy and LWB patients according to

hours of the day. It revealed that the highest values of measures of ED crowding were recorded on Saturdays, Mondays and Wednesday and that was the case for the mean number of patients LWBS too. The NEDOCS score and number of LWBS patients differed significantly by day ( $p=0.004$  and  $0.005$  respectively) but not for ED occupancy ( $p=0.076$ ).

The number of patients who LWBS showed a moderate positive correlation with both the NEDOCS score (Spearman's  $\rho = 0.648$ ,  $p < .001$ ), and the ED occupancy (Spearman's  $\rho = 0.650$ ,  $p < .001$ ), (Table 4).

**Table 1: Distribution of NEDOCS score, ED occupancy and LWBS over the study period**

Crowding measure	Frequency (n=168)	
		No. (%)
<b>NEDOCS Score</b>		
Not busy		3 (4.4)
Busy		24 (14.2)
Very busy		41 (24.4)
Overcrowded		34 (20.2)
Dangerous		44 (26.1)
Disastrous		22 (13.0)
Mean	118.96 ± 51.85	
Median	122.0000	
Min - Max	19-200	
<b>ED occupancy</b>		
<100.0%		57 (33.9)
>100.0%		111 (66.0)
Mean	138.47 ± 60.10	
Median	136.36	
Min - Max	18.18-272.73	
<b>LWBS</b>		
0		35 (20.8)
1		37 (22.0)
2		44 (26.2)
3		31 (18.5)
4		18 (10.7)
5		3 (1.8)
Mean	1.815	
Median	1.34	
Min - Max	0-5	

\*NEDOCS categories (0-20 not busy; 21-60 busy; 61-100 very busy; 101-140 overcrowded; 141-180 dangerous; >181 disaster)

**Table 2: Mean NEDOCS score, ED occupancy and LWB patients according to hours of the day at study hospital**

Hour of the day	NEDOCS		ED Occupancy		LWBS	
	Median	Min / Max.	Median	Min / Max.	Median	Min / Max.
2 A.M. -	110.5	72 .0- 200.0	113.6	90.9 – 227.2	2	0-4
4 A.M.-	61.0	20.0-172.0	54.5	18.1 – 190.9	0.0	0-4
6 A.M. -	54.0	19.0 – 170.0	59.1	27.2 – 172.7	0.0	0-3
8 A. M. -	92.5	51.0-160.0	100.0	81.8 – 181.8	1.0	0-3
10 A.M. –	166.0	92.0-200.0	181.8	127.2 – 245.4	2.0	0-5
12 P.M. –	153.0	113.0-200.0	181.8	145.4 – 227.2	3.0	1-4
14 P.M. –	174.0	145.0 – 200.0	209.0	190.1 – 236.3	3.0	0-5
16 P.M. –	101.0	60.0 – 200.0	109.1	81.8 – 272.7	1.0	0-5
18 P.M. -	59.0	28.0 – 110.0	68.2	54.5 – 109.0	1.0	0-2
20 P.M. –	133.5	91.0-200.0	172.7	127.2 – 167.5	2.0	0-4
22 P.M. -	143.5	91.0-200.0	181.8	109.0 – 245.4	2.5	0-4
24 P.M. – 2 A.M.	139.5	86.0 – 91.0	177.3	118.1 – 209.0	2.0	0-4
p value	0.000		0.000		0.000	

\* p value for Kruskal Wallis Test of significance

**Table 3: Overcrowding measures and left without being seen (LWBS) according to arrival day**

Day of the week	NEDOCS score		ED Occupancy		LWBS	
	Median	Range	Median	Range	Median	Range
Sunday	135.5	27.0 – 178.0	163.6	45.4 – 209.0	2.0	0-4
Monday	94.5	41.0 – 200.0	118.2	18.1 – 245.4	1.0	0-4
Tuesday	153.0	20.0 – 176.0	168.2	45.4 – 200.0	2.0	0-4
Wednesday	98.5	61.0-200.0	113.6	72.7 – 245.4	1.0	0-4
Thursday	143.0	20.0 – 189.0	172.7	45.4 – 218.1	2.5	0-4
Friday	91.5	19.0 – 200.0	118.2	27.2 – 227.2	1.0	0-5
Saturday	134.5	53.0 – 200.0	154.5	36.3 – 272.7	2.0	0-5
<i>p</i> value*		0.004		0.076		0.005

\* *p* value for Kruskal Wallis test of significance

**Table 4: Spearman correlation coefficient between NEDOCS scores, ED occupancy and LWBS in the MOH general hospital (Alexandria, 2018)**

LWBS	NEDOCS score	ED occupancy
	0.648	0.650
0.000*	0.000*	

\* *p* value for correlation coefficient test of significance

## DISCUSSION

The findings of the present study revealed an overcrowding status of our ED according to the NEDOCS score. The median score was 122 and 100 of the 168 samplings (59.3%) had NEDOCS scores >100 (overcrowded, dangerous and disastrous). Furthermore, the ED was in a dangerous or disaster crowding state in 39.1% of the samplings. NEDOCS scores were consistent with ED occupancy, where the median occupancy was 136.4%. These measurements are worthy an immediate action. Despite its importance, studies evaluating level of crowding and its association with patient outcomes are few in Egypt. A study was conducted in a 150 private tertiary hospital located in Cairo, where the computed NEDOCS score during the day shift (from 8:00 AM to 5:00 PM), had an average value of 105.<sup>(34)</sup>

There are no published studies describing crowding level in the ED of MOH hospitals according to our knowledge. The crowding in the present study ED may be attributed to multiple reasons. An input factor is the lack of accessibility to outpatient clinic after 2 P.M. This may explain the significant variation in NEDOCS score and ED occupancy by hour of the day. This could be illustrated more if we studied the triage categories during measurements to identify the degree of urgency of these visits. Limited working hours of outpatient clinics contributed to the high volume of non-urgent cases to the ED in Jeddah, Saudi Arabia where patients visiting ED for primary care treatable conditions reported limited working hours at Primary Health Care Centers (PHCCs) as one of the causes of their behavior.<sup>(35)</sup> Another cause of ED crowding in the present study is large population served due to the hospital location in the center of Alexandria in

comparison to other Public and University hospitals. Also, the hospital serves patients who are uncovered by insurance which increase the demand for ED services. ED occupancy which approached 200% in some moments demonstrates the demand capacity mismatch in the ED. Increasing the ED capacity, beds and manpower, is necessary to reduce ED crowding.

Public hospitals are limited compared to patient load. In 2015, statistics showed that there are on average 1.57 beds and 5.75 physicians in public hospitals for every 1000 population. This ratio is low when compared with other countries as France, Australia, Belgium, Italy and New Zealand (6.0, 3.8, 5.6, 3.2 and 2.6 beds per 1000 population, respectively). The low capacity of hospital beds relative to the population adds to the problem.<sup>(37)</sup>

Crowding measures varied significantly by day of the week where the highest NEDOCS median scores were on Saturday, Monday and Wednesday (135.5, 153.0.6 and 143.0, respectively). The increased crowding rates in those specific days coincide with receiving accidents and burn patients on Saturdays, Mondays, Wednesdays according to a monthly schedule for Alexandria hospitals. Accordingly, creating a dynamic staff schedule depending on the variability of demand by day and by week may improve the throughput of the ED. Analytic and simulation models have been used to guide decision makers to optimal staffing pattern in the ED. This may be enhanced by an information system that can accurately capture data such as patient arrival pattern, patient delay and time spent with each patient.<sup>(38)</sup>

The proportion of patients who leave without being seen in the emergency department is an outcome measure of impaired access to emergency care and represents failure of an emergency care delivery system to meet its

goals of providing care to those most in need. The results of the present study revealed moderate positive correlation between the crowding measures and LWBS patients' numbers. The present study findings are similar to several studies that found a link between crowding measures and LWBS.<sup>(27, 32)</sup> It is of utmost importance to address the LWBS rates given the risks associated with leaving the ED prior to treatment. For example, at a certain occupancy rate threshold, contingency plans to call additional staff to use areas outside of the ED such as observation units or using full capacity protocol where patients are allocated to inpatient beds in alternate units on a temporary basis. Implementation of a rapid triage and treatment protocol with initiation of treatment at triage, was shown to reduce the number of patients who LWBS.<sup>(39)</sup> More frequent communication to patients of their expected wait times and the provision of more rapid temporary treatment of their symptoms might also reduce LWBS rate.<sup>(40)</sup>

This study was performed at a single setting affiliated to the Ministry of Health. Thus, the results are not generalizable to the ED of other settings as Health Insurance Organization, private hospitals and University hospitals. In addition, during summer season the number of patients received by hospitals in Alexandria are expected to be much higher due to the nature of the city as a coastal touristic city. This research needs to be repeated during summer months to detect the crowding conditions during summer.

### CONCLUSION AND RECOMMENDATIONS

There is a high level of ED overcrowding occupancy in the study hospital. The level of crowding is affected by the time of the day and the day of the week. Overcrowding has adverse consequences on patient care and leads to increase in number of patients LWBS. Thus, it is recommended to follow a dynamic staffing patterns to establish a match between capacity and demand. In addition, the effective coordination between hospitals and ambulance diversion can play an effective role to decrease the numbers of LWBS patients. Policy makers and hospital managers must focus on measures to reduce non-urgent presentations to the ED.

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### CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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