

Evaluation of Overcrowding of Emergency Department in Imam Reza Hospital in 2015 by Implementing 2 Scales: NEDOCS and EDWIN

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Abstract

Background: The reason behind patients' overcrowding in emergency departments (ED) may be due to several factors such as great number of referring patients or inaccessibility of facilities or hospital beds.

Objectives: The present study aimed at evaluating the overcrowding of ED in Tabriz Imam Reza hospital in 2015 using 2 scales: National Emergency Overcrowding Scale (NEDOCS), and Emergency Department Work Index (EDWIN).

Methods: This was a cross-sectional descriptive study conducted in the ED of Imam Reza hospital affiliated to Tabriz University of Medical Sciences, Iran, in a one-year period (Jan- Dec 2015). Convenience sampling method was used for data collection. During the study, the researchers randomly selected 10 days out of every month and started to collect index variables 4 times a day at 6 AM, 12 noon, 6 PM, and 12 midnight. In total, 488 samples were gathered and both NEDOCS and EDWIN were implemented for each sample. Then, the frequency of overcrowding in the emergency department was reported based on the obtained results.

Results: Based on NEDOCS, ED was extremely busy, but not overcrowded in 51 cases (10.5%), it was overcrowded in 298 (61.1%) cases, severely overcrowded in 138 cases (28.3%), and it was busy only in one case (0.2%). However, based on the EDWIN scale, the ED was active but manageable in 91 cases (18.6%), very busy in 36 cases (7.4%), and extremely busy in the remaining 361 cases (74%).

Conclusions: EDWIN scale depicted August, July, December, June, and April to be, respectively, the most overcrowded months. This finding revealed EDWIN scale to perform better when trying to have an overall assessment of ED during the whole year, which helps us have clear-cut results for analysis and policy making in managing EDs.

Keywords: Emergency Department, Crowding, EDWIN Scale, NEDOCS Scale

1. Background

Patients' contentment can reflect the quality of services inside emergency departments (ED) (1, 2). More often, EDs are called a micro-universe of a hospital (3). This fact makes ED to be the only unit that faces overcrowdings and patients' congestion, revealing the proximity of hospital internal policies with national health policies (3, 4). Overcrowding can be either due to afterload inaccessibility of facilities and beds in which admitted patients cannot be hospitalized, or to preload inaccessibility of the patients to clinical care, forcing them to seek care inside emergency units (5). An overcrowded emergency department is usually accompanied by negative errors and results in its caring system (6).

There were different indexes to evaluate overcrowding in EDs. One of them was the national emergency department overcrowding scale (NEDOCS). Seven factors were used to measure the index, which are as follow: number of

ED and hospital beds, total patients in ED, number of respirators in ED, longest admit delay in first visit per hour, longest admit time, and total admits in ED. Another index was emergency department work index (EDWIN) that assumed the number of patients in each triage as its base and disregarded the number or activities of training nurses or care providers (6, 7).

Overcrowdings inside emergency departments cause more mortality, patients' injuries and unvisited patients, which are all the obvious signs of danger to the health system (8).

2. Objectives

Because no exact statistical data existed on overcrowded years or days of ED in our emergency department, we aimed at evaluating overcrowding of our ED using EDWIN and NEDOCS scales.

3. Methods

This was a cross-sectional descriptive study conducted in the ED of Imam Reza hospital affiliated to Tabriz University of Medical Sciences, Iran, in a one-year period (Jan-Dec 2015). Convenience sampling method was used for data collection. During the study, the researchers randomly selected 10 days out of every month and started to collect index variables 4 times a day at 6 AM, 12 noon, 6 PM, and 12 midnight. In total, 488 samples were collected and both NEDOCS and EDWIN were implemented for each sample. Inclusion criteria were medical records of all patients in the sampling time; and exclusion criteria were occurrence of unexpected events such as earthquake, flood, etc. This study was approved by the ethics committee of Tabriz University of Medical Sciences and registered under the code number 6101 on 01 Sep 2015.

The researchers collected patients' data from existing medical records in ED; then, they randomly selected 10 days out of every month of the year and systematically recruited samples in four different times every day at 6 AM, 12 noon, 6 pm, and 12 midnight. Randomizing of the months was done by software that selected 10 days out of a month, 12 months of a year. In summary, the ED of Imam Reza hospital was studied up to 488 times. At any time, all medical records of patients in the ED were evaluated.

NEDOCS Obtained data included number of Ed and hospital beds, number of patients in ED, longest admit delay at first visit, and number of respirators in ED. For each category, the scoring structure designed was as follows: 0 - 20 not busy, 21 - 60 busy, 61 - 100 extremely busy but not overcrowded, 101 - 140 overcrowded, 141 - 180 severely overcrowded, and 181 - 200 dangerously overcrowded. EDWIN scale obtained data included: the number of patients in ED for each ESI triage level, ESI reversed classification system (Level 1 for healthiest and level 5 for the most unwell patient), active doctors in ED, registered beds in ED, and total patients in ED. Scoring system was as follows: 0 - 1.5 active but manageable, 1.5 - 2 busy but not overcrowded, and 2 < (severely overcrowded).

3.1. Statistical Analysis

Data were analyzed by SPSS 17.0. To explain data, we used descriptive statistical methods such as frequency, percentage, mean \pm and standard deviation. To ensure normality of data distribution, Kolmogorov-Smirnov test was applied. To compare qualitative data, Chi square test, and for quantitative data independent sample t test were applied. To compare index results in different hours, we utilized Tukey test. P value less than 0.05 was considered meaningful.

4. Results

In this research, ED of Tabriz Imam Reza hospital was studied in 488 times. Of this number, 84 (17.2%) occurred in holidays and 404 (82.8%) in working days. According to NEDOCS, ED was extremely busy at least in 51 (10.5%) times of the year; it was also extremely busy but not overcrowded in 298 (61%) times, overcrowded in 138 (28.3%) times, and busy in one (0.2%) time.

According to EDWIN, ED was active but manageable in 91 (18.6%) times, very busy but not over crowded in 36 times (7.4%), and it was extremely busy in the remaining 361 times (74%). Mean \pm SD for NEDOCS during a year (4 seasons) in holidays was 130.36 ± 20.41 , and it was 126.43 ± 20.66 in working days. Therefore, no meaningful difference existed between holidays and working days in NEDOCS scores ($P = 0.113$). The first quarter of EDWIN score for holidays and working days was 1.86 and 1.89, respectively. Moreover, the median score was 2.72 and 3.21 for holidays and working days, respectively. Finally, the third quarter of EDWIN score for holydays and working days was 3.76 and 4.59, respectively, and the last one did not show any meaningful difference ($P = 0.109$).

Tukey test results revealed NEDOCS score to be meaningfully different at 6 AM from those of 12 noon, 6 PM and 12 midnight ($P < 0.001$ for each), suggesting a reduction in the level of overcrowding at 6 AM. On the other hand, the highest level of overcrowding was recorded at 12 midnight, which was meaningfully different only from 6 AM ($P < 0.001$) and it was similar to 12 noon and 6 PM ($P = 0.855$ and $P = 0.0112$). According to NEDOCS scale, the time points of 12 midnight, 12 noon, 6 PM, and 6 AM were the most overcrowded and the most reclusive hours of the day, respectively. However, in EDWIN, it was 12 midnight, 12 noon, 6PM, and 6 AM, respectively. Being equally overcrowded, there were no meaningful differences between seasons in NEDOCS ($P = 0.724$). However, with respect to EDWIN, spring and summer were the most overcrowded seasons ($P < 0.001$).

NEDOCS showed meaningful differences between months ($P < 0.001$). Although all months were overcrowded based on NEDOCS classification, April, August, December, and February were the most overcrowded months, respectively. On the other side, EDWIN scale illustrated a meaningful difference between months ($P < 0.001$) and revealed that August, July, June, and April were overcrowded months of the year, respectively. Based on EDWIN classification, all months were extremely busy and severely overcrowded.

Table 1 compares NEDOCS and EDWIN in different hours. If scores more than 140 in NEDOCS and more than 2 in EDWIN were to be the scores of overcrowding, then it

can be concluded that in both scales we had overcrowding almost in 71.1% of the studied times.

5. Discussion

Long waiting time to receive medical and clinical services is a common problem in ED of hospitals worldwide. Waiting means a time that patients spend in ED (9). Protraction of staying time in hospital and ED occupies the beds, consumes medical staffs' time and has a negative impact on the process of new admissions, and makes the departments chaotic (10). Based on gained results from the present study, about 17.2% of studied times were in holidays and we did not observe a meaningful difference between holidays, working days, level of crowdedness and activities.

Weiss et al. in their study, concluded that both scales acquire a high level of accuracy in prediction of crowdedness level in ED and that both scales can be implemented in ED (7). In all countries, health services are delivered by the existing health systems (11) that are comprehensive and complicated in nature. EDs are the initial points of hospital to where patients refer and they usually suffer from different problems and complications (12). In fact, the final goal of an ED is to provide high quality services in a short time (13-15). Bernstein et al. study on EDWIN scale concluded that the scale could appropriately predict overcrowding in EDs (6).

Anneveled et al. showed that NEDOCS scale could accurately predict overcrowdings in ED (16). McCarthy et al. evaluated both scales' accuracy to be average and resulted that ED occupancy rate was not ideal, but its simplicity makes it feasible every time anywhere (17). Crane et al. found that both EDWIN and NEDOCS scales were not adequately efficient in predicting overcrowdings in ED (18). One study by Jones et al. suggested that despite the efficiency of both scales there were no meaningful differences between the scales (19).

In the present investigation, EDWIN presented that August, July, December, June, and April, respectively, were the most overcrowded months, which could be identified with the summer, hot weather, and travel season. However, according to NEDOCS scale, April, August, December and February were, respectively, the most overcrowded months in which most part of traveling times were excluded from the scale. This study confirmed that 12 midnight was the most overcrowded time and 6 AM the most reclusive part of the day, indicating that patients' referral reduces in initial hours in the mornings, and patients dismiss late in the ending hours of the day. However, no meaningful difference was found between midday and evening

hours, which suggested equal overcrowding of ED in those parts of the day.

Both scales reported ED to be extremely overcrowded in 71.1% of the studied time, while only in 7.6% of times it was busy but manageable. Thus, the difference was not meaningful. According to the results, both scales reported the same busy and silent hours for ED. Nevertheless, when evaluating the most crowded months, EDWIN showed more compatibility with our national calendar in traveling seasons.

One limitation in this study was the evaluation of ED in only 10 days per month. Moreover, in the present research, we did not evaluate the facility of using scales, which should be studied in further researches.

Based on our study results, facility, and familiarity of the scales, both scales can be suggested to medical and emergency staffs. Regarding the compatibility of EDWIN with our national traveling seasons, it seems that by using this specific scale, we can gain better results when analyzing situations and making policies to manage ED appropriately.

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Footnotes

Authors' Contribution: All authors have read and approved the manuscript. Farzad Rahmani, Hassan Soleimanpour, Alireza Ala and Farzin Rezazadeh conducted data collection, literature review, and drafting of the manuscript. Maryam Soleimanpour and Robab Mehdizadeh Esfanjani undertook the major parts of the study design and performed the statistical analysis.

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Table 1. Comparison of EDWIN and NEDOCS in the Different Hours

		6 AM	12 PM	18 PM	12 AM	P Value
NEDOCS		116.22 ± 20.94 (Overcrowded)	131.24 ± 19.12 (Overcrowded)	127.59 ± 19.52 (Overcrowded)	133.24 ± 18.90 (Overcrowded)	< 0.001
	First quantile	1.09 (Active but manageable)	1.83 (Very busy)	2.31 (severely overcrowded)	3.31 (severely overcrowded)	
EDWIN	Median	1.58 (Very busy)	2.68 (severely overcrowded)	3.10 (severely overcrowded)	4.00 (severely overcrowded)	< 0.001
	Third quantile	3.17 (severely overcrowded)	4.18 (severely overcrowded)	4.29 (severely overcrowded)	5.41 (severely overcrowded)	

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References

- Soleimanpour H, Gholipouri C, Salarilak S, Raoufi P, Vahidi RG, Rouhi AJ, et al. Emergency department patient satisfaction survey in Imam Reza Hospital, Tabriz, Iran. *Int J Emerg Med.* 2011;**4**:2. doi: [10.1186/1865-1380-1-2](https://doi.org/10.1186/1865-1380-1-2). [PubMed: [21407998](https://pubmed.ncbi.nlm.nih.gov/21407998/)].
- Eshghi M, Rahmani F, Derakhti B, Robai N, Abdollahi F, Tajoddini S. Patient satisfaction in the emergency department: a case of Sina hospital in Tabriz. *J Emerg Practice Trauma.* 2015;**2**(1):16-20. doi: [10.15171/jept.2015.06](https://doi.org/10.15171/jept.2015.06).
- Khorasani ZM, Ebrahimi HA. Evaluation of patients' reasons for discharge against medical advice in shafa hospital, kerman, iran. *Health Inf Manag.* 2013;**10**(3):1-8.
- Feizi A, Mohammadi R, Nikravesh M. Patients' views about the factors affecting the patient's confidence to nurse. *Razi J Med Sci.* 2006;**13**(52):177-96.
- Jalil M, Fathi M, Eslami B. Emergency department management principles: Translation the selected chapters of Emergency Management Principles and Applications. Iran: Abnus; 2008.
- Bernstein SL, Verghese V, Leung W, Lunney AT, Perez I. Development and validation of a new index to measure emergency department crowding. *Acad Emerg Med.* 2003;**10**(9):938-42. [PubMed: [12957975](https://pubmed.ncbi.nlm.nih.gov/12957975/)].
- Weiss SJ, Ernst AA, Nick TG. Comparison of the National Emergency Department Overcrowding Scale and the Emergency Department Work Index for quantifying emergency department crowding. *Acad Emerg Med.* 2006;**13**(5):513-8. doi: [10.1197/j.aem.2005.12.009](https://doi.org/10.1197/j.aem.2005.12.009). [PubMed: [16551777](https://pubmed.ncbi.nlm.nih.gov/16551777/)].
- Kulstad EB, Hart KM, Waghchoure S. Occupancy rates and emergency department work index scores correlate with leaving without being seen. *West J Emerg Med.* 2010;**11**(4):324-8. [PubMed: [21079702](https://pubmed.ncbi.nlm.nih.gov/21079702/)].
- Guttmann A, Schull MJ, Vermeulen MJ, Stukel TA. Association between waiting times and short term mortality and hospital admission after departure from emergency department: population based cohort study from Ontario, Canada. *BMJ.* 2011;**342**:d2983. doi: [10.1136/bmj.d2983](https://doi.org/10.1136/bmj.d2983). [PubMed: [21632665](https://pubmed.ncbi.nlm.nih.gov/21632665/)].
- Wiler JL, Griffey RT, Olsen T. Review of modeling approaches for emergency department patient flow and crowding research. *Acad Emerg Med.* 2011;**18**(12):1371-9. doi: [10.1111/j.1553-2712.2011.01135.x](https://doi.org/10.1111/j.1553-2712.2011.01135.x). [PubMed: [22168201](https://pubmed.ncbi.nlm.nih.gov/22168201/)].
- Horwitz LI, Green J, Bradley EH. US emergency department performance on wait time and length of visit. *Ann Emerg Med.* 2010;**55**(2):133-41. doi: [10.1016/j.annemergmed.2009.07.023](https://doi.org/10.1016/j.annemergmed.2009.07.023). [PubMed: [19796844](https://pubmed.ncbi.nlm.nih.gov/19796844/)].
- Henneman PL, Nathanson BH, Li H, Smithline HA, Blank FS, Santoro JP, et al. Emergency department patients who stay more than 6 hours contribute to crowding. *J Emerg Med.* 2010;**39**(1):105-12. doi: [10.1016/j.jemermed.2008.08.018](https://doi.org/10.1016/j.jemermed.2008.08.018). [PubMed: [19157757](https://pubmed.ncbi.nlm.nih.gov/19157757/)].
- Horwitz LI, Bradley EH. Percentage of US emergency department patients seen within the recommended triage time: 1997 to 2006. *Arch Intern Med.* 2009;**169**(20):1857-65. doi: [10.1001/archinternmed.2009.336](https://doi.org/10.1001/archinternmed.2009.336). [PubMed: [19901137](https://pubmed.ncbi.nlm.nih.gov/19901137/)].
- Pines JM, Hollander JE. Emergency department crowding is associated with poor care for patients with severe pain. *Ann Emerg Med.* 2008;**51**(1):1-5. doi: [10.1016/j.annemergmed.2007.07.008](https://doi.org/10.1016/j.annemergmed.2007.07.008). [PubMed: [17913299](https://pubmed.ncbi.nlm.nih.gov/17913299/)].
- Golaghaie F, Sarmadian H, Rafie M, Nejat N. A study on waiting time and length of stay of attendants to emergency department of Vali-e-Asr Hospital, Arak-Iran. *Arak Med Univ J.* 2008;**11**(2):74-83.
- Anneveld M, van der Linden C, Grootendorst D, Galli-Leslie M. Measuring emergency department crowding in an inner city hospital in The Netherlands. *Int J Emerg Med.* 2013;**6**(1):21. doi: [10.1186/1865-1380-6-21](https://doi.org/10.1186/1865-1380-6-21).
- McCarthy ML, Aronsky D, Jones ID, Miner JR, Band RA, Baren JM, et al. The emergency department occupancy rate: a simple measure of emergency department crowding?. *Ann Emerg Med.* 2008;**51**(1):15-24. doi: [10.1016/j.annemergmed.2007.09.003](https://doi.org/10.1016/j.annemergmed.2007.09.003). [PubMed: [17980458](https://pubmed.ncbi.nlm.nih.gov/17980458/)] 24 e1-2.
- Crane PW, Zhou Y, Sun Y, Lin L, Schneider SM. Entropy: a conceptual approach to measuring situation-level workload within emergency care and its relationship to emergency department crowding. *J Emerg Med.* 2014;**46**(4):551-9. doi: [10.1016/j.jemermed.2013.08.113](https://doi.org/10.1016/j.jemermed.2013.08.113). [PubMed: [24411657](https://pubmed.ncbi.nlm.nih.gov/24411657/)].
- Jones SS, Allen TL, Flottemesch TJ, Welch SJ. An independent evaluation of four quantitative emergency department crowding scales. *Acad Emerg Med.* 2006;**13**(11):1204-11. doi: [10.1197/j.aem.2006.05.021](https://doi.org/10.1197/j.aem.2006.05.021). [PubMed: [16902050](https://pubmed.ncbi.nlm.nih.gov/16902050/)].