

An Overcrowding Measurement Study in the Adult Emergency Department of Gazi University Hospital, Using the "National Emergency Departments Overcrowding Study" (Nedocs) Scale

Gazi Üniversitesi Hastanesi Erişkin Acil Servisinde "Ulusal Acil Servisler Kalabalık Çalışması (Nedocs)" Skalasını Kullanarak Kalabalık Ölçüm Çalışması

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Abstract

Objective: To determine the causes of overcrowding in the Adult Emergency Department (ED) of Gazi University Hospital and assess the validation of the "National Emergency Departments Overcrowding System" (NEDOCS) scale among international EDs and EDs of various sizes.

Materials and Methods: Administrative data collected prospectively in the adult ED of a university-affiliated hospital in Ankara between March 31st and April 7th, 2008. A total of 918 patients who were 18 years and older and who had presented to the ED were included in the study. The factors causing overcrowding in the ED and the correlation between the NEDOCS scale and ED staff's perception for overcrowding were determined.

Results: The most important cause of overcrowding was determined to be the inability to transfer patients to inpatient beds in a timely manner. No significant difference was found for the perception of overcrowding among the ED staff. The coefficient of determination was quite low for the regression model, in which the NEDOCS scale was the independent variable and scores of the ED staff regarding the perception of overcrowding were dependent variables ($R^2=0.064$). When the threshold value for the ED overcrowding was determined as 199, the sensitivity of the NEDOCS scale was measured at 92%; however, specificity was found to be quite low (32%). The area under the ROC curve was 0.617 and it was not statistically significant.

Conclusion: In order to explain the perception of overcrowding for the Adult ED staff at Gazi University Hospital, more variables were needed in addition to the NEDOCS components. (*JAEM 2011; 10: 60-4*)

Key words: Emergency department, overcrowding, NEDOCS

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Özet

Amaç: Gazi Üniversitesi Hastanesi Erişkin Acil Servisinde yaşanan kalabalık nedenlerinin ortaya konması ve "National Emergency Departments Overcrowding System" (NEDOCS) skalasının uluslar arası ve değişik büyüklüklerde acil servislerde kullanım geçerliliğinin değerlendirilmesidir.

Gereç ve Yöntemler: 31 Mart ve 7 Nisan 2008 arasında Ankara'da bir fakülte hastanesi erişkin acil servisinde prospektif olarak toplanan veri incelendi. Çalışma süreci içerisinde acil servise başvuran 18 yaş ve üstü 918 hasta çalışmaya dâhil edildi. Acil serviste kalabalığa neden olan faktörler ve NEDOCS skalası ile acil servis çalışanlarının kalabalık algısı arasındaki ilişki tespit edildi.

Bulgular: Kalabalığa neden olan en önemli faktörün, yatış verilen hastaların hastane yataklarına transfer edilememesi olduğu görüldü. Acil servis çalışanlarının kalabalık algıları arasında istatistiksel olarak anlamlı bir fark yoktu. NEDOCS skorunun bağımsız değişken, acil servis çalışanlarının kalabalık algısıyla ilgili verdikleri skorların bağımlı değişken olduğu regresyon modelinde belirtme katsayısı oldukça düşüktü ($R^2=0.064$). Acil servis kalabalığı için eşik değeri 199 kabul edilirse, NEDOCS skalasının duyarlılığı %92 olmakta ancak seçicilik oldukça düşük çıkmaktadır (%32). ROC eğrisi altında kalan alan 0.617 olup; anlamlı bulunmadı.

Sonuç: Gazi Üniversitesi Hastanesi Erişkin Acil Servisi çalışanlarının kalabalık algısını açıklamak için NEDOCS bileşenlerine ek olarak başka değişkenlere ihtiyaç olduğu anlaşılmaktadır. (*JAEM 2011; 10: 60-4*)

Anahtar kelimeler: Acil servis, kalabalık, NEDOCS.

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Introduction

In 2002, the "American College of Emergency Physicians" (ACEP) defined Emergency Department (ED) overcrowding as a state where the needs of EDs exceed available resources of EDs (1). In other

words, overcrowding refers to the function of the number of patients, patients' acuity, physical space, and the number of staff in charge (2). Today, the most cited cause of ED overcrowding in academic centers is the inability to transfer ED patients to inpatient beds (1). It has been claimed that this particular patient group not only takes a great

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amount of time of ED nurses and physicians, but also uses enormous medical resources in the ED, preventing new patients from being seen and treated (1, 2). The patient group that waits for inpatient beds in EDs, is also suggested to be the most important reason for ambulance diversion in EDs (1).

It has been claimed that real-time assessment of the overcrowding measurements would provide a better understanding of the progress by allowing continual monitoring and evaluation of EDs (2). It is stated that the results of these assessments could be used to develop short and long-term strategies (3).

Importance

Asplin et al. stated that they provided a solid framework by introducing their "input-through-output conceptual model of ED overcrowding" (1, 2). Four quantitative overcrowding scoring systems in the emergency medicine literature include the components of this model as well. The common purpose of all scales is to serve as a simple, quantitative, repetitive and reliable way of measurement of ED overcrowding that can be used in real-time and integrated with clinical information systems. The general applicability of these scales is not very obvious. No single study has been approved prospectively. Since all types of measurement have dynamic structures, their values can vary at any time (2, 3-9). In an independent study conducted by Spencer et al., it was emphasized that in EDs, where overcrowding mostly occurs, a calibration that is particular to that institution should be performed for all scoring systems. Of the assessment scales, the Emergency Department Work Index (EDWIN) and the National Emergency Department Overcrowding Study (NEDOCS) together with a sub-scale scoring system of the Real-Time Emergency Analysis of Demand Indicators (READI) which is presented as "bed ratio" were reported to provide a strong prediction for perceived ED overcrowding. However, again in the same study, it was stated that in EDs where overcrowding does not represent a problem, scoring systems lack scalability and they do not operate as they were designed to perform (4).

It was claimed that the scoring system that was introduced by NEDOCS scale showed a high correlation with the clinicians' perception of overcrowding. It was also declared to be valid and accurate for predicting the degree of overcrowding of EDs in academic centers. In this way, it was estimated that overcrowded days in EDs might be distinguished from the other days. Given this kind of measurement, it was claimed that ED administrators would be able to provide a single figure that shows the degree of ED overcrowding to hospital administration and also enable them to compare with other EDs (2, 8).

Goal of this study

In our study, we aimed to determine the state of overcrowding in the Adult Emergency Department of Gazi University Hospital by using the NEDOCS scale and assessing the ongoing validity of this scoring system among international emergency departments and emergency departments of various sizes.

Material and Method

Study Design:

A single-center prospective cohort study was conducted between March 31st and April 7th, 2008.

Settings

This study was conducted at the Adult Emergency Department of Gazi University Hospital, a university-affiliated, 1.020 bed Hospital of Gazi University, School of Medicine. One hundred and twenty nine beds belong to the intensive care unit. Approximately 2.100 outpatients are provided with health care services on a daily basis. There is no additional quota for patients that are referred by the ED, for out-patient follow-up, in the outpatient ward, which operates by phone appointments. Adult ED accepts all kinds of medical and/or traumatic patients and sees an average of 40.000 patients per year. There are 36 gurney beds including the 12 monitored beds in the ED. Three mechanical ventilators are also available for use.

This study was approved by the Gazi University, School of Medicine, Local Ethics Board on February 25th, 2008 with the issue number 069.

Selection of Participants

All patients 18 years and older who were presented to the Adult ED of Gazi University Hospital were included in the study. Moreover, patients who were presented to the ED prior to March 31st, 2008, yet whose treatment was still being continued in the ED due to unavailable inpatient bed, were taken into account in determining NEDOCS scores for 'admit-time'. However, demographic and triage information, timing of initial evaluation, consultations and other studies, data about final decisions for these particular patients were excluded from the study.

Interventions:

Patient demographic information and triage scores evaluated by Emergency Severity Index (ESI) presented to the Adult ED were recorded. Moreover, times for admittance, initial patient exam, laboratory and radiologic studies, consultation and patient's departure from ED were monitored and recorded. Information related to the patients who left the ED without being seen and ambulance diversions were determined. Final outcome of all patients (discharge, hospitalization, willing departure or departure against medical advice, exitus) were also determined.

Time points to perform sub-measures of the NEDOCS scale were determined as 04:00, 08:00, 12:00, 16:00, 20:00, and 24:00. Obtained NEDOCS sub-measures were placed on nomograms and the NEDOCS score for all measurement points were obtained.

In the third stage of the study, a six-scaled survey was performed in order to assess the perception of overcrowding of the senior resident doctors, nurses, and emergency medical technicians (1-6; 1=not busy at all, 6=it is dangerously overcrowded/very busy, ED is excessively full and ED is overwhelmed). Participants were asked to fill out the survey by considering work loads of doctors and nurses in charge, number of patients in ED and waiting room, and number of patients waiting for available inpatient bed in ED. Care was taken to ensure that doctors, nurses and emergency medical technicians who completed the survey answered the questions independently of each other.

Statistical Analysis

Data on the forms were then transferred to the computer by using "Statistical Packages for the Social Sciences (SPSS)" program, version 13.0, and analysis was performed.

Results

Over the study period, a total of 1,078 patients were presented to the Adult ED of Gazi University Hospital. Information on 918 of these patients was recorded. Of all patients whose admissions were recorded, 513 (55.9%) were females and the mean age of all patients was 44.9 ± 19.0 , median was 43.0 (18-95) years and 73 (8%) of the admissions involved forensic cases. Eight hundred and eighty (95.9%) of admitted patients had health insurances. While 598 (65.1%) of admitted patients were brought into the ED by private vehicles, admissions by ambulance accounted for 87 (9.5%) of all patients.

Distribution of urgency levels of the patients who were triaged according to ESI principles was found as: 497 (54.1%) Level 3, 217 (23.6%) Level 4, 145 (15.8%) Level 2, and 46 (5%) Level 5. Patients triaged as Level 1 consisted of 13 (1.4%) of all patients and they received urgent intervention.

While 800 (87.1%) of ED admissions were evaluated after being admitted, 108 (11.8%) of the patients left ED without being seen by a doctor. Moreover, patients who presented to ED by ambulance, but were referred to other centers due to lack of appropriate treatment wards, accounted for 11 (1.1%) of all admissions. When admissions by ambulance were taken into account, 11.9% of ambulances were diverted to other centers.

Mean wait-time for the initial evaluation of patients admitted to ED was 37.0 ± 49.0 minutes and median was 20 (0-335) minutes. Total time period starting from the admission of patients until their departure from ED after examination and treatment was calculated as 4 hours 28 minutes \pm 8 hours for mean and 2 hours 10 minutes (10 minutes - 90 hours 40 minutes) for median.

Sixty one (56.1%) patients who left ED without being seen by a doctor were female and mean age was 35.0 ± 16.3 , median 37.5 (18 - 94) years. Distribution of urgency level of this patient group was as follows: 55 (51%) ESI Level 3, 34 (32%) ESI Level 4, 10 (9%) ESI Level 5, and 9 (8%) ESI Level 2. Only 6 (5.8%) of the patients who left without being seen by a doctor did not have any health insurance. Mean wait-time for these patients before departing from ED was 75.0 ± 75.0 minutes and median was 40 (10-135) minutes.

The distribution of patients on the basis of urgency level, who presented to ED by ambulance and were referred to other centers was determined as follows: 5 (44.4%) ESI Level 2, 4 (33.3%) ESI Level 3, 1 (11.1%) ESI Level 4, and 1 (11.1%) ESI Level 5.

Consultation was required for 268 (29.2%) of the patients evaluated in ED. Consultant doctors arrived at the ED within 5 to 430 minutes.

Five hundred and eighty eight (64.1%) patients evaluated in ED needed a laboratory examination whereas 364 (39.6%) patients needed X-ray examination, and 96 (10.5%) of all went through other radiological imaging. It was determined that while written evaluation of ultrasonography examination took between 35 to 255 minutes, written evaluation time for computerized tomography varied from 25 to 1077 minutes.

Over the study period, 808 (88.1%) patients were discharged from ED after necessary examination and planned treatment and 62 (6.7%) patients were hospitalized for further evaluation and treatment. Thirty nine (4.3%) patients chose to leave the ED against medical advice and 3 (0.3%) patients left ED without any permission and 6 (0.6%) expired in ED.

Daily distribution of median value of the NEDOCS score that was obtained after the testing of the NEDOCS sub-measures on nomograms are shown in Figure 1.

All scores obtained in the Adult ED of Gazi University Hospital were presented in the "dangerously overcrowded" section of the NEDOCS scale. High values of patient index and admittance index together with the high number of patients on mechanical ventilator and long admit time contributed to reaching high NEDOCS scores. Over the study period, the daily number of patients on mechanical ventilators in ED varied from two to five. Some long admit-times, such as 238 hours, 201 hours and 153 hours were determined in the patient records.

There was no significant difference of the perception of overcrowding for the senior resident doctors, nurses, and emergency medical technicians found in the results of the survey conducted on emergency department staff (Pearson chi-square; $p=0.180$).

There was a low degree of positive correlation noted between the survey results on the perception of overcrowding for ED staff and the NEDOCS score (Spearman's correlation coefficient; $p=0.003$). In order to measure how well we can explain the perception of overcrowding for the ED staff by the NEDOCS score, we conducted a regression analysis. In this analysis, where the NEDOCS score was the independent variable and scores regarding the perception of overcrowding for the ED staff were dependent variables, the regression model was found valid ($p=0.004$). The regression model was $y=ax+b$; perception score= 0.056 (NEDOCS)- 7.822 . However, the coefficient of determination for the model was found to be quite low ($R^2=0.064$).

Thirteen (68.4%) of the emergency department staff, out of 19 whose perception score was 1, had the highest value (200) of the NEDOCS score. Since this result lowers the specificity of the NEDOCS scale, an appropriate threshold value for the NEDOCS score will not be accurate. As is observed in Figure 2, when the threshold value for emergency department overcrowding is determined as 199, sensitivity of the NEDOCS scale in the Adult ED of Gazi University Hospital is observed as 92%; however, specificity is found to be quite low (32%). The area that is below the curve is 0.617 and it presents no difference of more than 0.5 ($p=0.0745$).

Limitations

All NEDOCS scores obtained over the study period in the "dangerously overcrowded" area and very close values are the limitations of this study.

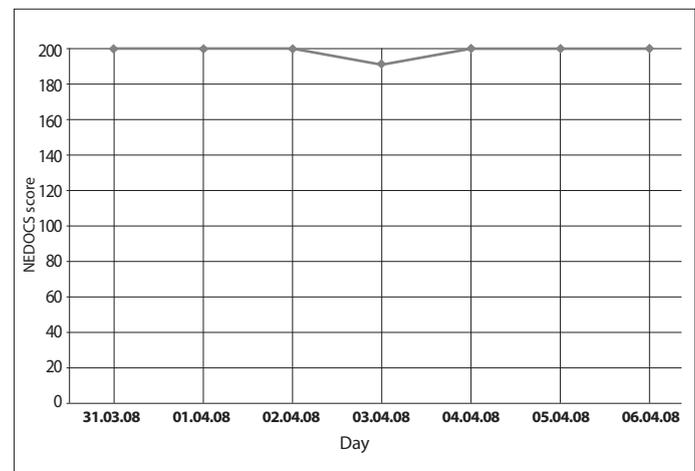


Figure 1. Distribution of Median Values of the NEDOCS Scores on Daily Basis

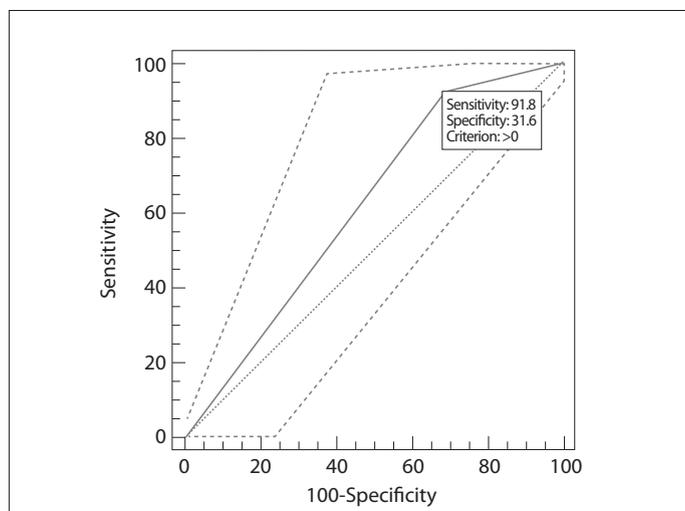


Figure 2. The ROC Curve for the Score 199 of Threshold Value of the NEDOCS Scale for the Adult ED of Gazi University Hospital

Discussion

Reports published in the United States of America (U.S.) in the 1990s would argue that ED overcrowding was mostly caused by substance addicts, homeless people, HIV patients, and particularly non-urgent patient admissions and patients lacking health insurance (1). However, over the following period, it was proved that the increase in ED admissions could not primarily be attributed to the patient groups mentioned above (2, 10-12). Data in our study also support the fact that the majority of patients being admitted to ED do have health insurance.

Today, the most common cause associated with ED overcrowding in the academic centers is the inability to transfer ED patients to inpatient beds (1). Numerous factors contribute to patients' waiting for hospital beds in the ED. Insufficient numbers of hospital beds, an unbalanced ratio between numbers of nurses and patients, isolation measures, delays in housekeeping services, overreliance on intensive care unit beds, inefficient diagnostic and auxiliary services in inpatient wards, delays in patient discharges and problems encountered in post acute treatment services may be listed among these factors (1).

The fact that only 87 (9.5%) ED presentations made by ambulances forces us to re-evaluate the availability and accessibility of pre-hospital health services in Turkey.

Together with the increasing population, the majority is also getting older and requires urgent care due to acute exacerbations of chronic diseases. The evaluation process of patients presented to ED has become more complicated and takes more time, with their various accompanying co-morbidities. In addition, technological progress, new pharmaceutical agents, medical advances, increases in practical standards and training of emergency medicine residents have resulted in changes in medical practices. For instance, trauma patients who were hospitalized for evaluations are being discharged from EDs today following comprehensive computerized tomography examinations. Again, a patient with chest pain is discharged from the ED after a series of cardiac enzyme examinations, telemetric monitoring and effort tests (13). Six hundred and sixty seven (72.7%) admissions to the Adult ED of Gazi University Hospital accounted for the patients that needed to be evaluated in EDs in terms of their triage scores. This result overlaps with the emergency medicine literature that depicts the increase in complexity of patients presented to EDs.

In a report published by the "Centers for Disease Control" (CDC) in 2004 in the U.S., it was stated that 12.5% of all ED admissions were non-urgent incidents which could be treated by primary level health care services (11). In our study, 359 (39.1%) admissions to the Adult ED of Gazi University Hospital consisted of patients who could be treated by primary level health care services. This patient group contributed greatly to ED overcrowding.

According to the report published by the CDC, patients had to wait for 45 minutes to see a doctor and ED visits lasted approximately for 2.5 hours in the U.S. (11). Patients presented to the Adult ED of Gazi University Hospital also had to wait approximately the same amount of time as the patients in the U.S.; yet ED visits lasted longer. These prolonged waiting times make patients and patients' relatives more impetuous and restless, and ED staff become physically and psychologically affected by the negative moods of patients and their relatives (13).

When sub-scores related to the reasons for high NEDOCS scores were examined over the study period in the Adult ED of Gazi University Hospital, the following striking points were determined: The prolonged evaluation time of patients of as much as 91 hours in the ED until their departure caused an increase in "patient index" scores. On the other hand, prolonged wait-times of almost 10 days for available hospital beds affected "admit index" scores. Again, it was observed that health care for a great number of patients by mechanical ventilators was continued in ED. It was also found that wait-times for patients prior to initial examination extended to almost five hours. In the light of all this data, it may be concluded that the failure of patients' transfers to other inpatient beds in the academic EDs is also a problem of the Adult ED of Gazi University Hospital.

Delays determined in the consultation and radiological services in the Adult ED of Gazi University Hospital prolong the length of patient stays in ED. In order to solve this problem, accessibility of specialists and diagnostic services should be made more rapid and efficient (1, 13, 14).

In the study conducted by Vieth et al., it was shown that ED overcrowding caused prolonged wait-times and an increase in rates of patient who left without being evaluated (15). Patients who left without being seen by a doctor or before their treatment was completed are described as an indicator for inefficient ED health care (1). It was determined that 108 (11.8%) admissions to the Adult ED of Gazi University Hospital left the ED after triage. According to the CDC reports, this rate was reported as 2% in the U.S. in 2004 (11). Ding et al. stated that the risk of leaving the ED without being evaluated increased in cases not having health insurance or having limited insurance; belong to young age group, or with a history of incomplete ED admission at least once within the previous year (16). It was determined in the Adult ED of Gazi University Hospital, that this patient group was young but had health insurance, and they waited longer in the waiting room than the patient group being evaluated by a doctor in ED. Bindmann et al. reported that 49% of this particular patient group needed health care within three hours, 28% presented to another ED, and 5% of them were hospitalized within the following two weeks (17). Our study supports the literature by indicating that 64 (59%) of the patient group leaving ED had ESI Levels 2 and 3.

Another indicator of inadequacies of EDs in meeting patient needs is "ambulance diversions". An ED rejecting an ambulance signals that it will not be able to provide a reliable health care service for

critically ill patients or any wounded/injured person. Ambulances referred to other centers not only affect emergency levels of patients, but also carry risks of delay in transportation, diagnosis, and treatment procedures (1, 18). It was also found that there was a low but disturbing correlation between ambulance diversion and trauma mortality (18). Since there is no institutionally and/or regionally described and approved criteria for ambulance diversions in Turkey, they still represent a common problem.

Even though there is no standard criterion for measuring ED overcrowding, the common measurement point in evaluating available scoring systems is their ability to match with the perception of overcrowding of ED clinicians (2, 5). Despite the concerns in the literature related to the perception of overcrowding for ED staff, no significant difference was found among the perception of overcrowding for the Adult ED staff of Gazi University Hospital. However, it was determined that the coefficient of determination was quite low in the regression model between the perception of overcrowding for ED staff and the NEDOCS scores ($R^2=0.064$). On the basis of this result, the NEDOCS score can only explain 6.4% of the perception of overcrowding for ED staff. On the other hand, since no appropriate "overcrowding threshold value" according to NEDOCS that might be applied for Adult ED of Gazi University Hospital could be determined, the concerns for the general applicability of the NEDOCS scale is once again supported (2, 4).

It was concluded that other variables were needed in addition to the NEDOCS' components in order to explain the perception of overcrowding for the Adult ED staff of Gazi University Hospital. Results obtained over the study period supported the concerns for the applicability of the NEDOCS scale on EDs of various sizes.

A concept such as waiting in the triage area or waiting room in order to be evaluated by a doctor was formed in the Adult ED of Gazi University Hospital. However, there was no concept of waiting until three years ago in our ED. It was also determined that the most important reason for the current overcrowding was patients waiting in ED for available inpatient beds after being diagnosed in ED.

In many ways, EDs can be regarded as barometers that show the situation of a health care system. Overcrowded EDs signal not only the difficulty in reaching first level health care services, but also inefficient use of hospitals. Addressing the factors that create ED overcrowding correctly and solving this problem is a must in order to protect not only EDs, but also the security it provides for everyone.

Conflict of Interest

No conflict of interest is declared by the authors.

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