



Original Contribution

The inaccuracy of determining overcrowding status by using the National ED Overcrowding Study Tool ☆☆☆★



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ABSTRACT

Background: Emergency department (ED) crowding has become more common, and perceptions of crowding vary among different health care providers. The National Emergency Department Overcrowding Study (NEDOCS) tool is the most commonly used tool to estimate ED crowding but still uncertain of its reliability in different ED settings.

Objective: The objectives of this study are to determine the accuracy of using the NEDOCS tool to evaluate overcrowding in an extremely high-volume ED and assess the reliability and consistency of different providers' perceptions of ED crowding.

Material and methods: This was a 2-phase study. In phase 1, ED crowding was determined by the NEDOCS tool. The ED length of stay and number of patients who left without being seen were analyzed. In phase 2, a survey of simulated ED census scenarios was completed by different providers. The interrater and intrarater agreements of ED crowding were tested.

Results: In phase 1, the subject ED was determined to be overcrowded more than 75% of the time in which nearly 50% was rated as severely overcrowded by the NEDOCS tool. No statistically significant difference was found in terms of the average length of stay and the number of left without being seen patients under different crowding categories. In phase 2, 88 surveys were completed. A moderate level of agreement between health care providers was reached ($\kappa = 0.5402, P < .0001$). Test-retest reliability among providers was high ($r = 0.8833, P = .0007$). The strength of agreement between study groups and the NEDOCS was weak ($\kappa = 0.3695, P < .001$).

Conclusion: Using the NEDOCS tool to determine ED crowding might be inaccurate in an extremely high-volume ED setting.

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1. Introduction

In recent years, with increased demands associated with the growth of annual emergency department (ED) visits in comparison with static or limited hospital and ED resources, ED crowding has become a more prevalent and worsening problem throughout the nation, especially in urban areas [1–3]. Despite an increase in the

literature concerning this subject, there is still no definitive consensus on terminology or an actual operational identification of ED crowding. Among all current models, the National Emergency Department Crowding Study (NEDOCS) outcome is currently considered the most commonly used and reliable ED crowding scoring tool developed to date in terms of its relatively higher consistency and better performance in determining the degree of ED crowding status [4–7]. It was developed from 8 academic EDs with moderate-to-high annual volumes (ranging from 40000 to 83000 with an average of 57000/year). It has been validated well in the setting of EDs with similar annual volumes when compared with those of the study group but remains unproven when compared with EDs whose volumes are outside the range of the study group. This is especially notable when using NEDOCS in the setting of an extremely high-volume ED.

In addition, NEDOCS and other ED overcrowding tools have been developed based on varying health care providers' perceptions of ED crowding, which may neither be objective nor accurate [4,8,5–7]. Furthermore, the intraobserver and interobserver variability of

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perceptions of ED crowding in different health care providers was rarely tested and compared in previous studies. Therefore, the goals of this study are (1) to determine the accuracy of using the NEDOCS scoring tool to evaluate ED overcrowding in an extremely high ED volume setting, and (2) to assess the reliability and consistency of using different health care providers' real time perceptions of ED crowding.

2. Materials and methods

2.1. Study design

This was a prospective observational 2-phase study designed to externally validate the accuracy of the NEDOCS scoring tool in determining overcrowding status in an extremely high-volume ED. The institutional review board approved the study.

The first phase involved data analysis of the NEDOCS scale to determine ED overcrowding status. This study was performed at ED of John Peter Smith Health Network from June 1 to June 24, 2013. The study ED is a publicly funded urban tertiary care hospital ED with an annual volume of approximately 110,000. This academic ED hosts an Emergency Medicine Residency Program and also is a level 1 trauma center. The NEDOCS score was calculated by using an online calculator (<http://www.nedocs.org>) every 2 hours at real-time points during the study period. Briefly, 2 constants (the number of ED and hospital-licensed beds) and 5 other variables were required to calculate the NEDOCS scores [4]. Considering that the number of ED-licensed bed was a fixed variable reported from the previous study, this constant was not changed when the hallway beds were added sometime at ED [4]. Emergency department crowding status was determined by the NEDOCS score and further divided into 3 different categories: not overcrowded, overcrowded, and severely overcrowded. Not overcrowded status was defined as NEDOCS score of less than 100, overcrowded was defined as NEDOCS score of less than 140 (including score of 100), and severely overcrowded was considered if the score was higher than 140 (including 140) [4]. All patients during the study period were assigned to have NEDOCS scores calculated at the time the patients were registered in the ED and then stratified into 3 different crowding categories. Patients who were directly admitted by other services and immediately moved out of the ED were excluded from this study. Patients who were transferred from our urgent care center due to a requirement for higher level of care and/or potential high-risk presentation were excluded from the study. Because of the study hospital policy, these patients who transferred from urgent care center will have the priority to be placed in an ED bed as earlier as possible no matter which emergency severity index (ESI) levels they triaged initially. Therefore, the length of ED stay of these patients might not well correlate with the ED crowding status. If NEDOCS score could not be calculated at certain time points due to incomplete data recorded, patients who registered at ED within those time periods were also excluded from this study (Fig. 1). To know whether ED overcrowding will potentially affect ED operations, length of ED stay and the number of patients who left without being seen (LWBS) were used as the markers for ED efficiency measurements. The length of stay (LOS) in the ED of each patient was collected, and the average of LOS was analyzed and compared under the different ED crowding conditions. Further analysis was performed and compared in terms of the LOS under the different categories including patient acuity levels and type of disposition (eg, discharge, admission, transfer, etc). In addition, the number of LWBS patients was also analyzed and compared in different ED crowding conditions determined by the NEDOCS scale.

The second phase was a survey questionnaire study to measure the group agreement of perceived ED crowding by different health care providers, including physicians, nurses, residents, and senior medical students as compared with the NEDOCS score. This phase of the study

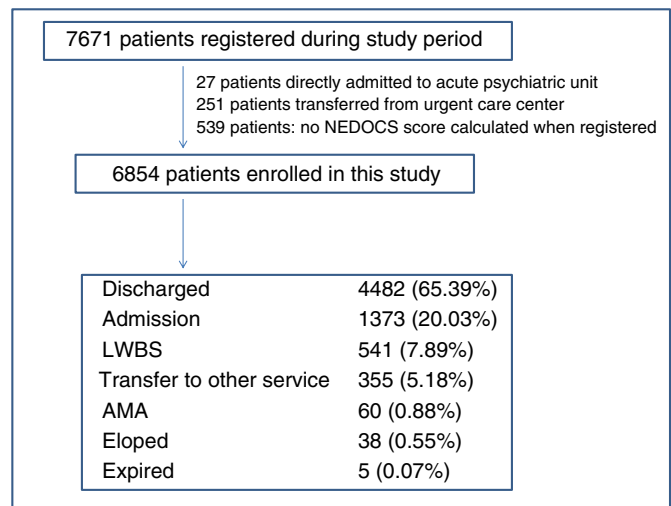


Fig. 1. Shows the flow diagram of the number of patients included in the ED crowding study in June 2013.

was conducted in July and August of 2013 separately. Clinical variables reviewed when deriving the NEDOCS score included total patients in the ED, total admits in the ED, number of ventilators used in the ED, longest admit time in hours, and waiting room time (in hours) of the most recent patient placed in a bed in the ED. Two constants including total ED beds and total hospital beds were also used in deriving the NEDOCS score. The NEDOCS model was designed based on the “input-throughput-output theory [9,10].” This model does not take into consideration the potential impact of the ESI score of patients in the ED at the time of scoring nor does it consider physician, resident, and nurse staffing levels as potential contributors to ED overcrowding scores. Our survey questionnaire study was designed based on an “input-throughput-output-overall staffing” model, which includes physicians, nurses, and residents on duty. Other clinical variables such as the number of patients with different ESI levels and the longest wait time of those patients in the waiting room at the time of scoring were also included. Ten different clinical scenarios consisting of 20 different operational variables of different levels in each scenario were given to physicians, nurses, residents, and medical students to determine perceived ED overcrowding (Appendix). Considering the importance of recognizing an overcrowded or severely overcrowded status in the ED by health care providers, most of these scenarios (8/10) were designed assuming a severely overcrowded status in the ED based on the NEDOCS score relative to each scenario.

Scenario 1 was considered the basic setting with the NEDOCS score of 150, indicating a severely overcrowded status in the ED. Each operational variable that was initially not included in NEDOCS was changed at different severity levels in scenarios 2, 3, 5, 6, 8, and 10 when compared with the basic setting (see detail in Fig. 2). These potential independent operational variables were the numbers of nurses, physicians, and residents on duty; different acuity levels of the test patients who had already been seen and evaluated by physicians/residents in the ED and whose dispositions were pending; different acuity levels of test patients in the waiting room who had not yet been seen; and the longest time that a test patient had remained in the waiting room pending examination room placement. These operational variables were considered to represent a potentially more profound effect on ED overcrowding yet are not included in the NEDOCS scoring system. In addition, the severity of NEDOCS variables

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