

Comparison of the International Crowding Measure in Emergency Departments (ICMED) and the National Emergency Department Overcrowding Study (NEDOCS) in Tertiary Care Hospital to Measure Emergency Department Crowding

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ABSTRACT

Objective: To compare NEDOCS with ICMED in predicting clinicians' concerns regarding crowding in the Emergency Department of a tertiary care hospital in Pakistan.

Study Design: Prospective comparative study.

Place and Duration of Study: Accident & Emergency Department, Pak Emirates Military Hospital, Rawalpindi Pakistan, from Dec 2021 to Jan 2022.

Methodology: This study was conducted at the Accident and Emergency Department over 14 different days, 30 data sets of 3-hour intervals each were collected using the NEDOCS and ICMED proforma. NEDOCS Scores and ICMED scores were calculated. In addition, perceptions of the staff regarding crowding and danger to the patient's status were recorded on Visual Analogue scales.

Results: The mean recorded NEDOCS score was 577.94 ± 251.57 , with 29 'extremely overcrowded' and 1 'overcrowded' data set. The mean ICMED score was 2.86 ± 0.83 . Twenty-four (80%) sets did not have crowding, with only six (20%) sets being categorized as 'crowded'. The NEDOCS score had a moderately positive correlation with the crowding perception of the staff (Correlation coefficient (r)=0.593).

Conclusion: NEDOCS was a more suitable measure for recording ED crowding in Pakistan, as it recorded the quantitative component of waiting time. ICMED, on the other hand, only recorded waiting time on a binary scale, with the waiting time impact not translated fully on the total score.

Keywords: Emergency department crowding, International Crowding Measure in Emergency Departments (ICMED), National Emergency Department Overcrowding Study (NEDOCS).

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INTRODUCTION

Crowding in the Emergency Department (ED) is a significant public health problem. Crowding is defined by the American College of Emergency Physicians (ACEP) as a circumstance in which the resources available in the ED, hospital or both are insufficient to fulfil the need for identified medical emergency services.^{1,2}

A notable increase in ED crowding has been reported in developed countries. However, this increase could not be explained based on population growth alone.³ Crowding can be caused by various factors depending on the time and location. Recent reports from the Emergency Medicine Practice Committee of the ACEP revealed over 90% crowding in ED on a routine basis.⁴

It is imperative to measure the crowding to develop and evaluate interventions in ED. However,

there needs to be more consensus amongst practitioners on how to measure ED crowding. The National Emergency Department Overcrowding Score (NEDOCS) is a valid instrument for measuring ED crowding.⁵ It is based on seven variables.

This measure has been found to strongly correlate with the number of patients leaving before getting treatment and ambulance diversion, although that is limited to large urban centres. However, NEDOCS is complex & needs to generate better across different settings.⁶ There is another measure called the International Crowding Measure in Emergency Departments (ICMED).⁷ This is a relatively simple scoring scale. Moreover, seven of the items are collected in real-time, partially validated and show good discriminant and face validity.⁸ Literature reports that both shortened ICMED and NEDOCS scores may have potential use for assessing crowding variation at long timescales. However, they could be more reliable in hour-to-hour variation.^{9,10} There is no reported

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literature in Pakistan that compares these instruments in assessing ED crowding in the Emergency set-up of hospitals in Pakistan. The present study aimed to compare NEDOCS with ICMED in predicting clinicians' concerns regarding crowding and severity/danger of patient status in Emergency Departments of a tertiary care hospital.

METHODOLOGY

The prospective comparative study was conducted at the Accident & Emergency Department of Pak Emirates Military Hospital (PEMH), Rawalpindi Pakistan, from December 2021 to January 2022. Ethical approval was taken from the PEMH Ethical Committee [No.A/28/EC/321/2021]. In total, 30 data sets were collected on 14 different days and for 3-hour intervals each.

Inclusion Criteria: Doctors and Nursing staff of the Emergency Department, of either gender, aged group 25 to 45 years were included in the study.

Exclusion Criteria: Staff who were on leave during the study or scheduled to have different working shifts other than the shifts in which the present study was conducted were excluded from the study.

A total of 30 data sets were collected with a total recorded observational time of 90 hours. The time selected for these data sets was from 1000hrs till 2200hrs pm. For each data set, ED crowding was assessed by taking records of any violation from among the seven variables for calculating the NEDOCS score and the eight violations of the ICMED items. The NEDOCS score was calculated using the following formula:

$NEDOCS\ score = -20 + 85.8 * (Total\ patients / ED\ Beds) + 600 * (Admits / Hospital\ Beds) + 13.4 * (ventilators) + 0.93 * (longest\ Admits) + 5.64 * (Last\ Bed\ Time)$.⁹ Each violation on the eight ICMED items was awarded a score of 1. Thus, an ICMED score of 0-8 was calculated. A score of 4 or greater for each data set was considered crowded.

Moreover, perceptions of the ED doctors and the nursing staff were recorded. Their perceptions of the crowding were recorded on a Visual analogue scale (VAS) of 0 to 10, with 0 as 'Not at all crowded' and ten as 'Extremely crowded'. Similarly, the severity/danger of the incoming patients was recorded on a VAS from 0 to 10, with 0 being 'Not at all dangerous' to 10 as 'extremely dangerous'. The NEDOCS scores were categorized into six different levels as follows: 1) Not Busy (0-< 20); 2) Busy (20-< 60); 3) Extremely busy but not overcrowded (60-< 100); 4) Overcrowded (100-

<140);5) Severely Overcrowded (140-<180) and 6) Dangerously Overcrowded (180 and more). Compared to the ICMED, NEDOCS levels 4-6 were considered crowded.⁹

All data were analyzed using Statistical Package for the Social Sciences (SPSS v26.0). Pearson's correlation coefficients were calculated for assessing the following associations: ICMED and NEDOCS scores; ICMED and Crowding Perception scores; NEDOCS and Crowding Perception scores; ICMED and Danger Perception scores, and NEDOCS and Danger Perception scores. Frequencies and percentages were calculated for the crowding levels of NEDOCS and ICMED. Mean and standard deviation were calculated for numerical variables. The *p*-value of ≤0.05 was considered statistically significant.

RESULTS

A total of 30 data sets of 3-hour intervals each were recorded. These data were recorded for a total of 14 days. A mean NEDOCS score of 577.94±251.57 was recorded. Only one (3.3%) observation had level-5(Severely Overcrowded) NEDOCS scores. The other 29(96.7%) remaining data sets had a NEDOCS score of level 6 (Extremely Overcrowded). A mean ICMED score of 2.86±0.83 was calculated. Out of the 30 data sets, 24(80%) did not have crowding as per the ICMED criteria. Only six (20%) of these data sets were categorized as 'crowded' in accordance with the ICMED criteria (Figure).

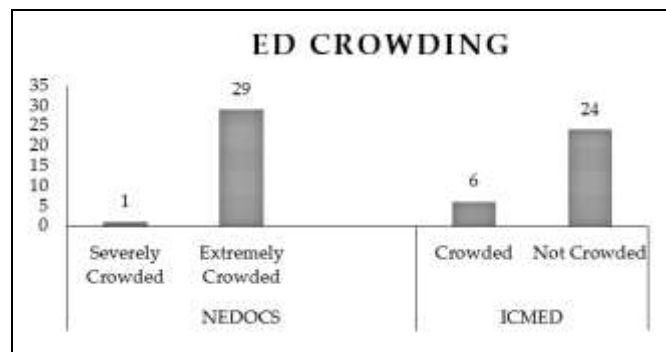


Figure: Crowding as Per NEDOCS & ICMED Criteria (n=30)

The mean crowding perception of the ED staff was calculated as 8.03±1.49. The mean danger perception of the ED staff was recorded as 6.72±0.88. The correlations of the NEDOCS with ICMED and staff perception score have been shown in Table-I. NEDOCS was found to not correlate with the ICMED score (*r*=-0.073, *p*=0.707). However, NEDOCS was moderately correlated with the Crowding Perception score

($r=0.593$, $p=0.001$) and weakly correlated with the Danger perception score ($r=0.221$, $p=0.249$).

The correlations of the ICMED score with the Crowding and Danger Perception scores have been illustrated in Table-II. Crowding perception was weakly correlated with the ICMED score ($r=0.357$; $p=0.053$). However, the Danger perception was found to have weak to no correlation with the ICMED score ($r=0.180$, $p=0.341$).

Table-I: Correlation between NEDOCS Score and ICMED Score, Crowding Perception and Danger Perception (n=30)

Variable	Comparative Variable	Pearson's Correlation Coefficient (r)	p-value
NEDOCS	ICMED	-0.073	0.707
	Crowding Perception	0.593	0.001
	Danger Perception	0.221	0.249

Table-II: Correlation between ICMED Score and the Crowding and Danger Perceptions (n=30)

Variable	Comparative Variable	Pearson's Correlation Coefficient (r)	p-value
ICMED	Crowding Perception	0.357	0.053
	Danger Perception	0.180	0.341

DISCUSSION

A significant crowding was observed in the present study. This was indicated by measurements of both the ICMED and the NEDOCS scores. Crowding in the ED is a growing problem throughout the world.^{10,11} Some studies suggest using measures such as ambulance diversion, occupancy of ED beds and proportion of people leaving before treatment to determine ED crowding.^{13,14} However, these measures have limitations and are thus not reliable in all circumstances.⁹ In 2003, Asplin *et al.* suggested a conceptual framework to determine the cause of ED crowding based on three components; input, which is the number of patients seeking treatment; throughput, which is the time a patient spends in the ED and output, which is the admission or discharge of the patient from the hospital.¹⁴ In this regard, many tools are available to measure crowding in the ED such as NEDOCS, ICMED, Severely Overcrowded, Overcrowded, and Not Overcrowded Estimation Tool (SONET) and Emergency Department Work Index (EDWIN).¹⁵

The present study aimed to compare the effectiveness of NEDOCS and ICMED to measure crowding in hospital ED. There was significant variation in the

ED crowding as reported by the ICMED and NEDOCS scoring systems. While the NEDOCS reported 100% crowding, only 20% crowding was found as per the ICMED system. The NEDOCS accounts for two waiting times: from triage to bed placement and the longest waiting time for patients to get admission. Both of these waiting times are incorporated in the NEDOCS formula. In our emergency set-up, the longest waiting time for patients to get admitted was quite long, resulting in a very high NEDOCS score. Therefore, controlling this single variable will result in much lower NEDOCS scores. A possible solution to reduce ED crowding is to form ED-based observation units to reduce the patient waiting for time and length of stay. A study by Rasheed *et al.* suggested that shifting patient load to the overall load relief of patients in the ED led to a reduction in the patients' stay and waiting time.¹⁶ In a study conducted by Boyle *et al.* in 2015 to validate ICMED to measure ED crowding, it was concluded that ICMED could be measured in different emergency departments having varying information technology systems. In addition, higher sensitivity (91.2%) and specificity (100%) rates were reported compared to other ED crowding instruments.⁸

Interestingly, in our study, a moderately positive association was found between the NEDOCS score and the 'crowding perception' of the ED staff. One factor that should be considered is that the crowding perception scores may be higher than the ground situation because the ED staff perceived the crowding by considering the patients and the attendants who were along with them. In our setting, many patients are accompanied by multiple attendants, and the resultant crowding situation appears to be much worse than it is. This is translated into the extremely high crowding perception scores of our study (mean crowding perception score= 8.03 ± 1.49).

There are also concerns regarding the complexity of the NEDOCS tool. Whether the measure works well outside the USA.^{17,18} A study conducted by Raj *et al.* in Australia concluded that the NEDOCS tool needed to be more valid in their setting, owing to inconsistencies in the reflection of the staff's sense of 'overcrowding'. However, they opined that NEDOCS is a significant instrument which has the potential to be improved.⁶

The findings of the present study suggest that in Pakistan tertiary care Emergency Department setting, NEDOCS is a more valid measure of assessing the crowding status when compared with the ICMED.

LIMITATIONS OF STUDY

The data was collected from only a single Emergency Department set-up. It would be interesting to compare Emergency Department crowding data from multiple centres in future studies. In addition, data collected from different parts of Pakistan could be helpful towards formulating national Emergency Medicine guidelines.

RECOMMENDATIONS

The subject study is unique, not only with regards to the scope and nature of the research carried out but also with respect to findings based on which these recommendations can be applied in the healthcare set-ups to improve ED efficiency and reduce crowding:

- Attendants accompanying patients should be refrained from entering the ED detention and should be limited to the designated waiting area. All ED set-ups should have an announcement system through a microphone to call upon the attendant inside the detention if and when required.
- Keeping in view the current working set-up of PEMH and most of the hospitals in Pakistan, it is proposed to have a separate Treatment Room in Out Patient Department Complex to cater for immediate treatment and stat doses advised to stable patients in OPDs and also for small procedures (like; nebulization, vaccination, intramuscular and stat intravenous injections, ascitic tap etc.). It will improve the quality of health care services by saving the time and energy of ED staff by reducing crowding in ED.
- There should be a Resuscitation Room in ED for attending critical patients on priority without any delay. Then once stable and diagnosed, they should be segregated and shifted to a separate medical bay or surgical bay accordingly.
- Crowding in ED can be significantly decreased if vitally stable patients who get admitted from OPDs and even from ED detention can be shifted to specific admission Centre instead of keeping them in ED till all paperwork is completed, availability of a bed in respective wards is confirmed, and other coordinates that cause admission procedure delay are checked. This will reduce the long occupancy time of beds in ED.
- It has been noticed that a considerable number of patients visit ED for follow-up and review of medicines or to get an opinion regarding their investigations after OPDs are closed. This practice should be strongly condemned at each level by patient education, and bringing awareness regarding

the sole purpose of ED should be to cater to medical and surgical emergencies only. In contrast, ease for patients coming from far areas should be maintained.

- Last but not least, the ED working is the face of the whole hospital, working 24/7 to provide the best possible facilities to the beneficiaries; thus, the number of nursing staff should be increased in the Emergency Detention to improve the efficiency of the system.

CONCLUSION

Regarding the comparison and effectiveness of NEDOCS and ICMED in measuring crowding, NEDOCS is a much more valid tool in ED set-ups in Pakistan, as it caters for each criterion separately. Therefore, the findings of the study should be used to formulate future guidelines for recording ED crowding in Pakistan.

Conflict of Interest: None.

Author's Contribution

Following authors have made substantial contributions to the manuscript as under:

ZZ & NA: Conception, study design, drafting the manuscript, approval of the final version to be published.

WA & AR: Critical review, drafting the manuscript, approval of the final version to be published.

QUA & SI: Data acquisition, data analysis, data interpretation, critical review, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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