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Overcrowding an encumbrance for an emergency health-care system: A perspective of Health-care providers from tertiary care center in Northern India

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Abstract:

BACKGROUND: Emergency department (ED) overcrowding is one of the leading problems of health-care organizations, discerned by ED medical staff, but it has never been measured objectively.

OBJECTIVE: A 2 months prospective cross-sectional study was conducted to compare ED overcrowding measurement tools with the perceptions of ED emergency physician and ED assistant nursing superintendent (EDEP/EDANS).

RESULTS: The results have shown that perceptions of ED overcrowding as noted by EDEP and EDANS, taken on a Likert scale, were 83.34% and 86.67%, respectively. Kappa values show a significant agreement between EDEP and EDANS subjective perceptions with objective values of the National Emergency Department Overcrowding Study (NEDOCS), Real-time Emergency Analysis of Demand Indicators (READI), and Emergency Department Work Index (EDWIN) scales. Furthermore, all three scales have statistically significant correlation; NEDOCS and READI had highest level of correlation coefficient ($r = 0.662$, $P < 0.01$) whereas READI and EDWIN shows least correlation coefficient value ($r = 0.155$, $P < 0.01$).

CONCLUSION: Therefore, these scales may serve to quantify the subjective impressions of ED overcrowding. Evidence is clear of overcrowding harms, measures are needed to provide urgent medical care and future work up is need of the hour to systematically evaluate interventions and guide evidence-based policies.

Keywords:

Overcrowding, perceptions, quality of care, quantitative scale

Introduction

Hospital Emergency Department (ED) overcrowding has become one of the leading problems faced by ED staff (physicians, nurses and paramedics) as well as by patients in developing as well as in developed nations.^[1] ED functions 24 × 7 round the year and is always well prepared to cater any sort of emergent and nonemergent crisis.^[2] Still, there are evidences that

patients admitted in overcrowded ED get harmed due to longer waiting times, quality care delays, increased probability of medical care errors, delays in critical treatment increased mortality rate, etc.^[3,4] ED overcrowding also impacts the physical as well as psychological health of staff; thereby leading to increased absenteeism, staff sickness, experienced staff leaving due to burnout, and comparatively junior and inexperienced staff is bound to deliver an inefficient and increasingly busy healthcare

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service. ED also has a significant impact on academics of resident medical doctors working in the ED.^[5,6]

ED is one such hospital area where the number of patients and the pace of workload is never predictable. The patient inflow and output of ED are not under the control of emergency healthcare staff and its managers. The ED environment has to bear vivid interruptions, diverse interactions, and sometimes requires a high density of urgent decision-making.^[7] Therefore, ED care inherently requires interdisciplinary physicians, nurses, paramedics and hospital managers, and even representatives from outside of ED to work in unison to provide quality care and to appropriately prioritize treatment based on urgency.^[8,9] Further, ED also plays a subtle role in an emergency and disaster preparedness and response system, but competing demands of such Mass Casualty Incidents can overstretch limited resources and potentially result in a reduction in the quality of health care.^[10-12]

This impression of overcrowding has been often discerned by attending physicians and nurses in ED in healthcare organizations, but it has never been measured objectively.^[13] There has been a significant body of research and a great deal of efforts to define overcrowding; yet, there is no standard definition for ED overcrowding. The World Health Organization 2018 statistics states that over 45% of the WHO Member States are reported to have less than one physician per 1000 population. In Indian scenario, there is a significant gap in terms of the number of doctors available to the country population, and Government data reports that there is one allopathic Government doctor available for around 11,082 people, and is >10 times the recommended ratio of 1:1000 as per National Health Profile, 2018. Hwang and Concato in 2004 found varying definitions of ED overcrowding in literature, but could not reach any consensus for a standard definition.^[11-32] Henceforth, due to the absence of ED overcrowding measurement standards, causes, and consequences of ED overcrowding are difficult to be determined. In literature, investigators have worked upon different measures to develop ED crowding scales, but no scale has found to be standardized till now, still, four quantitative ED overcrowding scales have been used definitely; the National Emergency Department Overcrowding Study (NEDOCS) scale, Real-time Emergency Analysis of Demand Indicators (READI), Emergency Department Work Index (EDWIN), and Emergency Department Crowding Scale (EDCS).^[33-39]

As there are no standard criterion for ED overcrowding measurement, yet, these scales have been adjudged to match perceptions of ED clinicians'. Although there have been debates about the reliability of clinicians' perceptions, still, these subjective measures have served

as a benchmark for comparing these ED scales.^[33,40] Therefore, this study was conceived with the objectives to compare these ED overcrowding measurement quantitative scales with the perceptions of healthcare providers, thereby, to measure ED overcrowding.

Methodology

This study was conducted in ED of one of the premier tertiary level referral multispecialty teaching hospital of North India. The 110-bedded hospital ED (110-bedded complex) caters around 1,60,000 patients visits per annum with a Bed Occupancy Rate of 250%–300%. Faculty members from the discipline of internal medicine along with Senior Residents/Junior Residents (SR/JR) are posted 24 × 7 in ED for providing patient care activities. Nursing staff, laboratory technicians, and other support staff are posted based on already existing demand patterns in the morning, evening, and night shifts to provide quality care to patients.

The study was conducted as questionnaire-based approach and to obtain the study objectives the attending ED emergency physician (EDEP) and ED assistant nursing superintendent (EDANS) were asked to answer a simple question: "How much is ED busy, at present?"; keeping in view total patient load, workload of attending SR/JR and nurses. Their perceptions were noted on the Likert scale:

1. Not crowded, not busy at all
2. Busy
3. Extremely busy, but not overcrowded
4. Overcrowded
5. Severely overcrowded; and
6. Dangerously overcrowded.

These perceptions of EDEP/EDANS served as the primary outcome of interest for the analysis.

It was a prospective, observational study conducted from April to May 2018. Patients were not contacted and none of the patients' specific data were collected. Data were collected at every 3 h duration; from 9 AM till midnight and 360 consecutive sampling instances were recorded in a study duration of 2 months.

Data analysis and interpretation

The data required to compute ED crowding scales (NEDOCS, READI, and EDWIN) were taken from ED registration. The ability of scales to predict ED crowding was compared with composite scores (an average of EDEP and EDANS composite perception survey scores). The READI score is a real-time ED crowding assessment, consisting of three distinct indicators; bed ratio (BR), acuity ratio (AR), and provider ratio (PR).

- The BR is a relationship between the number of treatment spaces and the number of ED patients. A BR >1 quantifies overcrowding
- AR is the average acuity of the current ED population and it defines the current ED illness burden
- The PR indicator incorporates the current ED patients, patients' arrival rate, and their movement through ED. The value of PR >1.5 indicates an understaffed ED
- The demand value incorporates the three aforementioned indicators and the value of >7 indicates overcrowding.^[16,33]

NEDOCS, a web-based tool, has been known to have the best discriminative properties for measuring ED overcrowding. For comparing the association between subjective scores and NEDOCS scores, variables were converted into six categories; 0–20 was ranked as 1, 21–60 as 2, and so on; (0–20 not busy; 21–60 busy; 61–100 very busy; 101–140 overcrowded; 141–180 dangerous; >181 disasters). Studies have shown that the NEDOCS scale has a good correlation with clinicians' perceptions, diversion of the ambulance, patients leaving without being seen.^[35,37] The NEDOCS scores consisted of the following parameters:

1. The total number of patients in ED occupying beds (including waiting area, hallways, etc.)
2. Total number of patients on ventilators
3. Total number of patients awaiting admission
4. Waiting time for the last patient called in from the waiting room
5. Longest time the patient waits for admission
6. Number of ED beds
7. Number of total beds (occupied and vacant).

EDWIN evaluation also has a high correlation to perceptions of clinicians'. This tool is based on four data points. The number of ED patients, number of EP, number of ED beds, and admitted patients waiting for an inpatient bed. Like READI scale, EDWIN is real-time analysis and its activity is divided into three zones: an active but manageable ED score of <1.5, a busy ED with scores between 1.5 and 2, and a crowded ED with score >2.

Cohen's weighted k was used to assess the EDEP and EDANS inter-rater reliability, and these calculations were based on differences between observed agreement and level of the agreement due to random chance. Linear association for each crowding scales was calculated using the Pairwise Spearman correlation coefficient (*r*).

Results

During the study period, a total of 8863 patients visited ED, with an average of 146 patients daily (range from 93 to 206, standard deviation [SD] 21.56). During

2 months study duration a total database of 360 NEDOCS, READI, and EDWIN scores samplings along with perceptions of the EDEP and EDANS were collected.

The perceptions of ED overcrowding as noted by EDEP and EDANS, taken on the Likert scale (>4 taken as overcrowding), was 83.34% and 86.67% of the samplings [Figures 1 and 2]. Table 1 shows EDEP and EDANS responses to the six-point survey instrument and agreement matrix of sampling instances. Table 2 presents the weighted Cohen's kappa agreement between the subjective perceptions of EDEP and EDANS variables with the objective NEDOCS, READI, and EDWIN scale scores. The kappa agreement between EDEP perceptions and NEDOCS, READI, and EDWIN scales were $\kappa = 0.000$ (confidence interval [CI]: 0.00–0.031), $\kappa = 0.000$ (CI: 0.00–0.013), and $\kappa = 0.028$ (CI: 0.00–0.003) while for EDANS values were found to be $\kappa = 0.000$ (95% CI: 0.00–0.033), 0.000 (95% CI: 0.00–0.015), and $\kappa = 0.326$ (95% CI: 0.297–0.355), respectively. The results, thereby determine that these scales are a generalized solution to measure ED crowding.

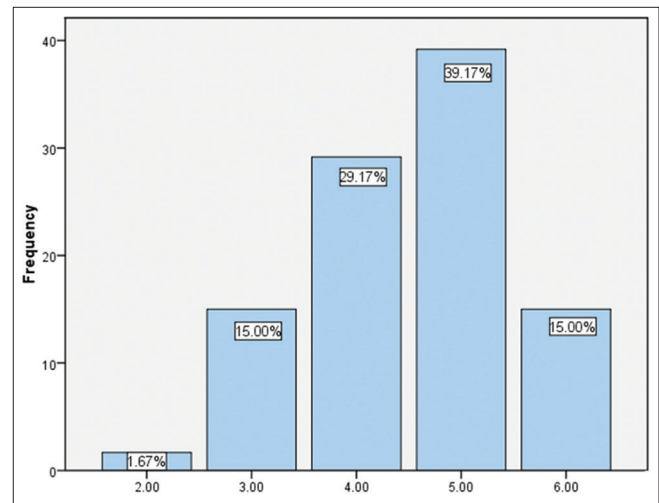


Figure 1: EDEP overcrowding scoring (likert scale)

Table 1: Frequency table for emergency department emergency physician/emergency department assistant nursing superintendent responses

EDEP rating	EDANS rating				
1	2	3	4	5	6
2	0	6	0	0	0
3	6	36	12	0	0
4	0	0	70	35	0
5	0	0	23	112	6
6	0	0	0	6	48

The frequency distribution of EDEP and EDANS responses to a six-point ED crowding tool. Rating 2 shows that ED is not crowded while rating 6 points about extremely busy and overcrowded ED. Exact agreement instances are shown bold. EDEP=Emergency department emergency physician, EDANS=Emergency department assistant nursing superintendent

Table 3 represents the sensitivity, specificity values for each of these scales. The predictive value was found to be 5.24 (SD 0.49) for the comparable scales. Table 4 displays the summary statistics for all of the computed crowding scales. The results showed that all the three scales have significant correlation [Figure 3]. NEDOCS and READI had highest level of correlation coefficient ($r = 0.662, P < 0.01$), whereas READI and EDWIN shows least correlation coefficient value ($r = 0.155, P < 0.01$).

Discussion

Overcrowding in healthcare organizations is a major problem worldwide which is often perceived by healthcare staff but has been difficult to determine quantitatively, yet, in literature different crowding measurement scales have been derived^[15,16,34] and as in most of the studies, NEDOCS has shown the best discriminative properties for overcrowding in the

ED.^[10,15,41] In the present study, three scales (NEDOCS, READI, and EDWIN) were studied and all these scales have provided good predictive power of ED overcrowding. These scales support the theory that there occur different underlying ED crowding determinants and NEDOCS and READI capture this construct.^[35] The degree of agreement for both subjective variables between EDEP and EDANS was quite high (63.88%), stating the fact that there was a degree of consensus among EDEP and EDANS as ED overcrowding is perceived even at different moments.

Studies have shown varying agreement scores between subjective feelings of EDEP and EDANS and objective ED overcrowding measuring instruments.^[10,41] Of all the samples, NEDOCS scored 356 (98.8%), thereby inferring that ED crowding in the present study ranged from “overcrowded” to “dangerous”. Similar were the findings with EDWIN (above 1.5) which scored 352 (97.8%) and findings varied from “very busy” to “crowded” ED. The findings were so as the study was done relatively during the summer season or onset of the summer season where patient load is comparatively on

Table 2: Degree of agreement between the subjective and national emergency department overcrowding scale, real-time emergency analysis of demand indicators, and emergency department work index

Overcrowding scales	EDEP	EDANS
NEDOCS	$\kappa=0.000$ (95% CI: 0.00–0.031) $\rho: 0.000$ (95% CI: 0.00–0.003)	$\kappa=0.000$ (95% CI: 0.00–0.033) $\rho: 0.000$ (95% CI: 0.00–0.003)
READI	$\kappa=0.000$ (95% CI: 0.00–0.013) $\rho: 0.000$ (95% CI: 0.00–0.003)	$\kappa=0.000$ (95% CI: 0.00–0.015) $\rho: 0.000$ (95% CI: 0.00–0.003)
EDWIN	$\kappa=0.028$ (95% CI: 0.00–0.003) $\rho: 0.007$ (95% CI: 0.00–0.008)	$\kappa=0.326$ (95% CI: 0.297–0.355) $\rho: 0.000$ (95% CI: 0.00–0.003)

NEDOCS=National emergency department overcrowding study, READI=Real-time emergency analysis of demand indicators, EDWIN=Emergency department work index, EDEP=Emergency department emergency physician, EDANS=Emergency department assistant nursing superintendent, CI=Confidence interval

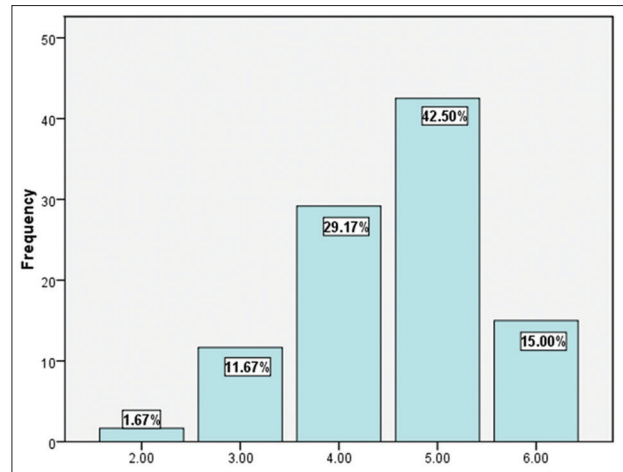


Figure 2: ED ANS overcrowding scoring (likert scale)

Table 3: Sensitivity and specificity values for each of the scales

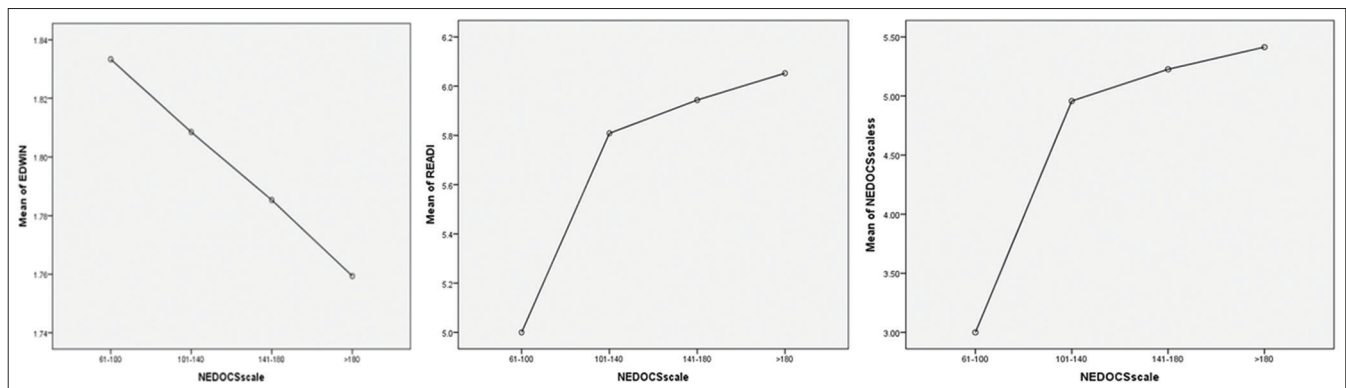


Table 4: Statistics for crowding scales

Crowding scale	Median	Interquartile	Range	Mean	SD
NEDOCS	5.00	5.00–6.00	3.00–6.00	5.24	0.72
READI	6.00	5.00–6.00	5.00–7.00	5.96	0.70
EDWIN	2.00	1.5–2.00	1.5–2.0	1.78	0.24

NEDOCS=National emergency department overcrowding study, READI=Real-time emergency analysis of demand indicators, EDWIN=Emergency department work index, SD=Standard Deviation

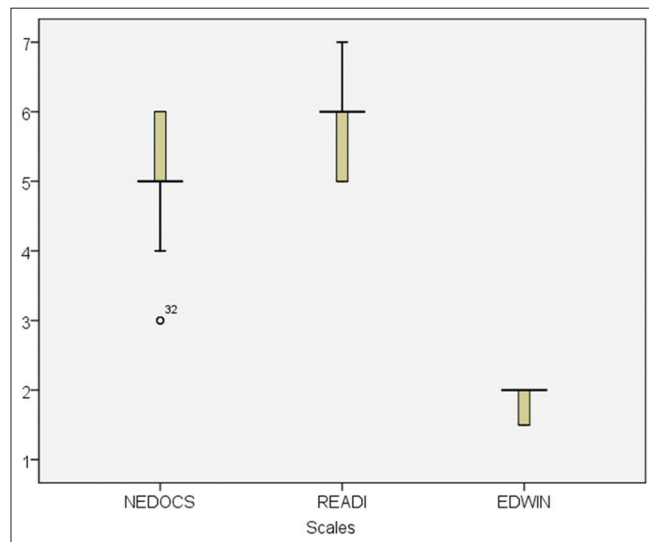


Figure 3: Statistics for crowding scales

a higher side. The degree of crowding was 98.8% for the NEDOCS scale (with values 4 or higher), for the READI scale it was in 97.8% and for EDWIN in 98.8%, similarly, EDEP and EDANS rated the degree of crowding Likert scale (>4 taken as overcrowding) in 83.34% and 86.67%, respectively. The findings implied that with a higher NEDOCS score, subjective feelings are also overrated. Furthermore, the degree of agreement between EDEP and EDANS and NEDOCS scale was significant; $\kappa = 0.000$ (CI: 0.00–0.031) and $\kappa = 0.000$ (95% CI: 0.00–0.033) respectively, hence, perceptions of being rushed was found quite high. Similar were the findings for the degree of agreement between EDEP and EDANS and READI and EDWIN scales. Therefore, when healthcare staff has a perception of being crowded, these tools can be used to quantify healthcare staff's subjective feelings of overcrowding and assess if there exists is a situation of overcrowding.

In a study by Peña-Orellana *et al.*^[42] it has been reported that ED overcrowding is one of the common features in hospitals of Puerto Rico and it endangers the ability of ED to respond in an effective way in case of MCIs. Similarly, in a study by Yang and Shih^[43] MCI management protocols specifically are aimed to MCI patients on priority and lead to a conflicting situation in the distribution of limited resources among MCI and already admitted non MCI patients. Therefore, an effective management protocol, efficient patient flow,

detailed planning, training, and disaster drills, shifting relatively stable patients to other support facilities are very much crucial for handling MCIs, thereby decreasing load in receiving hospitals. Regularly overcrowded ED hinders the hospitals' ability to meet the increased requirements in crises and appropriately prioritize treatments on the basis of urgency. Thus, in already overcrowding EDs when MCI victims require hospitalization, different measures such as transferring stabilized patients to adjoining community hospitals, efficient patient flow within the hospital, effective implementation of the defined protocols, ambulance diverting are required to ensure adequate care for all patients.

Conclusion

ED overcrowding is an increasingly identified issue across the world, especially in developing countries, and overcrowding can be evaluated objectively using quantitative tools along with subjective impressions. Since, the evidence is clear of ED overcrowding harms, as interim arrangement measure can be initiated to provide the urgent needed medical care, and on the other hand, a future workup is also need of the hour to systematically evaluate interventions and guide evidence-based policies.

Ethical approval

Ethical approval was taken from Institute Ethics Committee.

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Conflicts of interest

There are no conflicts of interest.

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