SHORT REPORT

Comparison of NEWS2 and PSI as mortality predictors in patients with community acquired pneumonia

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Abstract

In the West, National Early Warning Score 2 (NEWS2) is commonly applied to predict the severity of illness using only bedside variables unlike the extensive Pneumonia Severity Index (PSI). The objective of this study was to compare these scores as mortality predictors in patients admitted with community acquired pneumonia (CAP). This cross-sectional study was conducted in Jinnah Postgraduate Medical Centre, Karachi, Pakistan, for six months in 2020 on 116 patients presenting with CAP. Cases of aspiration pneumonia, hospital acquired pneumonia, pulmonary tuberculosis, pulmonary embolism, and pulmonary oedema were excluded. In-hospital mortality was taken as the outcome of this study. The mean age of the participants was 46.9±20.5 years. The in-hospital mortalities were 45(38.8%). NEWS2 was 97.8% sensitive but only 15.5% specific in predicting the outcome, whereas PSI was less sensitive (68.9%) but more specific (50.7%), which showed that in comparison with PSI, NEWS2 is a more sensitive mortality predicting score among hospitalised CAP patients.

Keywords: Community acquired pneumonia, Mortality predictor, NEWS2, PSI.

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Introduction

Community acquired pneumonia is a leading cause of hospitalisation worldwide. In the US, it is the top-most infectious killer.[1] Third world countries like Pakistan are no exception.[2]

This illness cripples the healthcare system in the developed world both economically and clinically despite the hospitals being fully equipped, and the situation only gets worse in the resource-poor settings in the developing countries.[3,4] Moreover, rates of hospital admissions for CAP are significantly inconsistent, one reason being the physicians' conflicting and variable approach to the severity assessment at the time of presentation.[5,6]

In recent ATS/IDSA guidelines,[7] although Pneumonia Severity Index (PSI) has been preferred over CURB-65 score, it requires time and resources and cannot be solely relied upon; therefore, clinical judgment is still called for.[7]

The score that has gathered attention recently is National Early Warning Score 2 (NEWS2) which works on the idea that haemodynamic instability foreshadows the clinical worsening and considers vital signs, state of consciousness, oxygenation, and need for supplemental oxygen therapy in the severely ill. It also ascertains the cautious use of oxygen in chronic hypercapnic patients.[8] Since CAP is associated with severe illness and mortality, NEWS2 can be incorporated into clinical practice for initial assessment.[9]

This score has been used in only one study in Pakistan, mainly done on COVID-19 patients.[10] However, it has not been studied in patients with community acquired pneumonia and its validity has not been compared with PSI in any study. Thus, this study aims to compare these scores to predict the in-hospital mortality in cases of CAP.

Patients/Methods and Results

This cross-sectional analytical study was conducted over a period of six months from June to November 2020 at the pulmonology ward, Jinnah Postgraduate Medical Centre (JPMC), Karachi, after receiving approval from institutional review board committee of JPMC, Karachi, (NO.F.2-81/2020-GENL/42870/JPMC). The patients were enrolled in the study after taking proper informed consent.

Through non-probability convenience sampling, a total of 116 hospitalised patients, age 12 years or more, and who met the inclusion criteria of clinico-radiological diagnosis of CAP were selected. The sample size was calculated using the formula n = (Zα/2) 2 *Var (AUC) / d 2 taking AUC as 0.71.[11] The decision for hospitalisation was taken if the subjects presented with any of the minor criteria of ATS/IDSA CAP severity criteria[7] and were admitted to the ICU if one major or three minor criteria were met. Patients with aspiration pneumonia, hospital acquired pneumonia, pulmonary tuberculosis, pulmonary embolism, COVID-19, and pulmonary oedema were excluded from the study. The primary outcome of our study was in-hospital mortality. PSI

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and NEWS2 scores were applied on each patient and the severity was calculated through both scores. Patients with NEWS2 score of <5 were deemed low risk and >5 were high risk. Patients with PSI score < 91 were low risk and those with score >91 were considered high risk. Variables such as gender, age, and other clinical indicators of disease severity were also studied.

SPSS version 22.0 was used for statistical analysis. Predictive validity of each score was evaluated utilising receiver operating characteristic (ROC) curve (for estimating AUC) with sensitivity analyses in relation to in-hospital outcome. Kolmogorov-Smirnov test was used to assess the normality by exploring all numeric variables and severity scores of NEWS2 and PSI. Non-parametric Wilcoxon Mann Whitney test was employed to compare all the numeric variables which were presented as median and were expressed as frequencies and percentages. The McNemar test served to evaluate cross validation of NEWS2 scores with PSI after stratification of these variables. Sensitivity analyses for the scores were performed considering in-hospital mortality as gold standard. Categorical variables such as in-hospital outcome, gender, and clinical indicators of the disease severity were shown as frequencies and percentages. Logistic regression analysis was performed in order to assess the impact of factors predicting mortality during hospital course. A $p \leq 0.05$ was deemed statistically remarkable.

Of the 116 patients, 75 (64.7%) were males and 45 (35.3%) were females. The mean age was 46.9±20.5 years. Forty-five (38.8%) patients died during the hospital stay. At a score cut-off of 5 or more (as high risk), NEWS2 identified 104 (89.7%) patients as being at high risk of death, while 12 (10.3%) at a low risk. PSI, however, identified 66 (56.9%) as high risk (score cut-off 91 or more) and 50 (43.1%) as low risk patients.

Sensitivity of NEWS2 in predicting in-hospital mortality in patients with CAP was 97.8% as 44 out of 45 cases who expired were classified as high risk by NEWS2. But it demonstrated low specificity; recognising only 11 (15.5%) of the 71 survivors as low risk at admission. Thus, NEWS2 fails to be an acceptable tool for detecting true negatives. The PSI, on the other hand, exhibits reasonable sensitivity (68.9%) and specificity (50.7%) as a mortality predictor. (Table-1). Sensitivity analysis of predictive scores is given in relation to the in-hospital outcome. On cross-validation, there was remarkable concordance between the predictive risk scorings of NEWS2 and PSI (Table-2).

Predictive validity of NEWS2 in terms of ROC [AUC: 0.725 (95% CI: 0.632-0.818), p=0.000] made evident the utility of the score in prediction of in-hospital morality, quite similar to that of PSI [AUC: 0.669 (95% CI: 0.568-0.769), p=0.002] (Figure). Logistic regression analyses uncovered stroke (OR=8.75, 95% CI: 0.99-77.5) and renal disease (OR=14.5, 95% CI: 1.67-125) as two predictors of severity that led to mortality Table-3).

Table-1: Predictive value of NEWS2 and PSI in relation to in-hospital mortality.

Predictive scores	In-hospital outcome		Sensitivity	Specificity	PPV	NPV
	Died	Survived				
NEWS2						
High risk (≥5)	44 (97.8)	60 (84.5)	97.8%	15.5%	42.3%	91.7%
Low risk (<5)	1 (2.2)	11 (15.5)				
PSI						
High risk (≥91)	31 (68.9)	35 (49.3)	68.9%	50.7%	47.0%	72.0%
Low risk (<91)	14 (31.1)	36 (50.7)				

Values given in parentheses are percentages. Sensitivity analysis of predictive scores is in relation to the in-hospital outcome; PSI- Pneumonia Severity Index

Table-2: NEWS2 and PSI Predictive Values' Comparison.

NEWS2 versus PSI	National early warning score 2 (NEWS2)		*p*-value
	Low risk (<5) (n=12)	High risk (≥5) (n=104)	
NEWS2 [Median (IQR)]	3.0 (1.25-4.0)	9 (7.0-10.0)	<0.001[a]
PSI [Median (IQR)]	77.5 (58.5-118.8)	105 (78.0-134.0)	0.086[a]
Low risk (<91)	7 (58.3%)	43 (41.3%)	<0.001[b]
High risk (≥91)	5 (41.7%)	61 (58.7%)	

[a] Statistical significance between Median (IQR: interquartile range) by using Wilcoxon Mann Whitney test.; [b] Statistical significance between percentages by using McNemar test of paired categorical data set for cross validation of NEWS2 with PSI; PSI- Pneumonia Severity Index; NEWS2- National Early Warning Score 2.

Table-3: Factors' analyses for severity of CAP and in-hospital mortality.

Factors	In-hospital outcome		Odd ratio (95% CI)	*p*-value
	Expired (n=45)	Alive (n=71)		
Gender				
Male	31 (41.3)	44 (58.7)	1.36 (0.62-3.0)	0.448
Female	14 (34.1)	27 (65.9)		
Age groups (years)				
≤20	17 (37.8)	34 (47.9)	--	
41–60	16 (35.6)	20 (28.2)	1.60 (0.66-3.85	
>60	12 (26.7)	17 (23.9)	1.41 (0.55-3.62)	
Hypertension	14 (31.1)	17 (23.9)	1.43 (0.62-3.30)	0.395
Diabetes mellitus	11 (24.4)	17 (23.9)	1.03 (0.43-2.45)	0.951
Asthma	0 (0)	4 (5.6)	0.16 (0.01-3.13)	0.105
Tuberculosis	1 (2.2)	6 (8.5)	0.25 (0.03-2.11)	0.170
Chronic Obstructive Pulmonary Disease	2 (4.4)	15 (21.1)	0.20 (0.04-0.93)	0.013
Liver disease	0 (0)	3 (4.2)	0.22 (0.01-4.26)	0.162
Heart failure	2 (4.4)	1 (1.4)	3.26 (0.29-37.0)	0.315
Stroke	5 (11.1)*	1 (1.4)	8.75 (0.99-77.5)	0.021
Ischaemic heart disease	8 (17.8)	9 (12.7)	1.49 (0.53-4.20)	0.449
Renal disease	6 (13.3)*	1 (1.4)	14.5 (1.67-125)	0.009
Other comorbid (s)	3 (6.8)	3 (4.2)	1.62 (0.31-8.40)	0.911
Smoker	5 (11.1)	11 (15.5)	0.68 (0.22-2.11)	0.505
Ex-Smoker	6 (13.3)	7 (9.9)	1.41 (0.44-4.49)	0.563

Values given in parentheses are percentages. *Show significantly higher proportion at 5% level of significance.

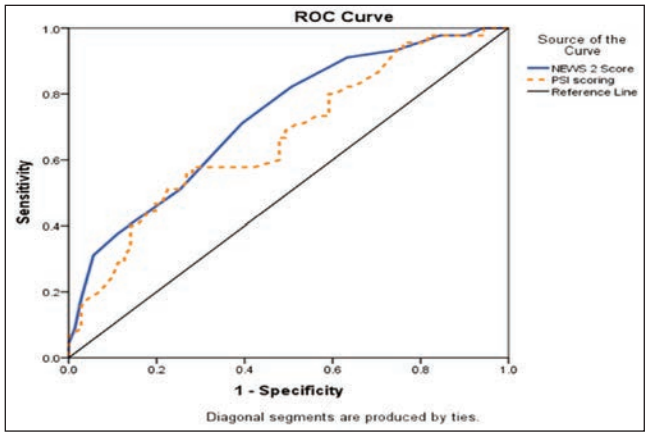

Figure: ROC curves for NEWS2 and PSI

[AUC (95% CI), p-value] for NEWS2 = [0.725 (0.632-0.818), p=0.000]. [AUC (95% CI), p-value] for PSI = [0.669 (0.568-0.769), p=0.002].

Discussion

The study results show that NEWS2 is highly sensitive but less specific in predicting death during the course of admission in patients with community acquired pneumonia. PSI, however, was observed to be a less sensitive but more specific score. Therefore, NEWS2 failed to qualify as an ideal score to predict in-patient mortality with pneumonia because of being less specific. But this score should be used in settings with scarce resources because it is easy to use and rarely misses any critical case.

A prospective cohort study, which was carried out over a period of six years in six tertiary care hospitals in Switzerland, compared PSI, NEWS, and CURB-65 and noted that the adverse events were better predicted by NEWS, which takes into account current clinical parameters. Conversely, PSI and CURB-65 outperformed NEWS in the prediction of all-cause mortality because the age of the patients and their co-morbid conditions were taken into consideration. Patients who were young and had very few or no co-morbid conditions but did need ICU admission and were missed by PSI and CURB-65 were tracked well by NEWS.[9]

In the current study, NEWS2 was preferred over NEWS because it has been recently updated and takes into account those patients with chronic lung disease who require more cautious use of supplementary oxygen in contrast to patients with previously healthy lungs.[8]

Various scoring systems were compared in another single centre study performed in China keeping mortality as their primary outcome. NEWS outdid all of those including PSI as a mortality predictor similar to our finding.[12]

An interesting study performed in a tertiary care hospital in Karachi by Maqsood A. Khan et al revealed that around half of the study population admitted in hospital with the diagnosis of community acquired pneumonia could be managed as out patients when PSI was applied to categorise them in severity classes similar to the present study in which 43.1% patients had low risk and could be managed as outpatients. However, NEWS2 was not used for comparison in the earlier study.[13] Another nation-wide cross-sectional study done across 10 cities in Pakistan showed that 37.50% patients were hospitalised despite the recommendation for out-patient treatment using CURB-65, but neither PSI nor NEWS2 were applied.[6]

A study performed in a tertiary care hospital in Pakistan,[14] to evaluate the risk factors associated with in-patient mortality revealed that admission to high dependency unit (HDU), multi-lobar CXR infiltrates, bedridden status, and anaemia with Hb 10.4 g/dL or less (at admission) were independently associated with in-hospital mortality. Whereas analysis of the current study brought forth stroke and renal disease as independent risk factors for in-patient mortality. The score used in the earlier study to categorise patients according to disease severity was CURB-65.[14]

A multicentre prospective cohort study was performed in Karachi, Pakistan, on 108 COVID-19 patients in which NEWS2 was used to stratify patients according to the severity of illness as critical if they scored above 6. NEWS2 was observed to be around 78% sensitive and 89.4% specific. But they did not include patients with community acquired pneumonia and did not use PSI in their study.[10]

The absolute strength of the present work is its originality. It is the first study in Pakistan comparing NEWS2 and PSI as predictors of mortality in hospitalised patients with pneumonia.

However, the limitations are that this study was conducted during the pandemic where majority of the patients who had mild lower respiratory infections were treated via online consultation and those with severe infection were initially admitted in COVID isolation before their COVID infection was ruled out via two negative PCR results and were then transferred to our ward. So there is a possibility that those patients if scored early in our study might have affected the results. Secondly, the patients were scored only at the time of admission. NEWS2 scores were not used again during the hospital course to assess change in the disease severity and thus risk status. It may be safe to assume that if NEWS2 had been calculated at different intervals during the hospital stay, its specificity may have been better. Most studies, including this, have seen the short-term mortality of patients when evaluating the scoring systems. Further studies can also look at how NEWS2 performs during extended follow-up of survivors.

Conclusion

When it comes to caring for patients presenting with community acquired pneumonia, NEWS2 serves as an extremely valuable and sensitive tool for physicians working in resource-poor settings where well-timed, life-saving decisions can be taken based solely on its score without having to expend precious funds and time on further tests that are accounted for in PSI.

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References

1. Xu J, Murphy SL, Kochanek KD, Bastian B, Arias E. Deaths: final data for 2016. National vital statistics reports: from the Centres for Disease Control and Prevention, National Centre for Health Statistics, National Vital Statistics System. Natl Vital Stat Rep. 2018; 67:1-76.
2. Dahn CM, Wijesekera O, Garcia GE, Karasek K, Jacquet GA. Acute care for the three leading causes of mortality in lower-middle-income countries: A systematic review. Int J Crit Illn Inj Sci. 2018; 8:117-42. doi: 10.4103/IJCIIS.IJCIIS_22_18.
3. Huang SS, Johnson KM, Ray GT, Wroe P, Lieu TA, Moore MR, et al. Healthcare utilisation and cost of pneumococcal disease in the United States. Vaccine. 2011; 29:3398-412. doi:10.1016/j.vaccine.2011.02.088.
4. Rozenbaum MH, Mangen MJ, Huijts SM, van der Werf TS, Postma MJ. Incidence, direct costs and duration of hospitalisation of patients hospitalised with community acquired pneumonia: a nationwide retrospective claims database analysis. Vaccine. 2015; 33:3193-9. doi:10.1016/j.vaccine.2015.05.001.
5. Fine MJ, Auble TE, Yealy DM, Hanusa BH, Weissfeld LA, Singer DE, et al. A prediction rule to identify low-risk patients with community-acquired pneumonia. N Eng J Med. 1997; 336:243-50. doi:10.1056/NEJM199701233360402.
6. Ullah S, Khan J, Khan A, Hashemy I. Assessing decision of inpatient or outpatient care in community acquired pneumonia: APT care study. J Pak Med Assoc. 2017; 67:380-5.
7. Metlay JP, Waterer GW, Long AC, Anzueto A, Brozek J, Crothers K, et al. Diagnosis and Treatment of Adults with Community-acquired Pneumonia. An Official Clinical Practice Guideline of the American Thoracic Society and Infectious Diseases Society of America. Am J Respir Crit Care Med. 2019; 200:e45-e67. doi: 10.1164/rccm.201908-1581ST.
8. Williams B. The National Early Warning Score 2 (NEWS2) in patients with hypercapnic respiratory failure. Clin Med. 2019; 19:94. doi: 10.7861/clinmedicine.19-1-94.
9. Sbiti-Rohr D, Kutz A, Christ-Crain M, Thomann R, Zimmerli W, Hoess C. The National Early Warning Score (NEWS) for outcome prediction in emergency department patients with community-acquired pneumonia: results from a 6-year prospective cohort study. BMJ Open. 2016; 6:e011021. doi: 10.1136/bmjopen-2015-011021.
10. Baig FA, Hamid A. Predictive performance of the National Early Warning Score 2 for stratification of critically Ill COVID-19 patients. Eurasian J Emerg Med. 2023; 22:49-54. doi: 10.4274/eajem.galenos.2023.99075.
11. Brabrand M, Henriksen DP. CURB-65 Score is Equal to NEWS for Identifying Mortality Risk of Pneumonia Patients: An Observational Study. Lung. 2018; 196:359-61. doi: 10.1007/s00408-018-0105-y.
12. Zhou HJ, Lan TF, Guo SB. Outcome prediction value of National Early Warning Score in septic patients with community-acquired pneumonia in emergency department: A single-centre retrospective cohort study. World J Emerg Med. 2020; 11:206-15. doi: 10.5847/wjem.j.1920-8642.2020.04.002.
13. Khan MA, Zeb-un-nisa, Ali SI, Kashif SS, Zafar F, Ali H, et al. Profile and management of community acquired pneumonia in a tertiary care hospital in Karachi. Int J Med Med Sci. 2018; 10:31-5.
14. Iqbal N, Irfan M, Siddique F, Arshad V, Zubairi ABS. Factors predicting in-hospital mortality among patients admitted with community acquired pneumonia at a tertiary care hospital Karachi, Pakistan. Clin Respir J. 2020; 14:328-34. doi: 10.1111/crj.13137.

Author Contribution:

NK: Concept, literature search, questionnaire design, data collection, writing.
NS: Study design, data interpretation, revision.
SJ: Concept, data collection, drafting.
AA: Questionnaire design, literature search.
NJ: Drafting, revision.
NA: Concept, study design.